Proposed T3 Copper Mine Project

Loci Environmental Pty Ltd

Environmental and Social Impact Statement

17EIA039TM – RP06 – D07

1st June 2020

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Quality statement

I hereby confirm that this report has been independently and objectively compiled and meets the required project scope and quality.

Name:	Position:	Signature:	Date:
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Executive Summary

This document is the detailed Environmental and Social Impact Assessment (ESIA) report for the proposed T3 Copper Mine Project – to be named “Motheo Mine” (hereafter referred to as “The Project”) in the Ghanzi District of Botswana. The Project will involve development of an open pit copper mine, a processing plant (concentrator) and associated infrastructure required for the development and operation of the mine. The proposed mine site is located within the boundaries of a freehold farm (153-NL), at the Ghanzi Farming Block area. An agreement on (voluntary) purchase of the land has been reached with the farmer, and no resettlement is required for the project.

The proponent of this Project is Tshukudu Metals Botswana (Pty) Ltd (hereafter referred to as “The Client” or “Tshukudu Metals”), which is a subsidiary of MOD Resources (Australia). Tshukudu Metals has engaged Loci Environmental (Pty) Ltd (Loci) to undertake the Environmental and Social Impact Assessment (ESIA) study for the Project, in accordance with the Environmental Assessment (EA) Act No. 10 of 2010, the Environmental Assessment Regulations of 2012, International Finance Corporation (IFC) Performance Standards (2012) and Equator Principles (2013). Loci has five practitioners registered with the Botswana Environmental Assessment Practitioners Association (BEAPA) on staff, with the project team leader for this project certified at the highest level as Principal Environmental Assessment Practitioner (PEAP).

Tshukudu Metals will be mainly staffed and supported by experienced Batswana employees, with specialist mining, processing safety and environmental expertise as needed. This will provide training by consultants and employees engaged by MOD Resources who have significant mining expertise gained in Australia. Australia is a world class mining jurisdiction with very high standards in all aspects of mining processes.

Project description

The Project scope for the T3 project, as assessed in this ESIA study, entails the open pit mine (with an expected mine life of 15 years – expansion case), waste dumps, tailings storage facility, processing plant and storage facilities for reagents and bulk fuel storage. It will have onsite support infrastructure including; temporary contractors camp, workshops, laboratory, offices and warehouses, a weighbridge, an electrical substation (220/22/11kV) with back-up power generators and water bores with related infrastructure (power supply, water pipes). There will also be pollution control infrastructure, water treatment plant for potable water, and associated services (air, water and reagents) distribution infrastructure. Off-site infrastructure includes an accommodation camp near Ghanzi (separate assessment), exploration camp(s) and core processing for other exploration areas (not part of this assessment), a services corridor including overhead power line and access road will also be developed through Farms 110-NL and 111-NL, and along the southern boundary of Farm 112-NL. An agreement on (voluntary) purchase of the land has been reached with the farmer on 111-NL and negotiations continue on 110-NL and 112-NL, and no resettlement is required for the project.

Policy, legal and administrative framework

The assessed project is required to conform to current policies, legal requirements, regional conventions and international obligations to which Botswana is a signatory. This includes relevant policies and legal instruments in operation, especially related to land use, resource conservation, and pollution control.

Methodology

The ESIA was carried out in accordance with the EA Act No. 10 of 2010. The overall process includes pre-ESIA reports and documentation including, submission of a Project Brief (screening phase), Scoping Studies (scoping phase), and Environmental Terms of Reference. Documentation and response or approval letters related to these submissions and reports are included in the ESIA appendices. The ESIA scoping process was undertaken and scoping approval received on 2nd August 2018 (reference DEA/GH/BOD/EXT/MINE 009 (5).

Public consultation was carried out during the scoping phase, also in line with the EA Act and its associated guidelines for public consultation methodology. This includes methods, documents and advertisement for public meetings, as well as stakeholder and Interested and Affected Parties (IAPs) consultation. Key informant interviews at national, district, and local levels were also conducted.

Specialist environmental consultants were involved in the undertaking of this ESIA, following the identification of key environmental and social areas which may be affected by the project as identified during the Scoping phase of the environmental assessment process. These included scientists and consultants in the fields of biodiversity, archaeology, hydrogeology, hydrology, geochemistry, soils, traffic, noise, air quality, landscape and visual amenity, waste management, health and social, cultural heritage and closure. The specialist studies were carried out through baseline studies involving desktop research and analysis of existing mapping and published data relevant to the study area, followed by site visits to the study area to assess the environmental conditions that are currently present.

Different methodologies were used to identify and assess possible environmental impacts that may result from the proposed project, these included the following:

- Site visits and surveys
- Checklists
- Modelling
- Interaction matrices
- Networks and overlays
- Geographic information system (GIS)
- Professional judgment.

Receiving environment and assessed impacts

The proposed development is in the Ghanzi District of Botswana, approximately 70km north east of Ghanzi village and 200km south of Maun. The project area is accessible via the A3 Ghanzi-Maun road, from where two existing farm access tracks can be used to reach the site (each approx. 12km in length). Based on detailed surveys and assessments, the potential impacts related to the project were identified. Such impacts may include (both positive and negative):

Table 1: Summary of impact table

Parameter	Description of Impacts	Significance (Profound, Significant, Moderate, Slight or Negligible)	Scale of Change			Description of Mitigation Measures	Significance after Mitigation (Profound, Significant, Moderate, Slight or Negligible)
			(Positive, Neutral, Negative)	(Permanent, Long term, Medium term, Short term)	(Direct/Indirect)		
Ecology (Flora)	Loss of vegetation and disturbance of plant communities due to bush clearing	Significant	Negative, permanent, direct			All areas to be cleared should be precisely demarcated. Bush clearing should only be carried out within the agreed areas	Moderate
	Increased risk of invasive or encroacher flora species establishing due to bush clearing and soil disturbance	Moderate	Negative, permanent, indirect			Potential invasive flora species should be identified, and action must be taken to clear these species	Negligible
Ecology (Fauna)	Disturbance and alteration of faunal and avifauna habitats	Slight	Negative, medium term, direct			Any fauna directly threatened by construction activities should be relocated in accordance with Fauna Management	Negligible
	Risk of fauna fatalities due to collisions with moving equipment	Moderate	Negative, medium term, direct			Drivers to be aware of the danger that traffic poses to the local fauna. Speed limits must be enforced and strictly adhered to	Slight

Parameter	Description of Impacts	Significance (Profound, Significant, Moderate, Slight or Negligible)	Scale of Change			Description of Mitigation Measures	Significance after Mitigation (Profound, Significant, Moderate, Slight or Negligible)
			(Positive, Neutral, Negative)	(Permanent, Long term, Medium term, Short term)	(Direct/Indirect)		
Air Quality	Decline in air quality from the production of dust from the use of heavy mining equipment, materials handling and use of unpaved haul roads	Moderate	Negative, local, medium term, direct			Dust suppression, ensure roads are monitored for dust generation and frequent use of water cart	Slight to moderate
Groundwater Impacts	Local change of groundwater levels (cone of depression) due to mine de-watering	Moderate	Negative, medium term, direct			Monitoring of abstraction volumes Monthly water level measurements Annual update of the numerical groundwater flow model Liaison with borehole owners (2 based on studies) to maintain water	Moderate
	Risk of contamination of local groundwater	Slight	Negative, medium term, direct			Pollution control measures built suitable for the potential pollutant. Geochemical sampling and testing	Negligible
Noise	Increased noise levels	Moderate	Negative, local, medium term, direct			Maintenance of equipment and roads, annual auditing	Slight

Parameter	Description of Impacts	Significance (Profound, Significant, Moderate, Slight or Negligible)	Scale of Change (Positive, Neutral, Negative)	Scale of Change (Permanent, Long term, Medium term, Short term)	Scale of Change (Direct/Indirect)	Description of Mitigation Measures	Significance after Mitigation (Profound, Significant, Moderate, Slight or Negligible)
Traffic	Increased number of road traffic accidents	Slight	Negative, medium term, direct			Maintain speed restrictions and follow all road rules. Dust suppression on unsealed roads Undertake road safety awareness campaigns	Slight
Waste	Risk of land pollution due to waste generated	Moderate	Negative, medium term, direct			Recycling if within viable transport distance from recycling plants. Waste management plan development	Slight
Archaeology	Risk of loss or damage of archaeological materials and cultural heritage resources	Slight	Negative, permanent, direct			Archaeological monitoring during clearance and excavation. Any chance finds must be reported	Negligible
Occupational health and safety	Increased instances of HIV/AIDS and STI infections, increased occurrence of TB and malaria	Significant	Negative, permanent, indirect			Development and implementation of the HIV/AIDS, STI and TB Policy. Partnership with DMHT	Moderate

Parameter	Description of Impacts	Significance (Profound, Significant, Moderate, Slight or Negligible)	Scale of Change			Description of Mitigation Measures	Significance after Mitigation (Profound, Significant, Moderate, Slight or Negligible)
			(Positive, Neutral, Negative)	(Permanent, Long term, Medium term, Short term)	(Direct/Indirect)		
Socio-Economic	Creation of Employment	Significant	Positive, long term, direct and indirect			Roles will be advertised locally to ensure residents opportunity to apply. No hiring at the site. Regional or national recruitment centres should be established	Significant
	Regional economic development	Significant	Positive, long term, direct			Utilise the existing local business database to identify local SMMEs Establish linkages with other key stakeholders in the area involved in skills and SMME development	Significant
	Skills transfer and development	Significant	Positive, long term, direct			Liaison with Vocational Training Centres (VTCs) and schools to promote skills development Promote in-house (work) related training. LED and CSR programmes should (where still possible) be designed in consultation with community.	Significant

Mitigation of impacts anticipated will be implemented through methods discussed in the mitigation and monitoring plan. All parties involved in the project are expected to familiarise themselves with the recommendations. In addition to the mitigation and monitoring plan, a Contractors Code of Conduct has been developed, for inclusion in any contract documentation for the proposed project.

Environmental and Social management

To manage the environmental and social impacts predicted during the assessment process, a project Environmental and Social Management Plan (ESMP) was developed. This includes a summary of all potential environmental effects expected during construction, operation and decommissioning phases of the project, lists the proposed mitigation measures required to address each impact, and assigns responsibility to the relevant party tasked with implementing such mitigation of impacts.

The structure of the ESMP contained herein has been created by the DEA and communicated to EIA practitioners through guidance within the EA Act. The use of the EMP will be primarily by the Client and any contractors or employees of the Client during all stages (design, construction, operation, decommissioning) of the project, as a tool to avoid, reduce and remedy negative impacts (and enhance positive impacts) where applicable.

Most mitigation measures documented in the ESMP are applicable to the construction and operational phases and will therefore require involvement of designated staff in charge of environmental management and social engagement. This includes contractors, project managers and the Client, all of whom will be required to employ certified and experienced personnel in the fields of environment, health, safety, and quality, to be able to confidently and holistically implement the requirements of the ESMP on site during all phases of the project.

Conclusion and recommendation

It is imperative that there is full compliance with the mitigation and monitoring measures outlined within the Environmental and Social Management and Monitoring Plan. Where it is found mitigation measures are not effective, a review is required to identify other strategies to achieve the desired outcome. Some of the key aspects in this regard are:

- Regional monitoring boreholes are required to assess the expansion of the cone of depression, to indicate potential effects on private users and for updating the groundwater model (part of annual groundwater monitoring and reporting to WAB)
- Continuous wildlife monitoring, and liaison with relevant authorities.
- Vegetation monitoring.
- Regular noise and air quality monitoring.
- Employment of a social team to ensure social mitigation and enhancement as outlined in this report.
- Financial provision for closure, progressive closure development and implementation, integration of closure into operations.
- Regular consultation with local and national organisations to develop on going strategies to improve the outcomes of environmental monitoring and social engagement.

Much of the baseline studies were done during ESIA study based on details presented in the T3 Pre-feasibility Study (PFS) announced by MOD Resources in Jan 2018. The technical details in this report however reflect the project scope as per The Feasibility Study (FS), and the impact assessment and mitigation measures have been based on the project scope as presented in the FS study.

During the operational phase of the Project, it is also recommended that the management and monitoring plans are reviewed regularly and are updated to effectively manage the environmental impacts based on the latest site conditions.

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Abbreviations

ABA	Acid Base Accounting
Ag	Silver
AIA	Archaeological Impact Assessment
AIDS	Acquired Immune Deficiency Syndrome
ALT	Alternating Units
ANC	Acid Neutralising Capacity
AP	Acid Potential
ARD	Acid Rock Drainage
ARI	Acute Respiratory Infections
ARV	Anti-Retroviral Drugs
A3	Road between Ghanzi and Maun
BCL	Bamangwato Concession License
BDF	Botswana Defense Force
BEAPA	Botswana Environmental Practitioners Association
BIDPA	Botswana Institute for Development Policy Analysis
BNMM	Botswana National Museums and Monuments
BOBS	Botswana Bureau of Standards
BPC	Botswana Power Corporation
CBD	Convention on Biological Diversity
CBNRM	Community Based Natural Resource Management
CBO	Community-Based Organisation
CCB	Cheetah Conservation Botswana
CDM	Clean Development Mechanism
CECO	Contractors Environmental Control Officer
CFR	Conservation-Forced Resettlement
CHMP	Comprehensive Health Management Plan
CITES	Convention on International Trade in Endangered Species
CKGR	Central Kgalagadi Game Reserve
CM	Contracts Manager
CSI	Corporate Social Responsibility Initiatives
CSR	Corporate Social Responsibility
Cu	Copper
dBA	Decibel – A weighting
DDP	District Development Plan
DEA	Department of Environmental Affairs
DFRD	Development-Forced Displacement and Resettlement
DTM	Digital Terrain Model
DTRP	Department of Town and Regional Planning
DWA	Department of Water Affairs
DWMPC	Department of Waste Management and Pollution Control

DWNP	Department of Wildlife and National Parks
EA	Environmental Assessment
EA Act	Environmental Assessment Act
EC	Electric Conductivity
ECO	Environmental Control Officer
EAP	Environmental Assessment Practitioner
EHS	(World Bank Group) Environmental Health and Safety Guidelines
EO	Environmental Officer
ESIA	Environmental and Social Impact Assessment
EMMP	Environmental Management and Monitoring Plan
ESMP	Environmental and Social Management Plan
EPA	(USA) Environmental Protection Agency
ES	Environmental Statement
ESIA	Environmental and Social Impact Assessment
ESIS	Environmental and Social Impact Statement
ESMS	Environmental and Social Management Plan
FDA	First Development Area
FGD	Focus Group Discussion
FHH	Female-headed Households
FPK	First People of the Kalahari
GARD	Global Acid Rock Drainage (Guide)
GDDP7	Ghanzi District Development Plan 7
GDP	Gross Domestic Product
GFB	Ghanzi Farm Block
GIIP	Good International Industry Practice
GIS	Geographical Information System
GPS	Global Positioning System
ha	hectare
HCRW	Health Care Risk Waste
HDPE	High Density Polyethene
HG	High Grade
HIA	Health Impact Assessment
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HSO	Health and Safety Officer
HWC	Human-Wildlife conflict
IAPs	Interested and Affected Parties
IBA	Important Bird and Biodiversity Area
IEC	Information, Education and Communication
IFC	International Finance Corporation
IIP	Incident Investigation Procedure
IUCN	International Union for Conservation of Nature
IWGIA	International Work Group for Indigenous Affairs

IWL	Integrated Waste Landform
JORC	Joint Ore Reserve Committee
JSS	Junior Secondary School
KAS	Kalahari Sands
KFO	Kuru Family of Organisations
KLOE	Key Line Of Enquiry
km	kilometre
Kt	Kilo-tonnes
Leq	Equivalent noise level
LG	Low Grade
LHD	Load-Haul-Dump
LLKII	Local Level Key Informant Interview
LMRL	Lower Marl Unit
LOD	Level of Detection
LoM	Life of Mine
LSI	Langelier Saturation Index
LST	Limestone Unit
m	metre
M&E	Monitoring and Evaluation
Mamsl	Metres above mean sea level
MAP	Mean Areal Precipitation
mbgl	Metres below ground level
MCC	Millennium Challenge Corporation
MDS	Material Data Sheet
MEA	Mean Areal Evaporation
MEWT	Ministry of Environment, Wildlife and Tourism
MFDP	Ministry of Finance and Development Planning
MIDR	Mining-Induced Displacement and Resettlement
ML	Metals Leaching
mlbs	Million Pounds
MLH	Ministry of Lands and Housing
MM	Mine Manager
MMEWR	Ministry of Minerals, Energy and Water Resources
MOA	Ministry of Agriculture
MOD	MOD Resources is the name of the Australian company who is 100% owner of Tshukudu Metals
MoZ	Million Ounces
MP	Member of Parliament
Mt	Million Tonnes
MSST	Marker Sandstone Unit
MTP	Medium Term Plan (for HIV/AIDS)
NACA	National Aids Coordinating Agency
NAG	Non Acid Generating

NAP	International Network for Acid Prevention
NAPP	Nett Acid Producing Potential
NDLKII	National, District and Local Key Informant Interview
NDP11	National Development Plan 11
NGO	Non-Governmental Organisation
NI	National Instrument
NMMAG	National Museum, Monuments and Art Gallery
NNP	Net Neutralisation Potential
Non PAG	Not Potentially Acid Generating
NP	Neutralisation Potential
NPR	Neutralising Potential Ratio
NWGTC	North West Grid Transmission Connection
ODMP	Okavango Delta Management Plan
OHRA	Occupational Health Risk Assessment
ORC	Okavango Research Centre
OVC	Orphans and Vulnerable Children
PAP	Project Affected Person
PEA	Preliminary Economic Assessment
PEAP	Principal Environmental Assessment Practitioner
PFC	Perfluorocarbons
PFS	Prefeasibility Study
PL	Prospecting License
PM	Project Manager
POP	Persistent Organic Pollutant
PPE	Personal Protection Equipment
PRA	Participatory Rural Appraisal
QQ	Quantitative Questionnaire
RAD	Remote Area Dweller
RADO	Remote Area Development Officer
RADP	Remote Area Development Programme
RAP	Resettlement Action Plan
RC	Reverse Circulation
ROM	Run of Mine
RSI	Ryznar Stability Index
S&CD	Social and Community Development
SABONET	Southern African Biodiversity Network
SADC	Southern African Development Community
SANS	South African National Standard
SB	Statistics Botswana
SCP	Stakeholder Consultation Plan
SD	Saline Drainage
SEIA	Social and Environmental Impact Assessment

SHE	Safety, Health and Environment
SHHA	Self Help Housing Agency
SIA	Social Impact Assessment
SIAPAC	Social Impact Assessment and Policy Analysis Corporation (Pty) Ltd.
SOIWDP	Southern Okavango Integrated Water Development Project
SPLP	Synthetic Precipitation Leach Protocol
SPR	Source-Pathway-Receptor
SSS	Senior Secondary School
SSW	Safe Systems of Work
STD	Sexually Transmitted Diseases
T1, T4	Other exploration areas (not part of this T3 project)
T3	Name of the project
TDS	Total Dissolved Solids
TGLP	Tribal Grazing Land Policy
ToR	Terms of Reference
TSF	Tailings Storage Facility
UB	University of Botswana
UNFCCC	United Nations Framework Convention on Climate Change
UTM	Universal Transverse Mercator
VDC	Village Development Committee
VTC	Vocational Training Centre
WAB	Water Apportionment Board
WB	World Bank
WHO	World Health Organisation
WIMSA	Working Group of Indigenous Minorities in South Africa
WMA	Wildlife Management Area
WUC	Water Utilities Corporation

Standard Units of Measure

The following detail outlines the standard units of measure used within this ESIA Report. This is based upon the International System of Units (SI):

- All monetary dollars are expressed in United States dollars ($) or Botswana Pula (BWP)
- Locational coordinates to be as per the Universal Transverse Mercator (UTM) projected coordinate system
- Weight
  - metric tonne (t) – 1,000 kilograms (kg)
  - kilograms (kg) – 1,000 grams (g)
  - grams (g)
- Distance
  - kilometres (km), metres (m), centimetres (cm) and millimetres (mm)
- Volume
  - cubic metre (m^3)
- Area
  - square kilometres (km^2) or hectares (ha)
- Copper
  - Grade is expressed as a percentage (%) of metal contained by weight
  - Total metal is represented as weight as pounds (lbs.)
- Silver
  - Grade is expressed as grams per tonne (g/t or g/t Ag)
  - Metal quantities are provided as a unit of weight, typically ounces (oz.) in which one ounce equals 31.104 grams.

Typically, all units of measure shall be presented in metric units, however some measurements may have been included in both imperial and metric terms where it is believed that this will assist the reader.

Glossary

Batswana	Citizens of Botswana. Plural (Motswana singular)
Air quality	A measure of exposure to air, which is not harmful to your health. Air quality is measured against health risk thresholds (levels), which are designed to protect ambient air quality. Various countries including South Africa have Air Quality Standards (legally binding health risk thresholds), which aim to protect human health due to exposure to pollutants within the living space.
Ambient air	The air of the surrounding environment.
Atmospheric pressure	The pressure created by the mass of air above a point or level; the total force per unit is the pressure.
Baseline	The current and existing condition before any development or action.
Climate	The integrated effect weather typical of a site or region.
Concentration	When a pollutant is measured in ambient air it is referred to as the concentration of that pollutant in air. Pollutant concentrations are measured in ambient air for various reasons, i.e. to determine whether concentrations are exceeding available health risk thresholds (air quality standards); to determine how different sources of pollution contribute to ambient air concentrations in an area; to validate dispersion modelling conducted for an area; to determine how pollutant concentrations fluctuate over time in an area; and to determine the areas with the highest pollution concentrations.
Continuous noise	Produced by machinery that operates without interruption in a continuous mode. This noise type is typical of factories and mines. Intermittent noise – is produced when noise levels increase and decrease rapidly, for example when a truck passes by, or when machinery operates in a cycle. A single instance of intermittent noise is referred to as a noise event.
Dispersion model	A mathematical model which can be used to assess pollutant concentrations and deposition rates from a wide variety of sources. Various dispersion modelling computer programs have been developed.
Dispersion potential	The potential a pollutant has of being transported from the source of emission by wind or upward diffusion. Dispersion potential is determined by wind velocity, wind direction, height of the mixing layer, atmospheric stability, presence of inversion layers and various other meteorological conditions.
Emission	The rate at which a pollutant is emitted from a source of pollution.
Emission factor	A representative value, relating the quantity of a pollutant to a specific activity resulting in the release of the pollutant to atmosphere.
Erosion	The lowering of the land surface by agents such as gravity, river flow, waves, currents, wind, etc that involve the transport of rock debris.
Evaporation	The dissipation of water into invisible water vapour.
Focus Group Discussion	A qualitative research approach involving extended discussions with homogeneous groups using a semi-structured instrument
Fugitive dust	Dust generated from an open source and is not discharged to the atmosphere in a confined flow stream.
Impulsive noise	The noise from impacts or explosions. It is brief and abrupt and startles people.
Inversion	An increase of atmospheric temperature with an increase in height.
Key Informant Interview	A qualitative research approach involving detailed, one-on-one interviews using a semi-structured instrument
Low frequency noise	Noise with a high energy content in the low frequency range. Typical examples are large diesel engines in transport and power plants. The noise is difficult to suppress and spreads easily

Motswana	A citizen of Botswana. Singular (Batswana plural)
Particulate matter (PM)	The collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface and includes dust, smoke, soot, pollen and soil particles. Particulate matter is classified as a criteria pollutant, thus national air quality standards have been developed to protect the public from exposure to the inhalable fractions. PM can be principally characterised as discrete particles spanning several orders of magnitude in size, with inhalable particles falling into the following general size fractions: ▪ PM_{10} (generally defined as all particles equal to and less than 10 microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung); ▪ $PM_{2.5}$, also known as fine fraction particles (generally defined as those particles with an aerodynamic diameter of 2.5 microns or less); ▪ $PM_{10\text{-}2.5}$, also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns); and ▪ Ultra-fine particles generally defined as those less than 0.1 microns.
PM_{10}	Refers to particulate matter that is 10 µm or less in diameter. PM_{10} is generally subdivided into a fine fraction of particles 2.5 µm or less ($PM_{2.5}$), and a coarse fraction of particles larger than 2.5 µm. Particles less than 10 µm in diameter are also termed inhalable particulates.
Precipitation	Ice particles or water droplets large enough to fall at least 100 m below the cloud base before evaporating.
Quantitative Survey	Survey conducted in a manner that allows the statistical generalisation of data from surveyed households to all households in the strata
Relative Humidity	The vapour content of the air as a percentage of the vapour content needed to saturate air at the same temperature.
Run of mine (ROM)	Raw material recovered from a mine, prior to any treatment.
Sesarwa	Term used in Botswana to describe a variety of San languages
Setswana	One of two official languages in Botswana (the other being English). The lingua franca of Botswana. Can also be used to describe 'Setswana culture'
Tonality in noise	Machinery with rotating parts often create noise with tonality. Tonality is characterised by the presence of one or several pure tones which can be identified through frequency analysis and the audibility calculated by comparing the tone level to the level of surrounding sound.
Total suspended particulates (TSP)	All particulates, which can become suspended and generally noted to be less than 75 µm in diameter (TSP).
Vehicle entrainment	The lifting of dust particles in the turbulent wake of a vehicle passing over an unpaved road or exposed area. The force of the wheels on the road causes pulverisation of the surface material and the particles are lifted and dropped by the rolling wheels.

1 Introduction

This document is the detailed Environmental and Social Impact Assessment (ESIA) report for the proposed T3 Copper Mine Project – to be named “Motheo Mine” (hereafter referred to as “The Project”) in Ghanzi District of Botswana. The Project will involve development of an open pit mine, a processing plant (concentrator) and associated infrastructure required for the development and operation of the mine. The proposed mine site is located within the boundaries of a freehold farm (153-NL), at the Ghanzi Farming Block area.

A service corridor of approximately 12.5km and 100m width will be established from the A3 road to the mine site. The proposed corridor will be developed within the footprint of Farms 110-NL and 111-NL, and along the southern boundary of Farm 112-NL. The corridor will include an overhead power line (to be connected to the proposed NWGTC 220kV line), access road, telecommunications infrastructure, and a site security and access control at the mine entrance. A safe cattle crossing between farms will be provided along the access corridor. Negotiations over the access corridor have been concluded on Farm 111-Nl but continue on 110-Nl and 112-NL.

The proponent of this Project is Tshukudu Metals Botswana (Pty) Ltd (hereafter referred to as “The Client” or “Tshukudu Metals”), which is a subsidiary of MOD Resources (Australia). Tshukudu Metals has engaged Loci Environmental (Pty) Ltd (Loci) to undertake the Environmental and Social Impact Assessment (ESIA) study for the Project, in accordance with the Environmental Assessment (EA) Act No. 10 of 2010, the Environmental Assessment Regulations of 2012, International Finance Corporation (IFC) Performance Standards (2012) and Equator Principles (2013). Loci has five practitioners registered with the Botswana Environmental Assessment Practitioners Association (BEAPA) on staff, with the project team leader for this project certified at the highest lever as Principal Practitioner (PEAP).

Loci has prepared this document in accordance with Section 8 (1) of the Environmental Assessment (EA) Act of 2010, after approval of the Scoping and Terms of Reference (ToR) report from the Department of Environmental Affairs (DEA). The approved ToR has been used to guide the ESIA team to prepare this informative and systematic report based on ESIA findings, referred to as an Environmental and Social Impact Statement (ESIS).

1.1 Project background

The T3 deposit was discovered in March 2016, when an RC drill hole intersected 52m @ 2.0% copper (Cu) and 32g/t silver (Ag) from shallow depth, immediately below a low order copper soil anomaly (28ppm Cu). In September 2016, six months after the discovery of T3, MOD announced a maiden resource at T3 comprising 28.36Mt grading 1.24% copper and 15.7g/t silver, containing approximately 350Kt copper (~772Mlbs copper) and >14Moz silver (MOD Resources, 2017).

The maiden resource included 18Mt grading 1.35% Cu and 16.7g/t Ag in the Indicated Resource category which represented 64% of the total resource (MOD Resources, 2017). This resource formed the basis of a mine feasibility scoping study, for an open pit mine. The scoping study indicated potential for strong financial outcomes.

On 24 August 2017, MOD announced a revised Mineral Resource estimate comprising 36Mt grading 1.14% copper and 12.8g/t silver, containing approximately 409Kt of copper and 14.8Moz silver. The revised resource model highlighted horizontal widths of >1% Cu mineralisation, up to 180m across the anticipated pit. Details of the revised Mineral Resource included estimates at different cut-off grades, including an additional largely inferred low-grade resource containing approximately 47.6Kt copper using a cut-off grade of 0.25% Cu. This resource estimate formed the basis of a Pre-Feasibility study (PFS) for the project.

A program of resource infill and extension drilling was undertaken at the T3 site and has been generating additional positive results. In July 2018 the Client announced another resource upgrade, with a revised mineral resource of 60Mt @ 0.98% Cu and 14g/t Ag at a cut-off of 0.4% Cu (prepared by consultants CSA Global). The Client has just completed a Feasibility Study, which is based on this latest resource update, and includes approximately 36Mt @ 1.14% Cu and 16g/t Ag in the Indicated Resource Category. Following the completion of this Feasibly study, the company is now preparing the application for a mining license.

Much of the assessments were done during ESIA study based on details presented in the T3 Pre-feasibility Study (PFS) announced by MOD Resources in Jan 2018. The technical details in this report however reflect the project scope as per The Feasibility Study (FS), and wherever there have been changes made relative to the PFS, the most up to date information has been used. As the PFS has been the basis for some of the specialist studies in this ESIA, some further detail is provided in the following section.

1.2 The Project pre-feasibility study (PFS)

In January 2017, MOD commenced a PFS for an open pit mine at T3 site based on the results of the December 2016 scoping study. The scoping study was based on a 2 Million tons per annum (Mt/a) processing plant, a mine life of 9.25 years and an average production rate of 21.8 kt/a of copper and 665,000ozpa of silver.

In August 2017, an upgraded resource resulted in total mineral resource tonnes increasing by approximately 27% from the maiden resource announced 26 September 2016. In response to the upgraded mineral resource estimate, the expected increase in the mineable inventory and the strengthening copper price since the scoping study was announced, the PFS plant throughput capacity was increased by 25% to a capacity of 2.5Mt/a, with potential for further plant expansion to 4.0Mt/a. This expansion capacity gives optionality in the event of further upgrades to the T3 resource and possible supplementary ore supply from the nearby T1 project, or other regional areas being explored (MOD Resources, 2017).

Further positive resource drilling results were announced on 5 January 2018, with significant widths of high-grade vein hosted copper and silver. Results included hole MO-G-94D which returned an intersection of 18m @ 4.3% Cu and 94g/t Ag from 146m downhole depth within a wide zone of 53.9m @ 2.0% Cu and 40g/t Ag from 128.5m downhole depth (refer to Figure 1.1). This intersection occurred in the middle of the T3 pit Project, approximately 100m above an intersection of 72.6m @ 1.5% Cu and 27g/t Ag from 250m downhole depth in MO-G-65D, below the planned pit design.

Figure 1.1 shows a simplified sketch of a cross section of the pit with intersections from some of the exploration boreholes, as mentioned above.

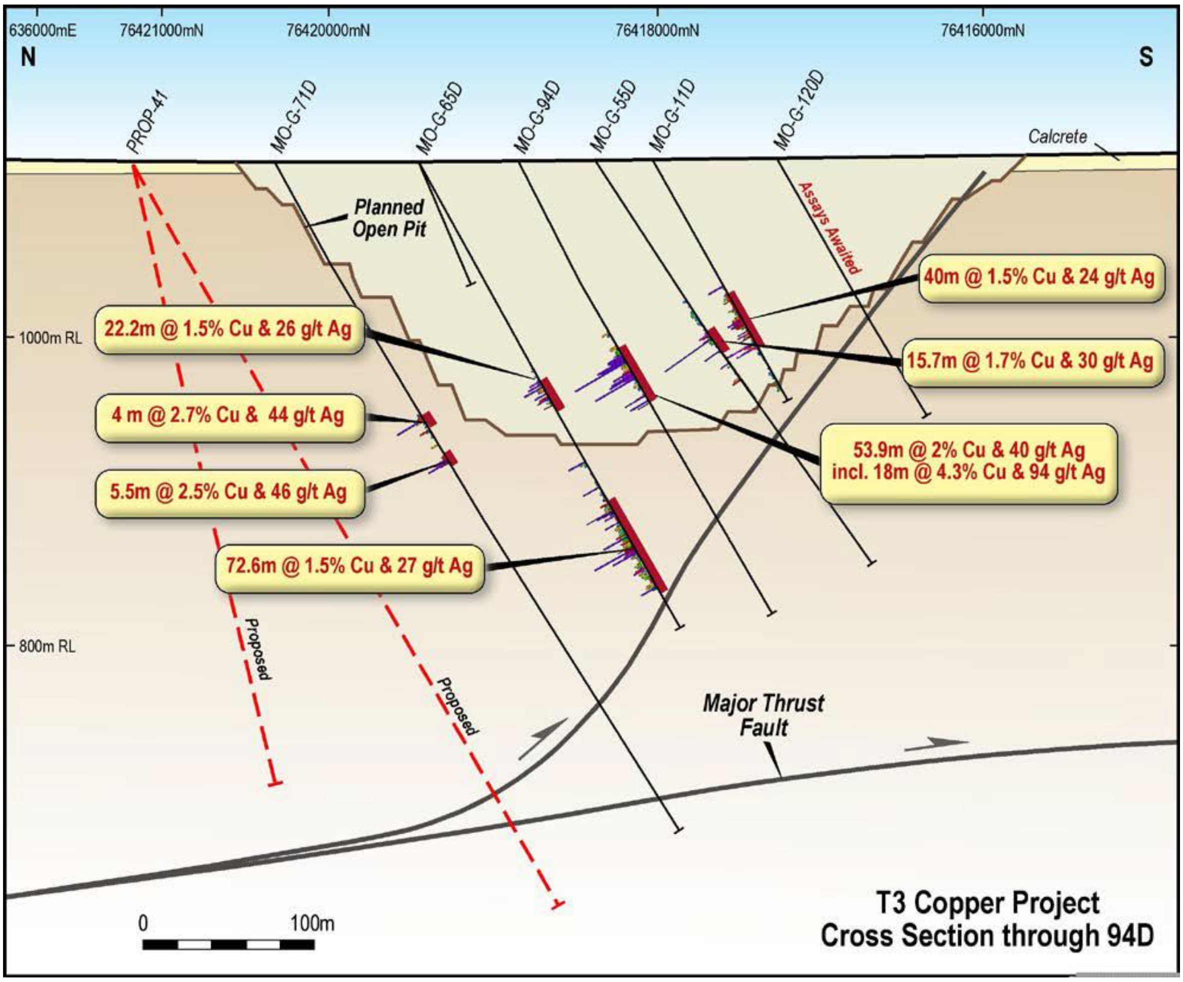


Figure 1.1: Simplified cross section through planned T3 pit showing significant ore intersections including MO-G-94D and MO-G-65D (Source: MOD Resources, 2017)

These recent results are included in the update to the Mineral Resource announced in July 2018, after the infill and extensional drilling program was completed. Detailed metallurgical testwork results developed during the PFS, including locked cycle flotation, have confirmed excellent copper and silver recoveries into low mass, high grade concentrates for each of the chalcopyrite, bornite and chalcocite ore domains. Further metallurgical testwork have been undertaken during the feasibility studies of the project, looking at Copper and Silver recoveries, grind sizes, tailings optimisation and other parameters required for the process engineering.

Based on the current known scope, the Project will include development and operation of an open pit copper mine, a processing (concentrator) plant, and associated on-site and off-site infrastructure, as detailed in Chapter 2 of this document.

1.3 Project location and site condition

The Project will be developed in Ghanzi District of Botswana. The T3 project is located approximate to known locations as follows (refer to Figure 1.2):

- Approximately 70km north east of Ghanzi Township

- Approximately 200km south west of Maun village
- Approximately 30km south east of Kuke village
- Approximately 40km north east of D'Kar village.

The project site is accessible via the Ghanzi-Maun A3 road, from where an existing farm access track can be used to access the site. The mine footprint will occupy a section of Farm 153-NL, which is a privately-owned cattle farm (at Ghanzi Farming Block area) located within PL90/2008 prospecting area held and explored (for copper) by Tshukudu Metals. An agreement on (voluntary) purchase of the land has been reached with the farmer, and no resettlement is required for the project.

A servitude/infrastructure corridor (including power supply), of approximately 12.5km will be developed from the Ghanzi-Maun A3 road to the mine site. The proposed corridor will transverse through Farms 110-NL and 111-NL (on the northern sections), and along the boundary of Farm 112-NL before it reaches Farm 153-NL. (Negotiations continue over the access corridor with the respective owners of farms 110-Nl and 112-NL, they are concluded with Farm 111-NL)The accommodation camp for the Project has been developed at Farm Grasspan No.54-NK, on the outskirt of Ghanzi Township at a current capacity of 40 accommodation units and will be expanded to 400 units. The camp is located approximately 4km north east of Ghanzi Township, adjacent to the Ghanzi-Maun A3 road.

The location of the proposed Project is shown in Figure 1.2.

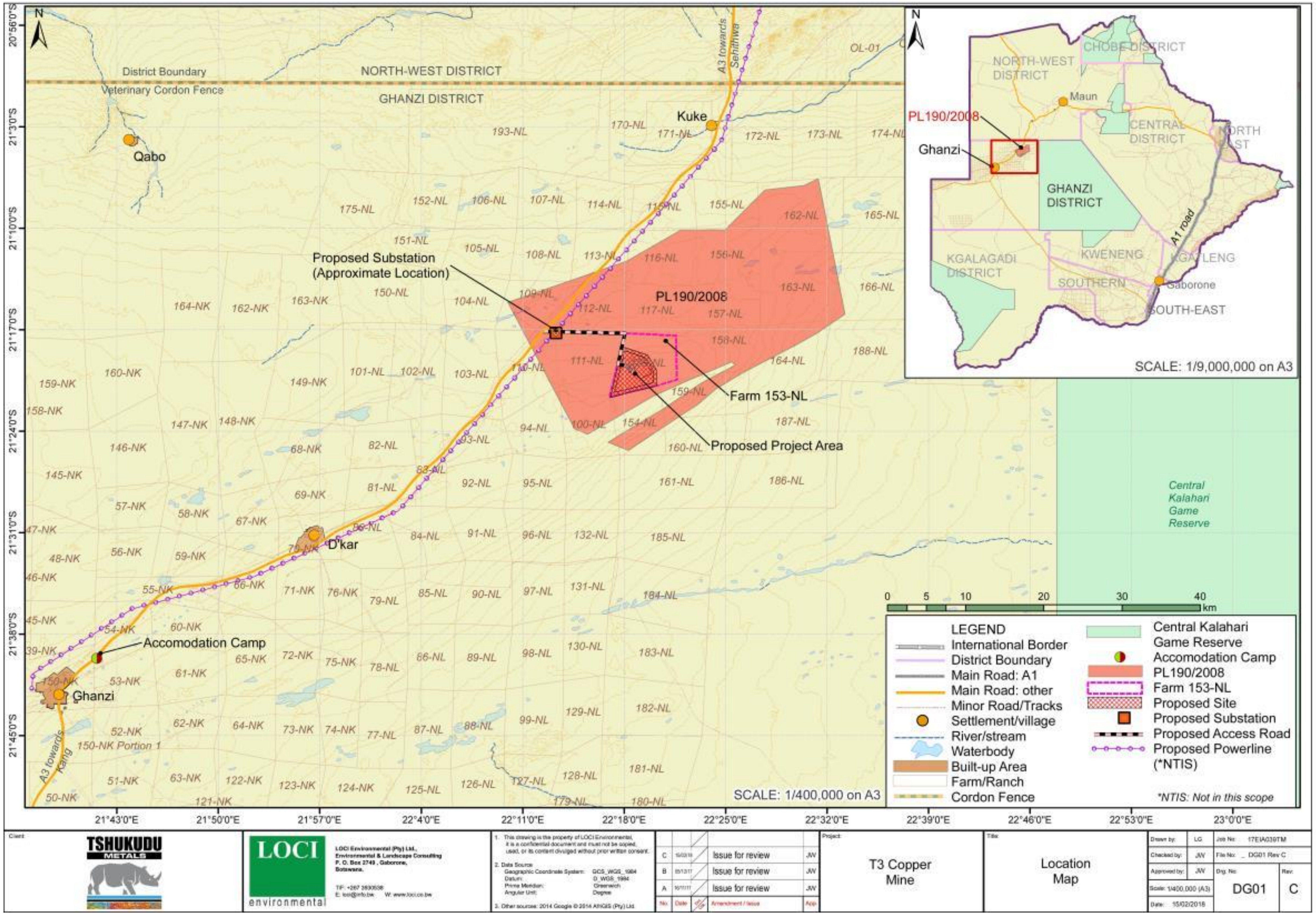


Figure 1.2: **Location of the T3 project**

For the development of the mine, a section of farm 153-NL will be acquired from the current farm owner, based on the footprints and layout from the PFS. During Q2 2018 an agreement was finalised to acquire the area of a farm where the T3 Project Area is located. The land area is approximately 25km^2, enough for the open pit, process plant and associated infrastructure with ample capacity for expansion above the PFS design parameters. The mine footprint (including buffer areas) are outside of the area where the farmers homestead is located, and this will allow the farmer to remain at his residence.

A long-term lease agreement has been executed with the farmer of farm 111-NL for a 100m wide strip of farmland to be used as an access road between the A3 highway and the T3 project This will be used to service the mine with enough space to accommodate the planned grid power spur line.

1.4 Project size, scale and context

The proposed T3 mine site is located within the boundary of Farm 153-NL. The farm is located within the PL190/2008 prospecting license area, held by Tshukudu Metals. The size of the farm is approximately 50km^2, and the size of the land agreement with the farmer is approximately 25km^2 of the farm. The footprint of the mine and associated developments will be approximately 400-600ha in size.

The proposed service corridor will be 12.5km long and 100m wide and will transverse through the northern sections of Farms 110-NL and 111-NL, and along the existing track located north and south of Farms 111-NL and 112-NL respectively. The total size of the T3 prospecting area is approximately 708km^2 and it extends across several freehold farms. The PL area forms part of the regionally extensive Kalahari Copper Belt and is one of many copper deposits that extend 1,000 kilometres along the Neoproterozoic age Damara Mobile Belt. It is located entirely within Ghanzi District. This belt extends from the Democratic Republic of Congo in the north to Namibia in the southwest. Ghanzi District is located within the western part of Botswana and it measures approximately 117,910km^2.

The total landholding the accommodation site (portion 7 and 26 of farm 54-NK) sits on is approx. 28ha. Only a small section of the plot (approx. 25%) is currently developed to accommodate 40 accommodation units. The plot will be developed further to be able to accommodate up to 400 people, with additional capacity for temporary accommodation during the construction phase.

Comparison of the area to be used for the mine development against areas covered by the District, CKGR, Farm 153-NL and PL area is provided in table below.

Table 1.1: Approximate areas covered by the project in comparison with other significant areas

Name of Area	Approximate Area covered (km^2)
Ghanzi District	117,910
Central Kalahari Game Reserve	52,800
PL area	708
Farm 153-NL	50
T3 mine	25

The Central Kalahari Game Reserve is located approximately 45km west of the project site.

1.4.1 Regional context

Neighbouring countries such as South Africa, Zambia and Namibia have established mining projects, which include coal mining, copper mining, platinum mining, gold mining, uranium mining and diamond mining. Large-scale copper mining operations have been established in the northern area of Zambia, South Africa and Democratic Republic of Congo. These include:

- Lumwana Mine in Zambia which was established in 2008
- Rio Tinto Copper Mine in South Africa, established in 1964
- Kamoa Copper Project in Democratic Republic of Congo, established in 2014
- Tenke Fungurume project in Democratic Republic of Congo, established in 2008.

In terms of copper smelting facilities within the region, these can be found in Botswana, Namibia, Zambia and South Africa, and include:

- BCL Smelting in Selebi Phikwe (Botswana)[1]
- Kansanshi, Chambishi, Mopani and Nchanha (Konkola Mine) smelters (Zambia)
- Tsumeb-Ongopolo Mining (Namibia)
- Phalaborwa (South Africa).

1.4.2 National context

Most of the mining activities in Botswana have been concentrated along the central and eastern side of the country. Large scale diamond mines are operated in Jwaneng, Letlhakane and Orapa, with several smaller diamond mining projects including Damshaa, AK06 and BK11 within the east-central region of Botswana. Large scale copper mines developed in Botswana included:

- Bamangwato Concessions Limited (BCL) mine at Selibe Phikwe in Central District, which was established in 1956 and stopped operating in 2016.
- Tati Nickel Mining near Matsiloje village in North East District established in 1995 and stopped production in 2016.
- Mowana Mine near Francistown in North East District which was established in 2007 and currently operating.
- Boseto Copper Mine project near Toteng village in North West District, which started production in 2012 and stopped production in 2015. This mine h

[1] Under provisional liquidation

Within the north western region of Botswana, the only similar scale mining operation was the Boseto Mine, originally developed and owned by Discovery Metals Limited. The Boseto Mine is located towards the south-east of Toteng village, and was operated for approximately 2 to 3 years, before operations were suspended in February 2015. The mine was put in provisional liquidation and Khoemacau Copper Mine (KCM) acquired it in July 2015. The mine operated several open pits, feeding a processing plant of a capacity of 3.2Mt/a. The proposed T3 copper mine project site is located approximately 120km south west of the Boseto Mine, and the scale of the proposed T3 project is comparable with the Boseto Mine. KCM plan to start mining the new Zone 5 copper deposit in the near future. It is estimated that KCM will employ 700-1000 personnel for the combined Boseto and Zone 5 projects.

Figure 1.3 shows the location of the T3 Copper project site compared to other established mining operations within Botswana.

T3 site

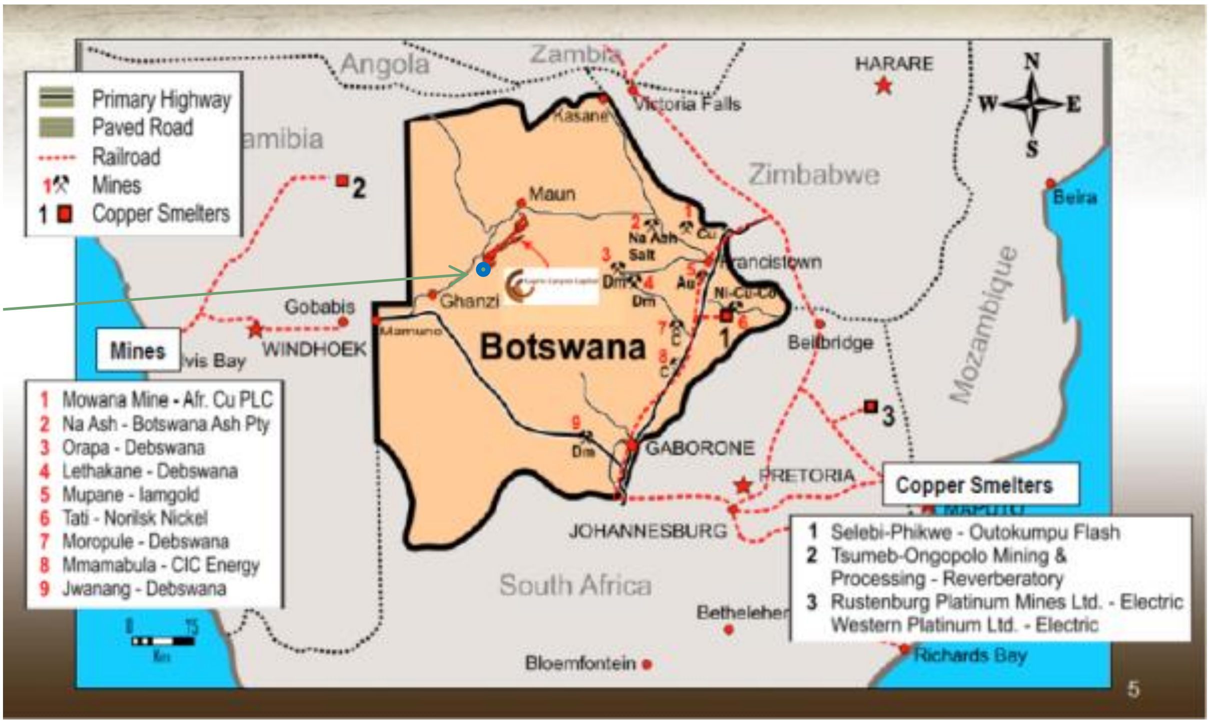


Figure 1.3: The project site (marked in blue) in relation to mining operations in Botswana and surrounding countries (Source: Botswana Chamber of Mines, 2017)

The lack of mining developments in the region, means the availability of infrastructure required for the mining operations is limited. Power infrastructure and social related facilities such as training centres will all require development in the area. An infrastructure project that is notable to mention in this context is the proposed development of the Trans-Kalahari Railway line.

In addition, Botswana Power Corporation (BPC) has commenced the construction of a 220kV transmission line from Toteng to Ghanzi, which will provide possibility for grid power supply for T3 mining operations. The North West Grid Transmission Connection (Lot 4) ESIA study has been approved and the contractor had started the construction works at the time of this report completion. It is estimated that BPC will employ between 300 and 500 personnel o work on this section of the transmission line.

1.4.3 Local context

At local economy levels, the proposed mine could potentially become one of the major economic drivers within the region. The mine can have a positive impact on the local economy of the region due to employment and entrepreneurship opportunities to be created, as well its possible contribution to the development of infrastructure and welfare of the communities of the area.

The other major development in the Ghanzi area is the development of a Botswana Defence Force (BDF) facility. In terms of footprint, the project is sizeable, but due to security sensitivities further information about the project has not been availed. It has been assumed that the BDF facility may bring a significant number of people and development to the Ghanzi area as well.

1.5 Project objectives and justification

Tshukudu Metals aims to develop and operate a copper mine project in Ghanzi District, with intention to raise income for its shareholders. If successfully implemented and operated, the Project will also contribute in increasing production of copper in the world, which is estimated to have declined by 2.6% in 2017 (International Copper Study Group (ICSG), 2017). According to the study, production of copper in Africa declined by 1% in 2017.

Considering the Project scale and estimated production schedule during the Life of Mine (LoM), the proposed mine will contribute positively towards the socio-economic development of Ghanzi District, as well as the economy of Botswana. This will be achieved through job creation, entrepreneurship opportunities, payment of royalties to Botswana Government and contribution to skills and infrastructure development within the region and at national level. During its operational phase, the Project will also assist in diversifying the economy of the District, which is heavily reliant on agriculture (cattle/beef farming)

1.6 Environmental background

Exploration activities for T3 project were initiated early 2017 to establish an updated resource estimate for the copper at the site, which was used for the development of a pre-feasibility study for a copper mine development. The exploration activities were authorised by DEA on the 26th October 2017 (DEA reference no. DEA/BOD/EXT/MINE 002 (7))

An authorisation was also acquired for the first phase of the development of the accommodation camp following submission of a Project Brief to DEA. The Project Brief was submitted on the 14th September 2017, and correspondence in response to the document was received on the 14th September 2017 (DEA reference no. DEA/GH/BOD/TOUR/CMP 011). The authorisation was granted for accommodation of 40 people, and Tshukudu Metals is planning to expand the camp to accommodate approximately 400 construction personnel. The assessment of the camp has been done in a separate study, to expedite the development of this facility.

Prior to embarking upon this ESIA Study for the T3 mine project, as per the EA Act of 2010, a Project Brief was completed and submitted to the DEA for review. The Project Brief also served as an introduction to the project and environmental screening tool. The Project Brief was submitted on the 16th November 2017, and correspondence in response to the document was received from the DEA on the 23rd November 2017 (DEA reference no. DEA/BOD/GH/EXT/MINE 009 I (2)).

The response letter from the DEA required that:

- Implementation of the proposed project would require undertaking and approval of a detailed Environmental Impact Assessment.
- Public consultation should be undertaken in accordance with section 7 (2) of the EA Act No. 10 of 2011 as part of the scoping exercise, to identify the salient issues to be addressed by the ESIA study.
- A practitioner who has been duly certified by the Botswana Environmental Assessment Practitioners Association (BEAPA) must be engaged to undertake the study.
- Two hard copies and a soft copy of the Scoping report and draft Terms of Reference should be submitted to the DEA for review and approval before proceeding with the detailed assessment.
- Upon submission, the reports must be accompanied by a fee for review as prescribed in Schedule 3, Regulation 4 of the Environmental Assessment Regulations, 2012.

The scoping process was undertaken, and scoping approval received on 2nd August 2018 (reference DEA/GH/BOD/EXT/MINE 009 (5).

1.6.1 EIA process

A general overview of the process of preparing the ESIA, which includes the scoping and ToR stage, as per the EA ACT (2010) and the Environmental Regulations (2012) is illustrated below in Figure 1.4.

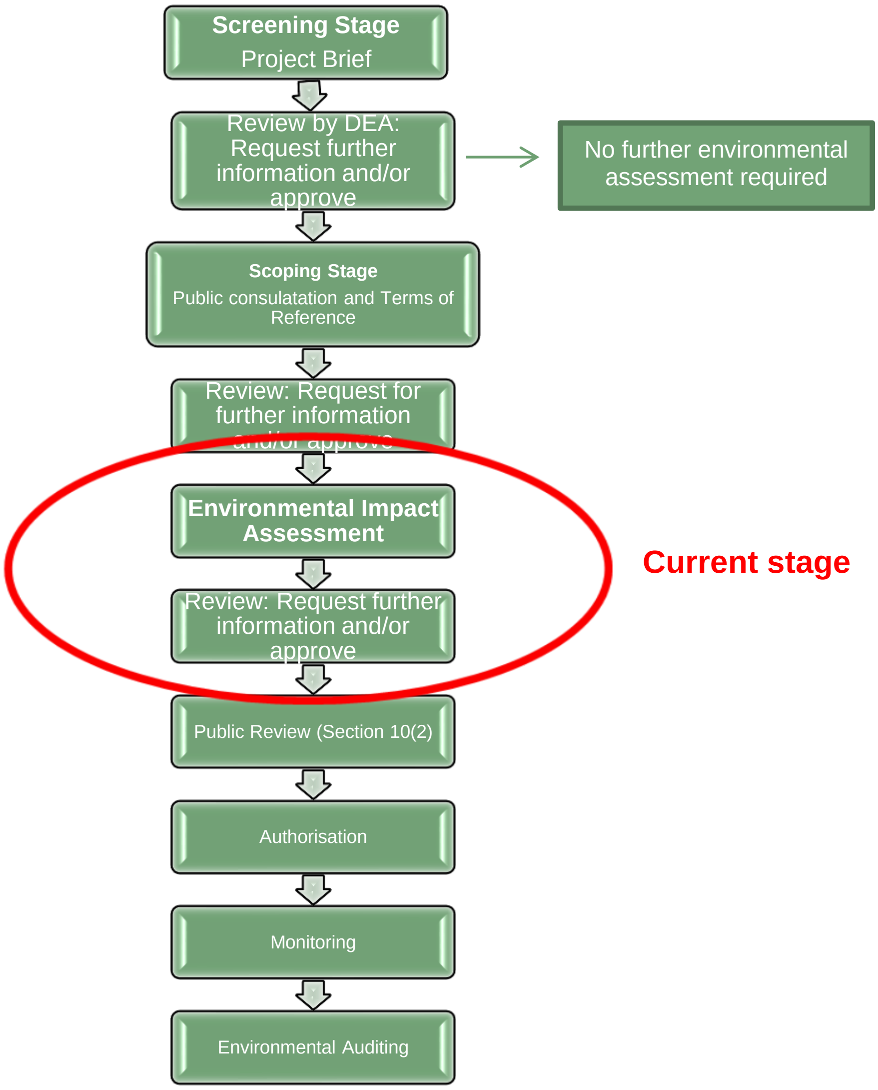


Figure 1.4: Environmental Assessment process in Botswana as guided by the EA Act (2010)

1.6.2 Scoping and ToR

The EA Act specifies that the next step in the environmental assessment process after the Project Brief is the Scoping and ToR stage, where the environmental ToR for the ESIA study must be approved by the DEA, to provide certainty for the DEA and other stakeholders that the important issues will be addressed to the depth needed during the ESIA stage.

Environmental scoping was undertaken by the environmental team to analyse the receiving environment and establish a baseline against which predicted changes to the environment can be measured, and the potential impacts that may arise from the proposed development can be identified.

The scoping phase also included significant public and stakeholder consultation. The public and stakeholder consultation for the proposed project was done in accordance with the Environmental Assessment Regulations of 2012. The consultation plan and Project Information Document (PID) were developed by Loci during the scoping phase to organise the public and stakeholder consultations as effectively as possible.

In general, the objectives of the scoping exercise were:

- To identify possible effects of the proposal on the environment.
- Focusing the ESIA study so that only relevant and important issues are addressed by the ESIA.
- Refining time or geographical boundaries for the ESIA.
- Facilitating an efficient assessment process that saves time and resources and reduces costly delays.
- Considering reasonable and practical alternatives to the Project.
- Allowing for an informed prioritisation of issues to be addressed.
- Organising, focusing and communicating the potential impacts and concerns.
- Setting up ESIA conduct.
- Establishing the terms of reference (ToR) to be used as the basis of the ESIA.

Based on the results from the scoping exercise the specialist studies and impact assessment were undertaken during the ESIA phase. Once the impacts were predicted, identified and analysed in this ESIA, an Environmental and Social Management Plan (ESMP) was developed to offer specific management actions designed to minimise the risks arising from adverse impacts and to enhance the positive ones.

1.7 Project proponent

The proponent of this Project is Tshukudu Metals Botswana (Pty) Ltd. Tshukudu Metals is a wholly owned subsidiary of the Australian company MOD Resources (ASX and AIM listed[2]), focussed on the exploration and development of copper projects in the Kalahari Copper Belt.

The company is continuing the strategy to test extensions to T3 and conduct a substantial exploration program exploring for satellite deposits at other priority targets around T3. These may be located within the same prospecting license, or in one of the other licenses the company holds regionally in the Kalahari Copper Belt. The prospecting licenses extend from south west of Ghanzi into North West District neat Sehitwa, as shown in Figure 1.5. The location of the T3 project (which is the scope of this study), is centrally located in this overall area of licenses.

[2] Australian Stock Exchange and London Stock Exchange

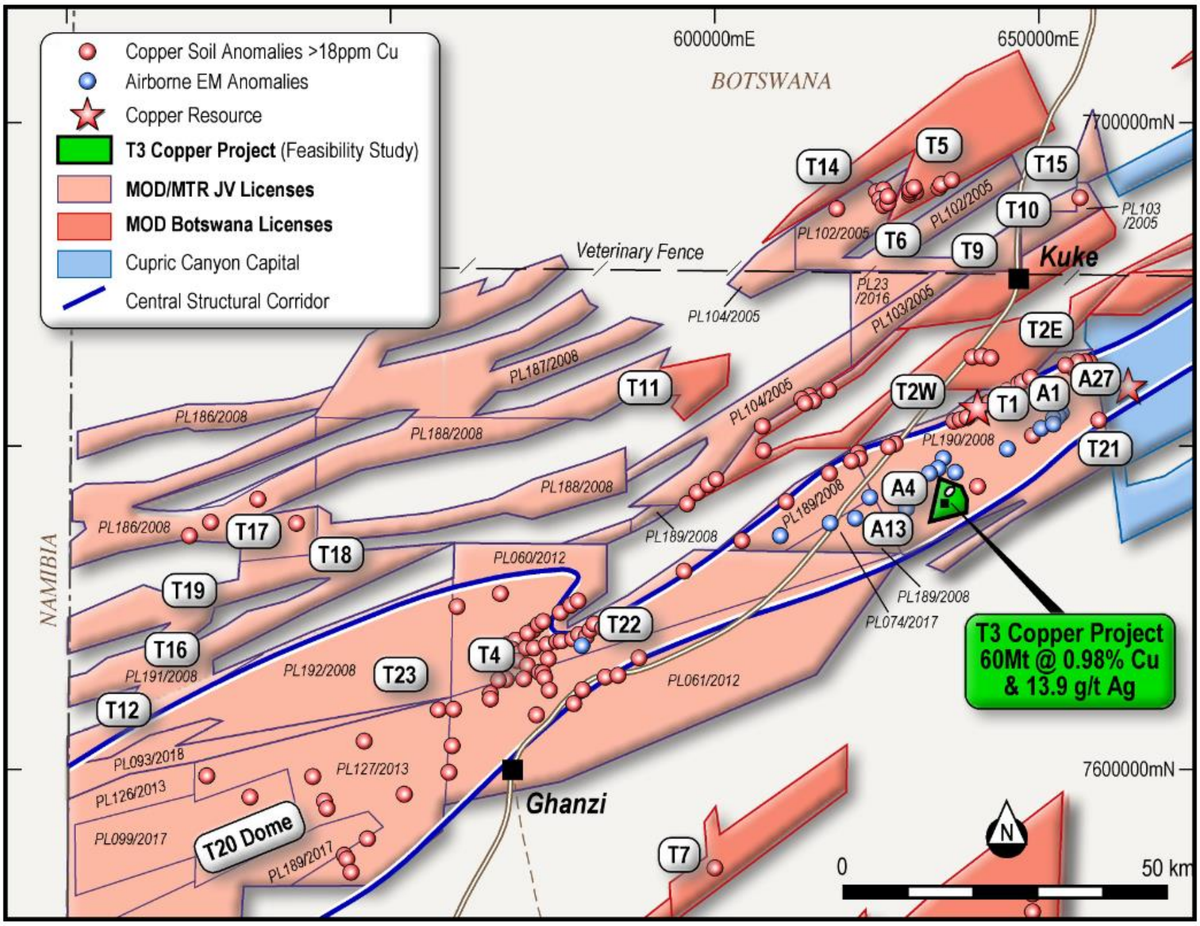


Figure 1.5: Licenses held by Tshukudu Metals, Tshukudu Exploration or MOD Resources (Source: MOD, 2018)

The contact details for the Client for this project are summarised in the table below.

Table 1.2: Details of the project proponent

Project Proponent	Tshukudu Metals (Pty) Ltd
Contact Person	Mr Gaba Chinyepi
Postal Address	Private Bag 00427, Gaborone
Physical Address	Farm 153-NL, Ghanzi District, Botswana
Telephone Number	+267 393 5386
Fax Number	+267 71139451
E-mail Address	chinyepigg@tshukudumetals.co.bw

1.8 ESIA consulting team

Loci Environmental is a Botswana-based environmental consultancy firm, with its earliest roots in Landscape Architecture and Environmental Engineering-related consulting. The founders registered Loci Environmental (Pty) Ltd in Botswana in February 1998. Since then, the company has expanded to include all aspects of environmental consulting. The company's strength has been attributed to a growing depth of local knowledge, a continually-growing network of leading regional sub consultants and added years of experience in Africa and abroad. In accordance with the Environmental Assessment (EA) Act of 2011, Loci consultants are accredited by the Botswana Environmental Assessment Practitioners Association (BEAPA), with one certified Principal Practitioner (PEAP) and four Environmental Assessment Practitioner (EAP).

The company growth has resulted in a focus on environmental consulting projects in the Southern African region. Loci has a wealth of experience in Botswana, but has also successfully completed projects in Lesotho, Zambia, Namibia and Zimbabwe and is able to apply this experience in other countries throughout Southern Africa. Loci has a strong team of strategic partners and specialists throughout Southern Africa to further support these activities.

The team of experts that has undertaken the ESIA for the proposed project is shown in Table 1.3 below.

Table 1.3: ESIA team

ESIA Team Leader	J. Westra (BEAPA registration no. 20130058)
Environmental Consultant	G. Sibanda (BEAPA registration no. 20140069)
Groundwater specialist	A. Preston and C. Smith
Geochemical specialist	E. Tuplin
Air Quality specialist	N. Enslin
Noise specialist	K. Collett
Landscape and Visual Amenity specialist	L. Gaolekwe
Waste specialist	K. Otto
Biodiversity	S. Sacranie and C. Klopper
Environmental Health and Safety specialist	D. Barnes (Dr.)
Traffic Assessment specialist	O. Lekote
Archaeologist	N. Walker (Dr.)
Soils Scientist	M. Pienaar
Closure plan specialist	C. Galli
Social Assessment (field team leader and consultations)	V. Lelaka (BEAPA registration no. 20150078)
Social Assessment (compliance and quality control)	H. Konigkramer
GIS/Mapping	L. Gaolekwe
Reporting	J. Westra and S. Maswabi

2 Project description

The following sections include a detailed description of the Project, as it has been assessed within the ESIA. A brief description of the exploration history has been provided in Chapter 1, as background information. The technical information presented in this Chapter is based on the latest scope and details from the project Feasibility Study.

Any elements of the proposal that are added by the developer or otherwise come to light later in the Project life must be addressed with separate assessments, as the current scope of works outlined herein has formed the basis of the current assessment and modelling.

2.1 Overview of the proposed development

The T3 area has been subject to exploration activities to find areas of economic mineralisation. Like other mining projects, the Project had to go through several exploration stages and mining related studies to determine its economic feasibility. The Client has undertaken a Prefeasibility Study (PFS) for the Project, which was completed in early 2018. The results of the PFS are positive and Tshukudu Metals is now undertaking detailed feasibility studies for the Project.

The detailed feasibility study for the project is usually carried out to assess the economic viability of the Project in depth. As part of the feasibility study, further in-fill drilling has been undertaken at the T3 resource area. The purpose of this drilling program was to further define quality and quantity of the mineralisation, and to gain further metallurgical information that is required to finalise designs of the mine pit and processing plant, including related mining facilities. Detailed engineering and geotechnical studies for the Project will also be finalised during this phase. The detailed feasibility study was completed in May 2019, and the Client is preparing for the submission of a mining license application at the time of completion of this ESIA study.

A schematic of a typical mining development stages from discovery until project completion, as followed for the Project development, are shown in Figure 2.1.

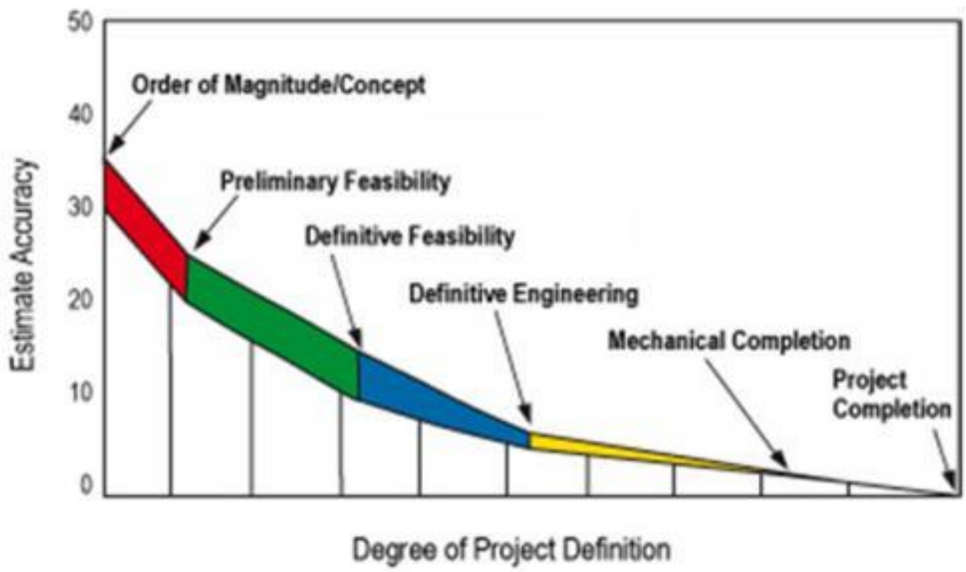


Figure 2.1: Typical stages of mine development (AusIMM, 2013)

2.2 Project scope summary

Therefore, the technical scope discussed in this Chapter is based on the currently available designs from the Feasibility Studies, which provided sufficient level of detail for the ESIA study. The previous environmental report (scoping and ToR) was undertaken based on the pre-feasibility studies, and some reference is made to this earlier study for comparison.

The Project scope for the T3 project, as assessed in this ESIA study includes:

- Open pit mine
- Waste rock dumps (overburden) and topsoil dumps
- Tailings storage facility
- Processing plant (concentrator) including:
  - Crushing (primary and secondary)
  - Milling
  - Floatation
  - Concentrate filtration and handling
  - Tailings handling and storage
  - Reagents mixing and storage
- On-site support infrastructure, including:
  - Temporary contractors camp (for construction activities)
  - Workshops (for processing plant and for mining equipment)
  - Laboratory
  - Offices and warehouses
  - Weighbridge
  - Material storage areas
  - Back-up power generators
  - Electrical substations (voltage assumed to be 220/11kV)
  - Bulk fuel storage for mine equipment
  - Explosive storage bunker
  - Emulsion mixing
  - Water boreholes and related infrastructure (power supply, water pipes)
  - Raw water dams, pollution control dams
  - Water treatment plant for potable water

- Sewerage, water and electrical reticulation
- Sewage treatment facilities
- Surface water management (drainage) system
- Concentrate storage facility
- Site access control and security
- Fencing.

■ Off-site infrastructure including:

- Accommodation camp near Ghanzi
- Exploration camp(s) and core processing for other exploration areas (not part of this assessment)

■ A services corridor including:

- Overhead power line (anticipated to be 220kV)
- Access road
- Telecommunications (fibre optic and possibly extra communication towers)
- Site security and access
- Safe cattle crossing point between the farms

The Project start-up (Base Case in the PFS) assumed open pit mining and conventional flotation processing using a 2.5Mt/a plant for the first three years of production, with an expansion case that allows for the plant to be upgraded to enable it to process 4Mt/a of ore during year 4 of production and onwards (MOD, 2018). These scenarios were fully described in the environmental scoping studies and formed the basis of that (earlier) stage work.

In July 2018 the Client announced a major increase of the T3 Resource, following the completion of much of the infill drilling work at T3. The infill and extension drilling was completed with the objective to upgrade existing Inferred Mineral Resources to Indicated and Measured Mineral Resource categories (higher level of confidence). Drilling also targeted deeper vein extensions to the East, West and North of the proposed T3 mine pit.

Based on this resource upgrade, a review of the planned throughput for the T3 process plant has been undertaken. The feasibility study is based on an increase (compared to the PFS base case) in the process plant throughput to 3.2Mt/a, with allowance for staged future expansion. The throughput selection was based on criteria that included the tonnes of indicated category resource, target mine life of at least 10 years and the optimal operational and financial outcome for Tshukudu Metals. The staged expansions for the planned mine still consider 3.5Mt/a and 4Mt/a (which was the expansion case from the PFS), which has formed the basis of the environmental modelling and assessment of the ultimate mine impact within this ESIA study.

Based on the current groundwater studies, water supply for the mine operation will be sourced from boreholes within the farm boundaries of the mine and Farm 153-NL, mainly from dewatering process. Some additional production boreholes have been developed for additional water supply (back-up) all located within farm 153-NL as well. An external wellfield is not anticipated for the Project.

At full operation, the mine is expected to directly employ between approximately 450-550 people. The construction of the mine is expected to commence during the second half of 2019, after a decision to mine has been made based on the completion of the feasibility study, and all relevant licenses and authorisations having been granted.

The LoM is expected to be approximately 10 to 15 years. This LoM is based on the currently available information (from drilling) and is likely to be extended with ore from T3 underground, or other areas such as T1 or T4. The development of these other deposits will be subject to separate ESIA studies, and they are not included in this assessment.

2.3 Detailed project location

The proposed T3 mine development will be undertaken in Ghanzi District of Botswana. The District is located within western region of the country and shares its borders with the North West District on the north, Central District on the east, Kweneng District on the southeast and Kgalagadi District on the south. The Ghanzi District also shares its western borders with Namibia.

The District is administered in Ghanzi Township, located approximately 600km west of Gaborone (Botswana's capital city). The capital of Namibia, Windhoek, is located approximately 526km west of Ghanzi Township. The District is accessible from Gaborone via Trans-Kalahari Road (A2) and from Maun village via the A3 road.

Sections 2.3.1 and 2.3.2 below provide further details on the layouts and designs of the project components. The mine location and proposed service corridor route are illustrated in Figure 2.2.

An agreement has been reached with the relevant farmers in relation to the voluntary purchase of the land for the mine footprint and the service corridor. No resettlement of people is required for the project implementation. The Client has commenced the process of fencing the section of farm 153-NL which has been part of this agreement. The service corridor is within and along farm boundary fences and is being utilised as an access into the T3 area. The corridor will be further developed after approvals have been obtained. Access agreements into the farms were initiated during the exploration works undertaken by the Client.

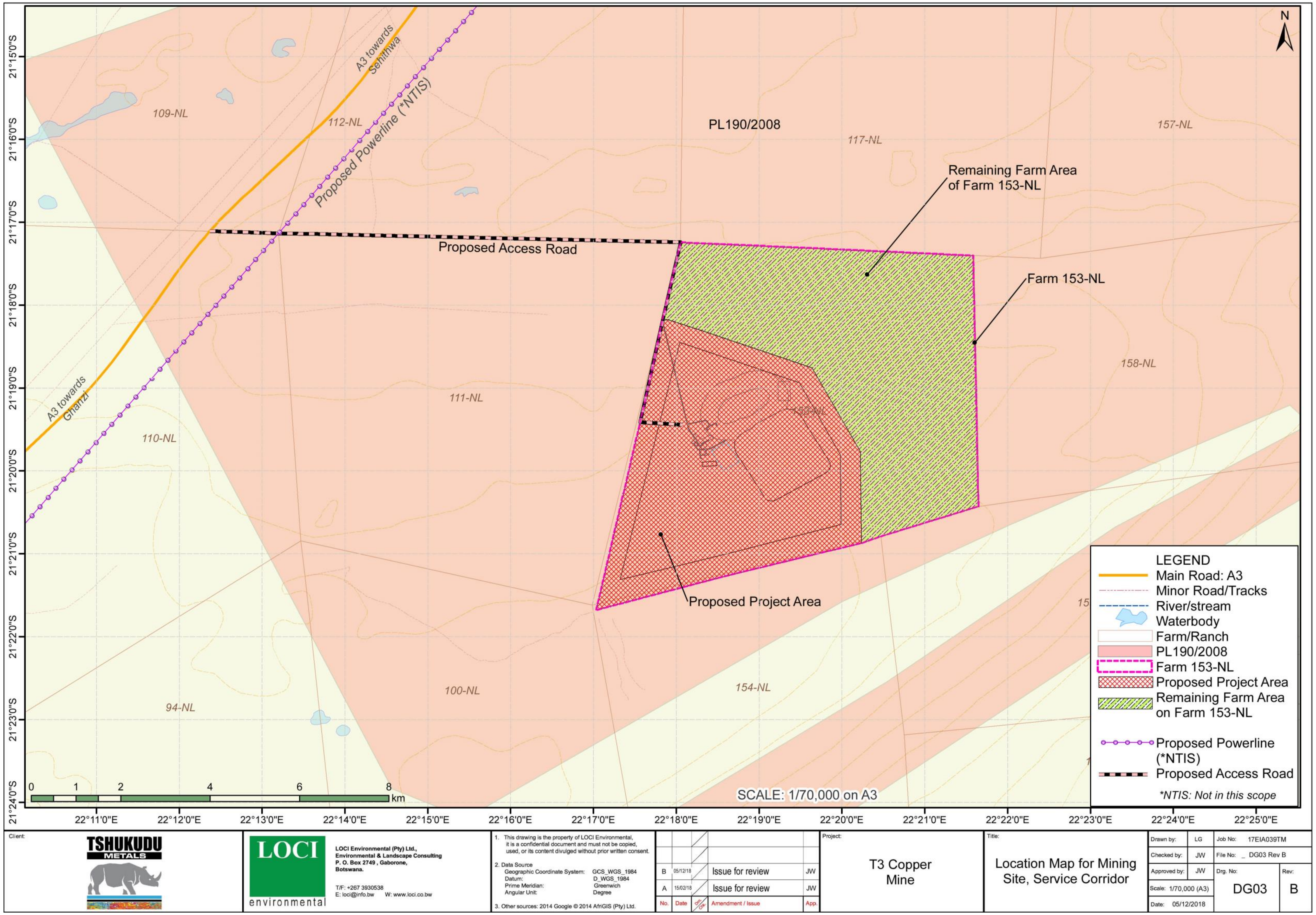


Figure 2.2: Detailed project location map

2.3.1 Proposed mine site

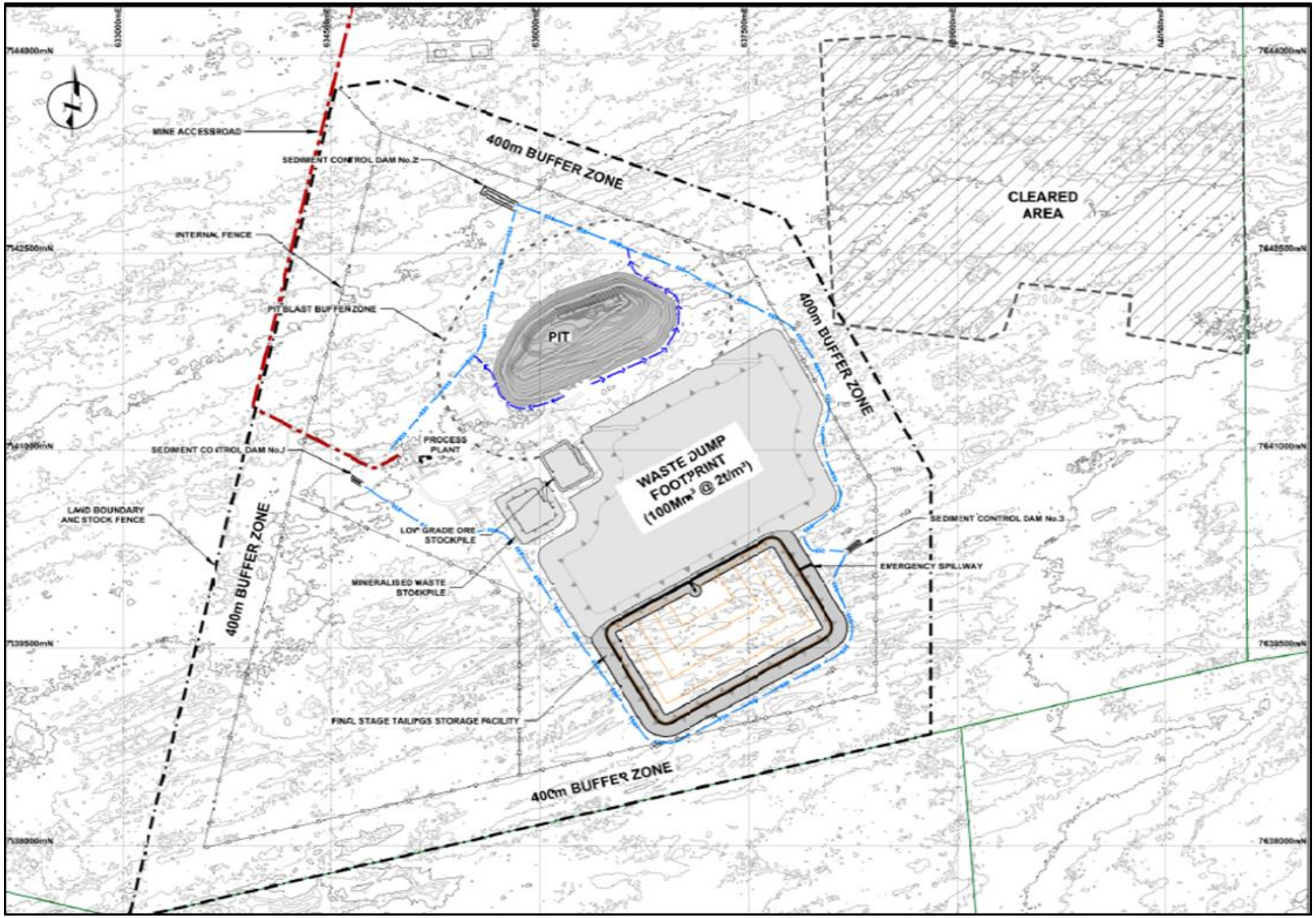
The proposed mine pit and related mining facilities (waste dumps, processing plant and tailings storage facility) will be developed within a section of Farm 153-NL, at Ghanzi Farming Block area. The site is within prospecting licence (PL 190/2008) held by Tshukudu Metals.

The site is accessible via the A3 Ghanzi-Maun road, from where an existing access track is currently used to reach the site. The track was an existing track developed and used by farmers, which is crossing through farms 110-NL and 111-NL. A second access is available along the northern boundaries of farms 110-NL, 111-NL and 153-NL, which is proposed to become the site access corridor. Access to the site is being transitioned from the main access track crossing the farms to this track on the northern boundary, to avoid crossing farms and limit traffic coming past the homesteads of farm 111-NL.

It must be noted that the location of the mine pit, mining related facilities and the on-site facilities within Farm 153-NL are based on the available mine designs. Although the designs are still ongoing, the footprint is well defined at this stage and not expected to change much during the detailed designs. The agreement in relation to the land has therefore been completed based on this anticipated footprint and is not expected to change or exceed the footprint (not considering other deposits such as T1 and T4, which will be subject to separate studies).

2.3.2 Mine site layout plan

The mine site will include the mine pit, waste dumps, processing plant, tailings storage facility and the on-site supporting infrastructure. To ensure there is adequate room for expansion and to provide space between adjacent farms, a 400m buffer zone has been included around the project site. The preliminary layout for the mine site is provided in Figure 2.3.


400m BUFFER ZONE
CLEARED AREA
MINE ACCESSROAD
SEDIMENT CONTROL DAM No.2
INTERNAL FENCE
PIT BLAST BUFFER ZONE
PIT
PROCESS PLANT
SEDIMENT CONTROL DAM No.1
WASTE DUMP FOOTPRINT (100Mm³ @ 2t/m³)
LAND BOUNDARY AND STOCK FENCE
LOW GRADE ORE STOCKPILE
MINERALISED WASTE STOCKPILE
SEDIMENT CONTROL DAM No.3
EMERGENCY SPILLWAY
FINAL STAGE TAILINGS STORAGE FACILITY
400m BUFFER ZONE
400m BUFFER ZONE
400m BUFFER ZONE

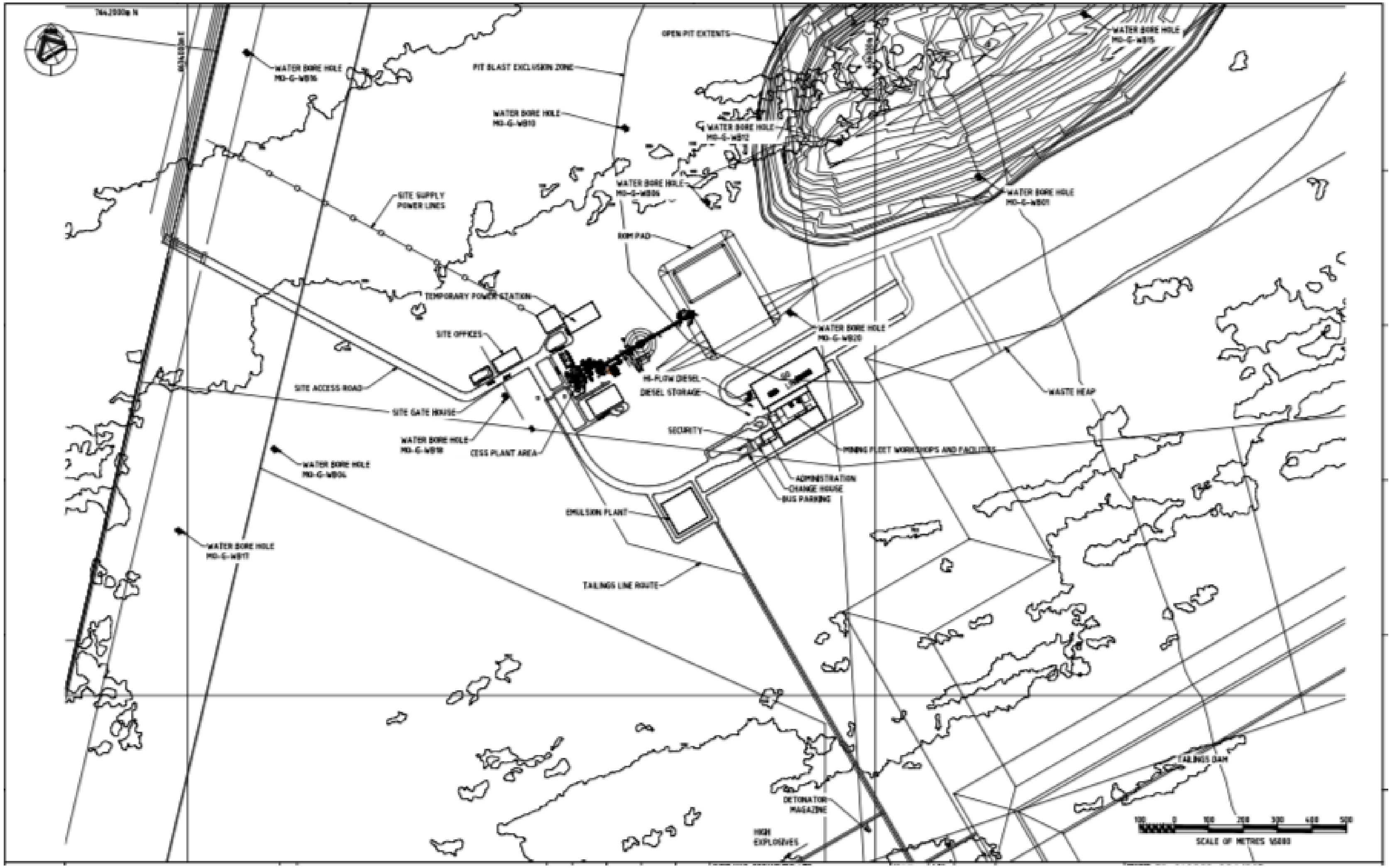


Figure 2.3: Layout of the mine site, including on-site infrastructure (Source: Knight Piesold, 2019)

2.3.3 Proposed access route, substation and accommodation camp sites

As shown in Figure 2.2, a service corridor, of approximately 12.5km will be developed from the A3 road to the mine site. The proposed route is located within the northern section of Farms 110-NL and 111-NL and south of Farm 112-NL. Negotiations for the land for the corridor are also on-going with the owner of Farm 111-NL and 112-NL. The corridor will include the 220kV transmission line connecting power to the site from the Lot 4 transmission line developed by BPC (Toteng to Ghanzi). The temporary accommodation camp is being developed at Farm Grasspan No.54-NK, on the outskirt of Ghanzi Township. The camp site is approximately 4km north east of Ghanzi Township, near the A3 road.

2.4 Project scale and perimeters

The overall Project scale discussed and assessed in this ESIA study is based on the expansion case scenario as per the PFS studies (4Mt/a). It is however anticipated that the mine will initially be developed at a smaller scale (as explained in Section 2.2) of 3.2Mt/a, with expansion into full scale at subsequent years. The development scenario is based on development of an open pit mine, a conventional flotation ore processing with a plant and ore supply from proved and probable ore reserves. The LoM is anticipated to be 11 years minimum (MOD, 2019).

The expansion of the mine and processing facility will focus on a production target utilising both the ore reserve and additional production from existing inferred, measured and indicated mineral resources. The LoM for the full-scale operation is anticipated extend from 10 to 15 years with the implementation of the expansion case.

The key parameters for each of these cases are presented in Table 2.1.

Table 2.1: Production target parameters (MOD, 2019)

Production target parameters	Initial start-up project	Expansion Case
Open Pit Ore Reserve (indicated) total (as per March 2019)	34.4Mt	
Total T3 Mineral resources (indicated and inferred, 0.4% cut-off)	60Mt	
Copper Grade	1%	
Silver Grade	13.2g/t	
Copper in concentrate – LOM	342.7kt	
Plant capacity (and mining scale)	3.2Mt/a	4Mt/a
Life of Mine from production	11.5 years	12 – 15 years
Waste: Ore ratio (Approx.)	5.7	5.7

Based on the data presented above, several different scenarios and comparisons are developed as part of the feasibility studies, to decide on the proposed scale of the operations. Issues that are key to this process are:

- Minimum content of copper and silver in ore that will be processed in the plant
- Chemical composition of concentrate after processing

- Assumed market price for the copper concentrate
- Financial market variables such as exchange rates of currencies.

The "expansion case" from the PFS is the scope assessed in the ESIA studies, as this assesses the maximum anticipated impacts related to the Project and allows for the Project growth. Figure 2.4 below illustrates the copper resource for the T3 project as per the July 2018 update. It must be noted that this may be further updated in the future, after further drilling results are assessed and modelled.

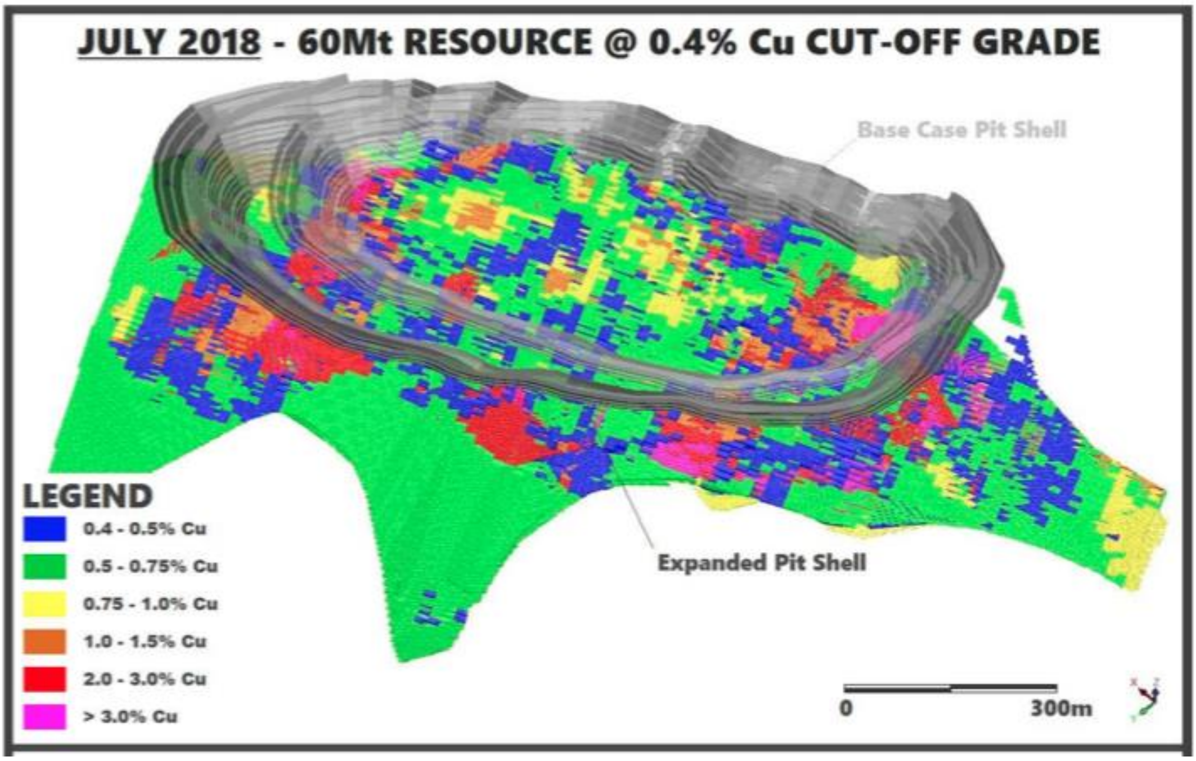


Figure 2.4: Copper Resource (MOD, 2018)

2.4.1 Mine pit development plan

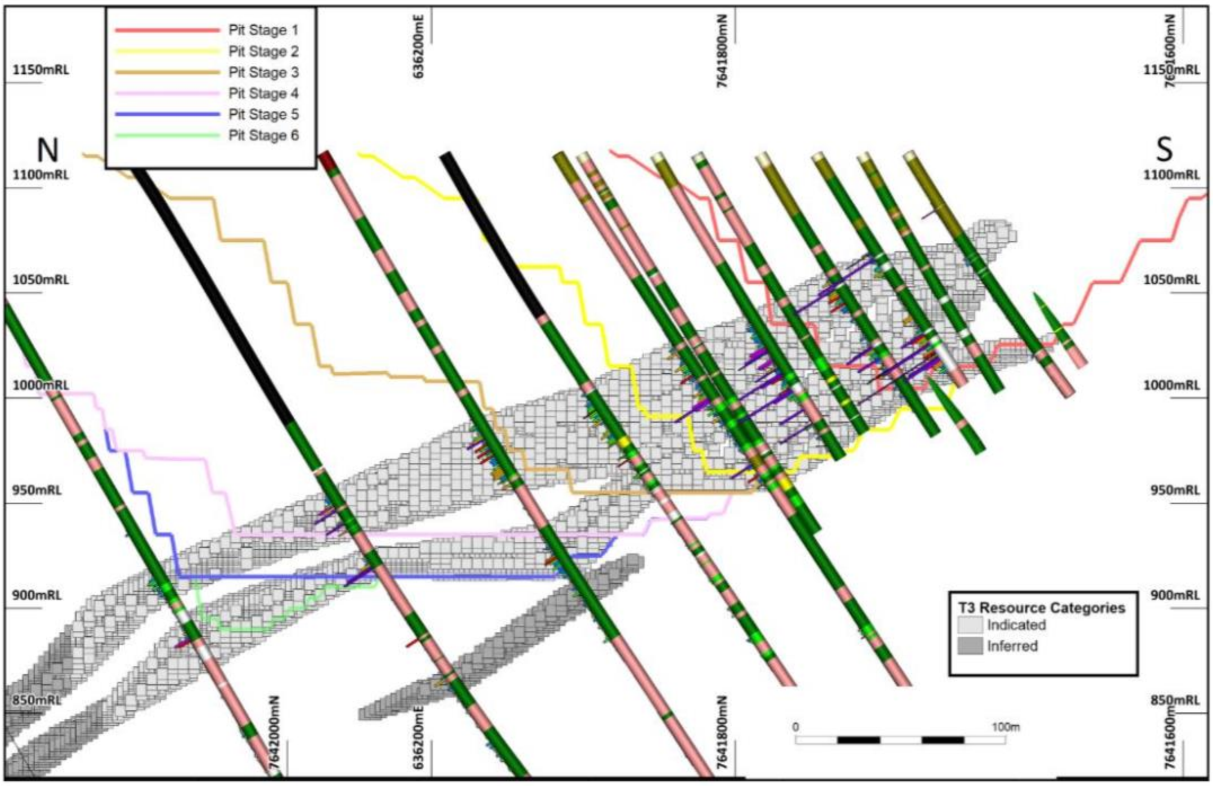
Open pit mine design and planning was conducted during the PFS study (including geotechnical and pit optimisation), which resulted in a mine design to meet requirements for the 2.5Mt/a flotation plant. Additional resource model update, mine development and geotechnical studies conducted during the FS enabled the start-up phase to be increased to 3.2Mt/a and is the basis for the detailed feasibility study, with the expansion case still being 4Mt/a as the ultimate size of the operation.

The current open pit design is based on the following parameters and assumptions:

- Indicated mineral resources used to generate proved and probable ore reserves
- A six-stage pit design
- 9-month pre-strip phase to expose enough ore to maintain sustainable mining production rates
- Waste-to-ore ratio of 5.7

- Conventional hydraulic excavators and rear dump trucks
- 10m blasted bench height, with most material requiring blasting.

The mine pit design was based on the LoM copper price of US$2.91/lb. A mining contractor will be engaged to undertake mining activities under the technical and managerial supervision of the Client. Figure 2.5 illustrates the mine development plan (Proposed 6-Stage Pit).



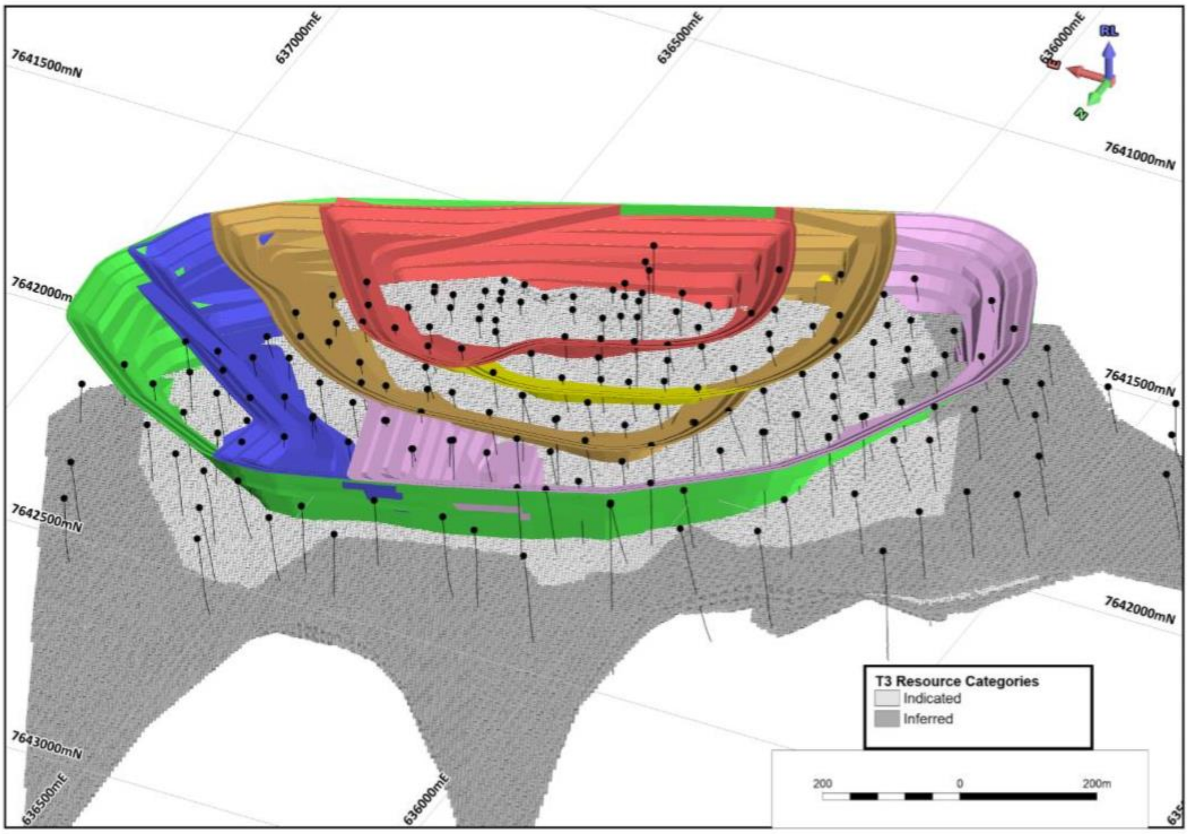


Figure 2.5: Proposed 6-Stage Pit (MOD, 2018)

The draft quarterly mine production schedule proposed by the Client is provided in Figure 2.6. This schedule is from the FS study and shown to illustrate the quantities mined.

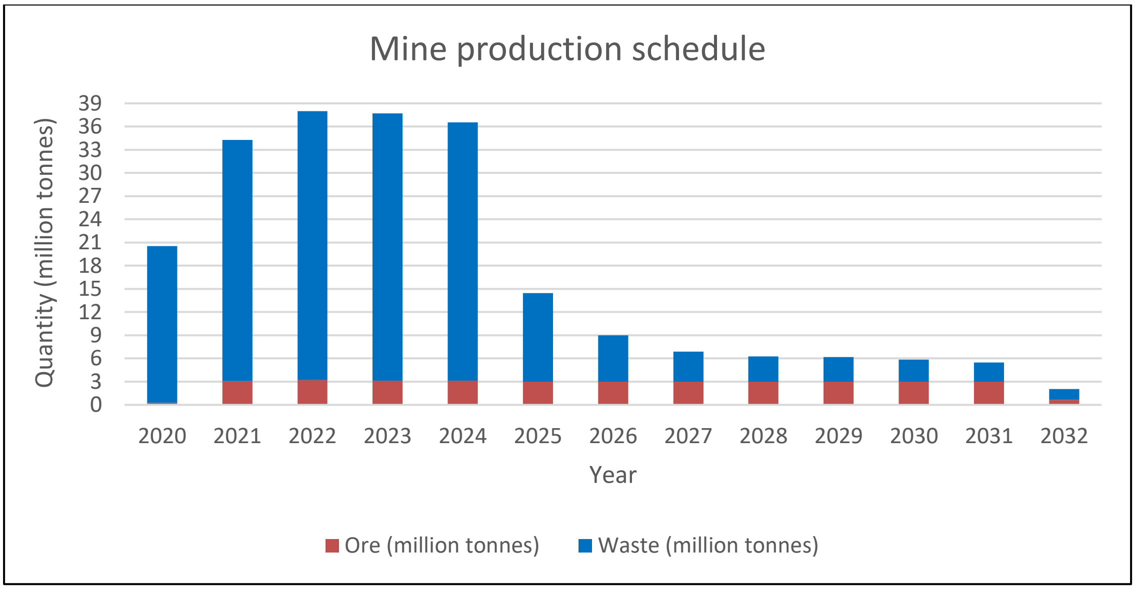


Figure 2.6: Draft quarterly mine production schedule (MOD, 2019)

The geotechnical parameters applied to the pit design are summarised in Figure 2.7 and shown in Table 2.2. It is noted that 10 m and 5 m bench heights have been included on the FW so as to better follow the FW orebody contact. The overall batter-berm angle (of 20m batter and 20m berm) remains unchanged.

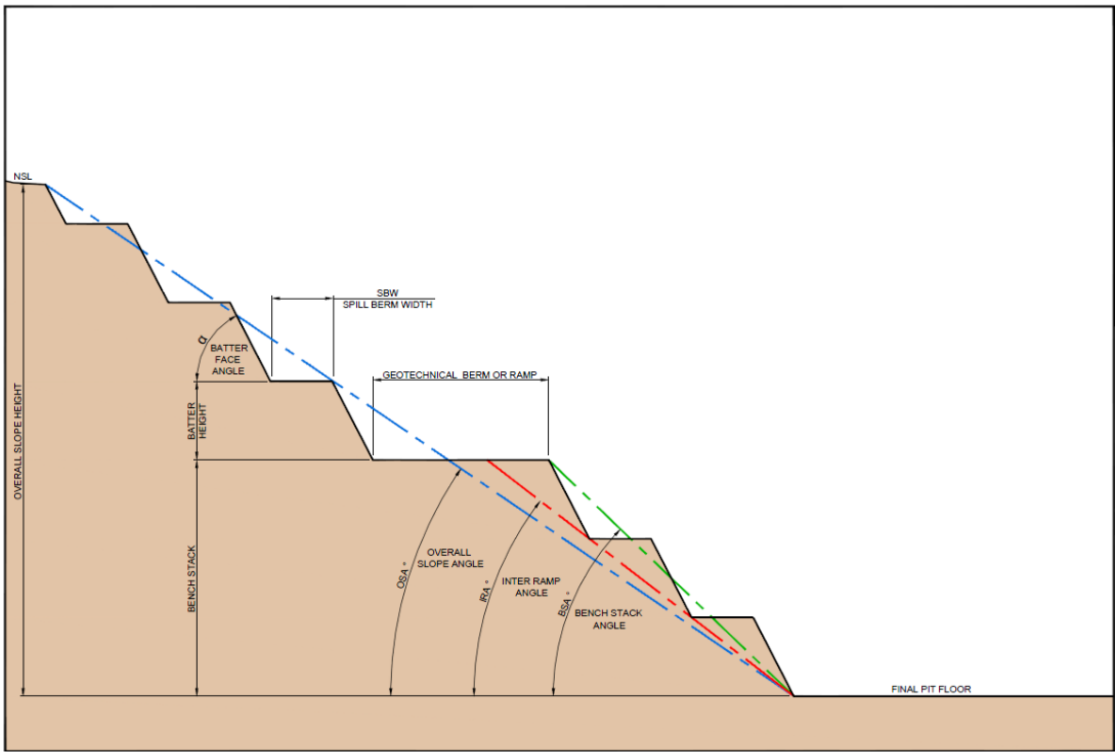


Figure 2.7 Geotechnical design terminology

Table 2.2: Anticipated mine pit slopes (MOD, 2019)

Item	Unit	Fresh rock zone below RL 1095m				Surface zone above RL 1095m
		Hanging Wall	Foot Wall			
Overall slope angle	Degree (°)	57	35			27
Batter angle	Degree (°)	80	65			35
Bench height	m	20	20	10	5	10
Berm width	m	7.5	20	10	5	5
Geotechnical berm width	24m for Hanging wall adopting 120m stack heights					
	24m for foot wall adopting 80m stack height					

2.4.1.1 Expansion

Both the PFS and the detailed feasibility study have planned for an expansion of the production capacity at the mine after a few years of operation at start-up capacity. This expansion has assumed to include some of the copper resource that is currently modelled to “inferred” status into the production schedule. The confidence level for “inferred” material is less than the “indicated” material and will require further drilling before deciding on the feasibility of the expansion. However, based on the already undertaken drilling work in the project area and the understanding of the geology, it is likely the drilling will bring the material currently shown as “inferred” to “indicated” status, which would motivate the anticipated expansion.

Based on the above, this ESIA study has assume the expansion case of the mine as the ultimate mine size and has assessed impacts based on the expanded mine scale. Reference is made to the start-up case in some instances, as this is the proposed initial mine size.

2.4.2 Waste dumps

Waste dumps will be developed for mined overburden material and waste rock (that is commercially unsuitable). The mine pit design has allowed for the waste dumps to be located south east of the mine site, between the mine pit and the tailings storage facility (TSF), as shown in Figure 2.2 Progressive rehabilitation is limited by the life of mine and the nature of waste and tailings management proposed. Concepts for rehabilitation have been included in the conceptual mine closure plan which involves progressive rehabilitation of starter embankments, trials and investigations.

The conceptual cover design for closure includes a blend of competent coarse rock and top soil. Revegetation will include local provenance drought tolerant plant species. Conceptual designs have included retention of top soil, stability and containment of surface water run-off from the waste dumps comprising of a store and release cover system. Erosion and landscape evolution modelling concepts propose the outer embankments are limited to 18 degrees.

Final land use concepts include habitat for fauna, livestock grazing, medicinal plants, season vegetables and thatching grass.

2.4.3 Mining activities

The following sub-sections will briefly describe the mining activities. Mining will be carried out by a mining contractor. The mining process will include the following:

- Bush clearing
- Site preparation including topsoil stripping and stockpiling
- Haul road construction and maintenance
- Drilling and blasting of the ore, mining and haulage of waste and low-grade material into dumps
- Haulage of the ore, waste and low grade to the relevant stockpiles and dumps
- Pit dewatering
- Installation of stormwater management berms and drains.

2.4.3.1 Waste stripping

A large part of the mining activity is related to the removal of waste material from the open pits, to provide access to the ore.

2.4.3.2 Site preparation

Some of the areas have been cleared already during the drilling operations at the T3 project. Any additional areas requiring clearance will be done using the following process:

- Where the topsoil is less than 0.5m in thickness, it will be dozed or scraped into heaps, which will then be loaded and hauled to a topsoil storage stockpile located near the area being cleared. This will ensure that topsoil is available near where it may be used in future for rehabilitation purposes. The areas cleared of topsoil will then be prepared for mining operations or stockpiling of waste rock or ore.
- Topsoil will be salvaged and stockpiled separately for each vegetation community type. Stockpiles will be restricted to 5m high or less depending upon outcome of soil investigations and studies to utilize topsoil viability. Handling and haulage of topsoil will be kept to a minimum.
- Vegetation will be cleared along with the topsoil to ensure that organic material remains in the topsoil stockpiles, as well as to preserve the existing seed bank for future rehabilitation purposes.
- Where practicable, stripped topsoil will be used for rehabilitation purposes to fully utilise the viable soil and associated seed bank as soon as is practicable.
- Storm water drainage will also be addressed (as stipulated in the storm water management plan) as part of the site preparation phase and the following will be undertaken:
  - Pit contours, as well as storm water runoff requirements will be evaluated and analysed to prevent flooding of the pit excavation.
  - Following this assessment appropriate storm water management systems will be implemented. This may comprise the installation of flood diversion water drains and/or berms around the pit, as well as any other measures that may be required.

New internal haul roads will be required for the operation of the mine, and these will be constructed when mining commences and will utilise waste rock material from the mining process and/or will be compacted and graded to an acceptable standard, after clearing and stockpiling of topsoil has been completed.

2.4.3.3 Load and haul

All site layout preparations will be done once the Mining Contractor is on site. The Contractor will utilise its mining equipment to undertake the necessary activities (Refer to Section 2.4.4 for mining fleet equipment to be used).

All waste rock and low-grade ore that is stripped will be loaded by the excavator in the pit and hauled with dump trucks to the waste rock dumps (refer to Figure 2.3 for more detail on location). Materials on the waste rock dumps will be levelled and shaped using a dozer.

2.4.3.4 Drilling and blasting

Drilling and blasting: Initial planning indicates that drilling and blasting will take place in benches at a depth of 10m. The proposed methods, drill hole sizes and type of explosives are not yet available and will be further investigated during the detailed feasibility studies and detailed engineering and mine design.

Blasting will comply with Botswana's mine (explosives) regulations and the appropriate legal appointment will be made in this respect. It is expected that the blasting design will be in such a way that buildings within the project area will not be affected. However, in the event that any damage is experienced, a complaint must be raised by affected party, followed by investigations and compensation (where appropriate).

2.4.3.5 Material haulage

An excavator will load the ore/waste into the haul trucks, where after the haul trucks will haul the material to the appropriate destination. Ore will be taken to the ROM tip and will either be placed onto a stockpile or tipped directly into the plant feeding bin. Waste rock and low-grade ore will be hauled to the waste dumps. Low-grade ore will be dumped in a separate compartment in the waste rock dump, to ensure access thereto for possible future processing.

2.4.4 Equipment

The main fleet of equipment that is expected to be used at the proposed mine is shown in Table 2.3 below.

Table 2.3: Anticipated mine equipment

Equipment	Type (or similar)
Production drills	Sandvik Pantera DP1500
Blasting emulsion truck	Tba
Grade control drills	Standard Reverse Circulation (RC)
Resource definition drills	Standard diamond drill
Drill for oversize	Carrier mounted and bin mounted drill
Hydraulic Excavators	120t loading ore, 190-250t loading waste
Ore and waste haulage trucks	100-140t
Ancillary mine fleet	▪ Standard FEL ▪ Grader ▪ Water cart ▪ Dozers
Mobile lighting plant	Kubota PR8000 (4*2000W)
Small trucks and vehicles for maintenance and supervision	Various

Some examples of the equipment listed in the Table are shown in Figure 2.9 below.


CATERPILLAR
CATERPILLAR
HITACHI
EX1200

Figure 2.9: Examples of equipment (A): Ore and waste excavator and truck (B): Production drill (C): mobile lighting

The equipment as listed in this Section has been used as the “typical fleet” for the purposes of this assessment and are assumed to be the maximum numbers of the equipment. The exact fleet and make/brand of equipment may vary, subject to further assessment during the detailed feasibility studies and negotiations with various equipment suppliers and mining contractors.

2.4.5 Dust suppression

Water carts will be used to spray water on the frequently used haulage routes each day. This is done to reduce air borne dust arising from the haulage roads when the large trucks travel from them. The water trucks will have a tank with a capacity of approximately 70,000 litres and when dispensing water onto the roads, it will be refilled approximately once per hour. One example of this size of water truck is a 90-tonne class Cat 777 D, as shown in Figure 2.10 below.

Figure 2.10: Example of water truck

The water trucks are expected to be manned almost every day of the year, due to low average rainfall in the project area, and it is assumed the trucks will be operated for approximately 16 hours each day. Each truck will therefore dispense approximately 0.4Ml per day, based on current assumptions. The number of water trucks will initially be 2 or 3, and as mining progresses and haul roads become longer, this number may be increased. Water for dust suppression will be obtained from dewatering boreholes and from the in-pit sump.

2.4.6 Ore processing

Once the ore has been extracted from the pit and transported to the processing facilities, it will go through several processing stages to produce a copper and silver concentrate, to be sold for smelting. There may be subtle changes to the processing steps outlined below because of further metallurgical investigations and testing. However, the following steps are the anticipated steps for processing the ore to produce a marketable copper/silver concentrate for the Project.

The Client engaged a specialist process plant design company called Sedgman for the process plant designs for the detailed feasibility studies.

2.4.6.1 Comminution

The Run-of-Mine (ROM) material will be large rocks, transported by haul trucks into a ROM dumping pad. The first step of processing will be to reduce the size of the material from large rocks into smaller and consistent sized material, using a primary jaw crusher. The crushed rock discharges the primary crusher and is transported by way of conveying to the coarse ore stockpile (COS). The stockpile creates capacity in case of breakdowns or temporary problems with parts of the plant or mine pit.

Crushed ore from the COS is reclaimed by way of vibrating feeders. Ore is discharged from the feeders onto a conveyor and transferred to the grinding circuit. The grinding circuit consists of a SAG and Ball mill, with the ball mill operating in closed circuit with a set of hydrocyclones to control the feed size required for flotation. Coarse competent rocks (pebbles) discharge from the SAG mill and are conveyed back to the SAG mill feed conveyor. A provision has been made for the future installation of a pebble crusher should it be needed to improve grinding circuit power efficiency.

As stockpiles can create impacts in relation to dust, dust suppression sprays will be utilized at transfer points and rock discharge points.

2.4.6.2 Flotation, concentrate management and tailings

Primary cyclone overflow (grinding circuit product) flows via gravity to the flotation feed sampler, used to automatically collect a sample to test the feed grade of the ore. Slurry discharges from the sampler to the flotation conditioning tank, where reagents are added to enable separation of the valuable minerals through froth flotation. The slurry flows through a number of flotation stages, where the copper/silver concentrate is separated from the waste product.

The waste product is concentrated (tailings thickener) and disposed of in the tailings dam. The concentrate will be cleaned (via additional flotation stages), thickened, filtered and stockpiled prior to being loaded into bulk bags or containers for storage and subsequent transport to third-party smelters. The water recovered from the thickening process will be re-circulated back into the plant as process water.

At several places within the process, the density of the material will be measured by specific equipment, which requires a nuclear source. The process will also require chemicals, water and power as major input sources. The tailings storage facility is described in Section 2.4.7.

The processing activities detailed above are illustrated in Figure 2.11.

The proposed plant design is relatively simple and conventional, reflecting the favourable metallurgical characteristics of T3 ores. It is anticipated to process ROM ore at a rate of 3.2Mt/a, to produce a copper concentrate and tailings during the first three or four years of production (start-up phase). The plant will have potential to be up-scaled to 4Mt/a in the event that production is increased at T3, or additional ore is sourced from satellite deposits (Expansion Case), which is the scope addressed in this study. The proposed plant is illustrated in Figure 2.12.

Based upon core logging data, the copper mineral proportions across the deposit are estimated to be 70:20:10 for Chalcopyrite, Bornite and Chalcocite respectively. On this basis and using metallurgical testwork data, recoveries are calculated to be 93.1% copper and 86.2% silver.

Life of Mine average metal in concentrate production is 30kt/a copper and 690kozpa silver. Locked cycle metallurgical testwork confirms the potential to produce high-grade copper/silver concentrates, which are proposed to be stored on site and transported in 2 tonne bulk-bags or bulk containers.

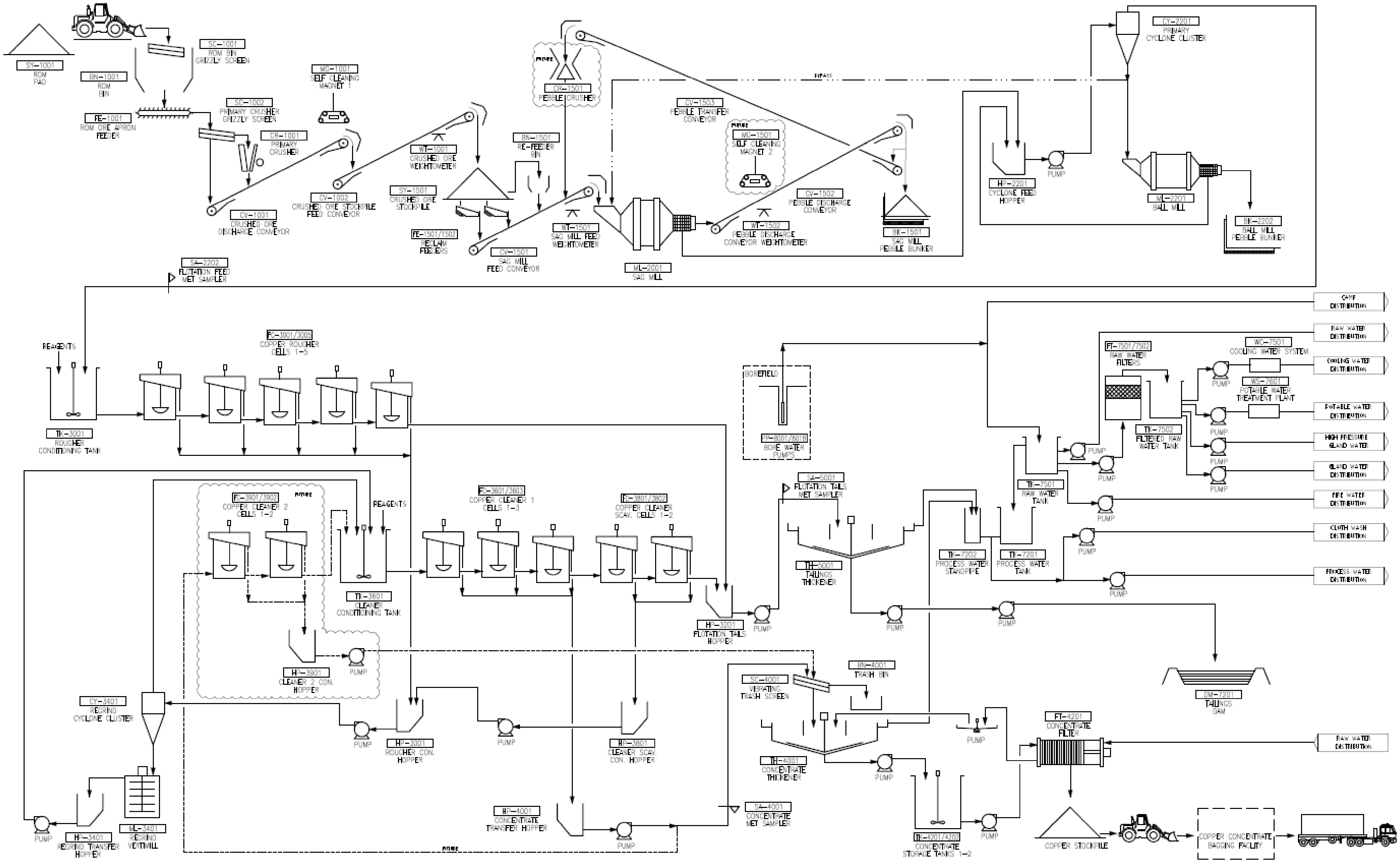


Figure 2.11: Illustration of the ore processing activities – Process flow diagram (Sedgman, 2018)

Figure 2.12: Model of proposed sulphide flotation plant (Sedgman, 2018)

2.4.7 Tailings disposal

The Client engaged Knight Piésold, a specialist consulting company to investigate several options in relation to the development of the tailings storage facility (TSF). The preferred option comprised a landform that integrates the TSF with the waste stockpile (Integrated Waste Landform). There is abundant gentle sloping room to allow for a significant increase in both tailings storage and waste stockpiling capacity.

The localised expression of a 3 to 5m thick layer of calcrete is an advantage for the TSF development, both in terms of water loss and in terms of neutralising potential for any acid drainage (although not anticipated based on geochemical studies). As a precautionary measure the TSF design includes a high-density polyethylene (HDPE) membrane. Water diversion channels will be constructed around the mine and process plant. These will be directed to storage areas/silt traps to mitigate contaminant transport.

2.4.7.1 TSF design

The TSF will comprise a paddock facility consisting of a zoned, downstream constructed embankment designed to store the tailings. The designs done during the FS is based on a storage capacity of 34.4Mt, at a filling rate of 3.2 Mt/a. The total footprint area (including the basin area) for this facility be approximately 50ha for the Stage 1 TSF, increasing to 150ha for the final TSF. The TSF designs are being updated during the detailed feasibility studies based on the increased plant capacities, and both the quantities of disposal and footprint are part of the update. However, the general design principles will remain the same, and were used for the assessment within this study.

The TSF will be constructed as an integrated waste landform (IWL). It will be constructed as a paddock type storage facility to the south of the waste dump and open pit with the waste dump as a buttress on the northern walls. The embankment will be constructed in stages, with the core zones being constructed by a specialised earthworks contractor and the structural embankment being progressively constructed by the mining fleet as part of the mine waste operations from the open pits.

The facility will be constructed initially as a two-cell arrangement, Cell 1A (Stage 1) and Cell 1B (Stage 2) (Knight Piésold, 2018).

The basin area will be cleared, grubbed, topsoil stripped, and a 300mm depth compacted soil liner constructed over the entire basin area, comprising either reworked in-situ material or imported low permeability material. A geosynthetic HDPE membrane will be installed over the whole basin to reduce the risk of the seepage loss from the facility. The design will incorporate an underdrainage system to reduce pressure head acting on the basin liner, reduce seepage, increase tailings densities, and improve the geotechnical stability of the embankments. A leakage collection and recovery system (LCRS) will be installed beneath the basin liner.

Tailings will be discharged into the TSF by sub-aerial deposition methods, using a combination of spigots at regularly spaced intervals to maintain the supernatant pond near the decant tower(s). A decant tower will be constructed within each cell. The decant towers will collect and pump reclaimed water to the process plant via a decant return pipeline. The active tailings beach will be regularly rotated around the facility to maximise tailings density. The decant towers will also extract supernatant and rainwater from the tailings surface over the life of the facility.

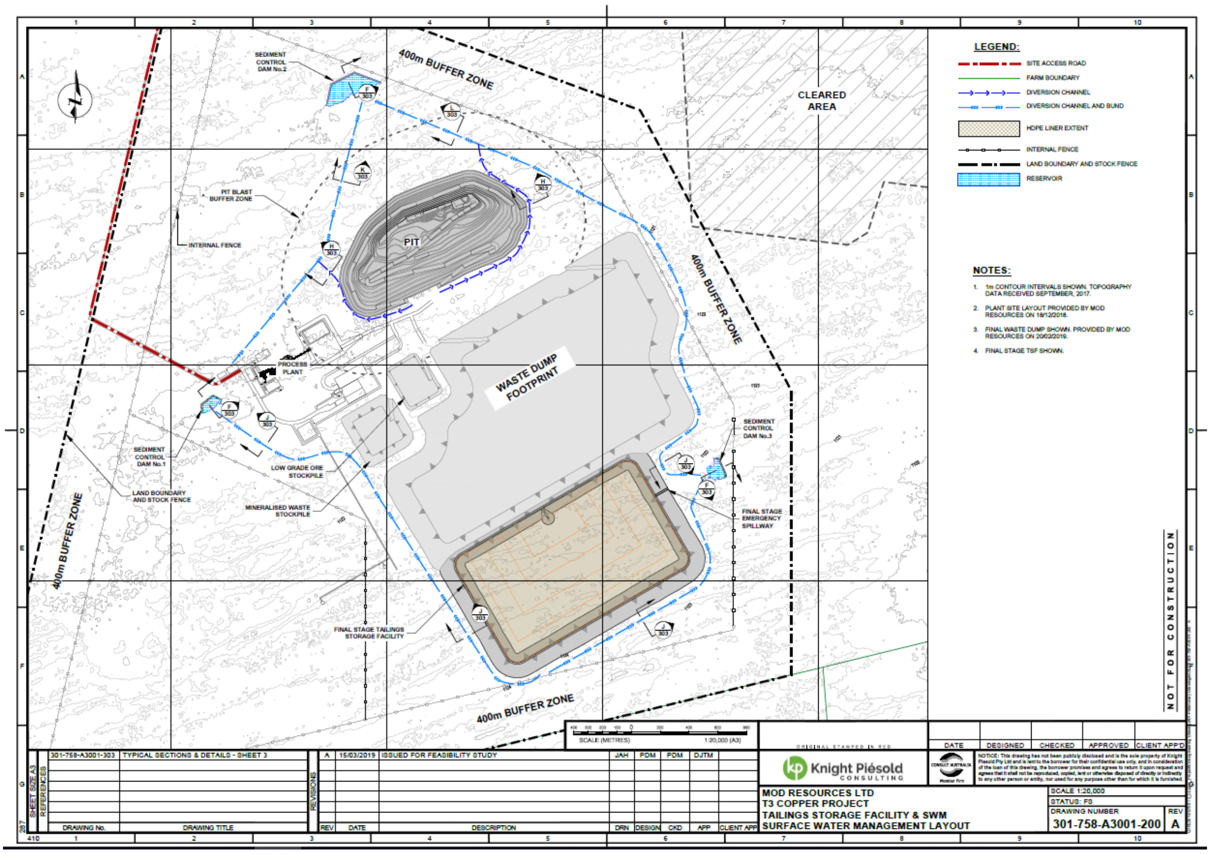
An emergency spillway will be constructed with each embankment raise. The closure spillway will be located to discharge via embankment access ramps to ensure all rainfall runoff from the TSF will safely discharge after operation ceases. The key design parameters in relation to storm water management and pollution control used for the TSF design, are shown in Table 2.4 below.

Table 2.4: TSF design parameters (Knight Piésold, 2018)

Storm events	Design application
1:2 yr	Temporary diversion structures during construction.
1:100 yr ARI Critical Duration	Diversion channel capacity.
1:1000 yr/72 hr in addition to the maximum operating volumes for average climatic conditions or 1:100 wet year whichever is most critical	TSF stormwater storage capacity.
PMP storm event	TSF has emergency and closure spillway which will have capacity to convey.
Water management	
Supernatant pond	Minimum operating pond (target pond size) of 5,000 m^3.
Operations	
Fluid Management	■ Basin underdrainage system reports (via gravity) into a collection sump within each cell, pumped to supernatant pond. ■ Decant tower removal of supernatant solution via pipeline to the plant. Decant towers located adjacent to divider embankment within each cell. Decant towers raised to design pond elevations. ■ Collect surface water (runoff) via decant.
Embankments	
General	■ Deposition towards decant tower. Minimum tailings freeboard of 0.5m. ■ Minimum freeboard of 0.5m to critical pond, the

	greater of: – Average annual rainfall plus 1 in 1,000-year recurrence interval, 72-hour duration storm event. – 1 in 100-year wet annual recurrence interval
Tailings basin	
Basin Liner	■ Composite liner over entire TSF basin area, comprising compacted soil liner overlain by 1.5mm smooth HDPE geomembrane liner. ■ Compacted soil liner comprises primarily in situ soils, scarified and re-compacted throughout basin area to form a 300 mm thick soil liner. ■ Where in-situ material is unsuitable for soil liner, suitable material will be imported to provide the liner.
Tailings Underdrainage System	■ Collector drains and finger drains throughout the basin area, with water collected from the tailings mass and discharged to a collection sump, then pumped to the supernatant pond.

In Figure 2.13, the plan view of the proposed TSF (preliminary design, subject to change) is shown, as well as a section of the embankment (final stage).



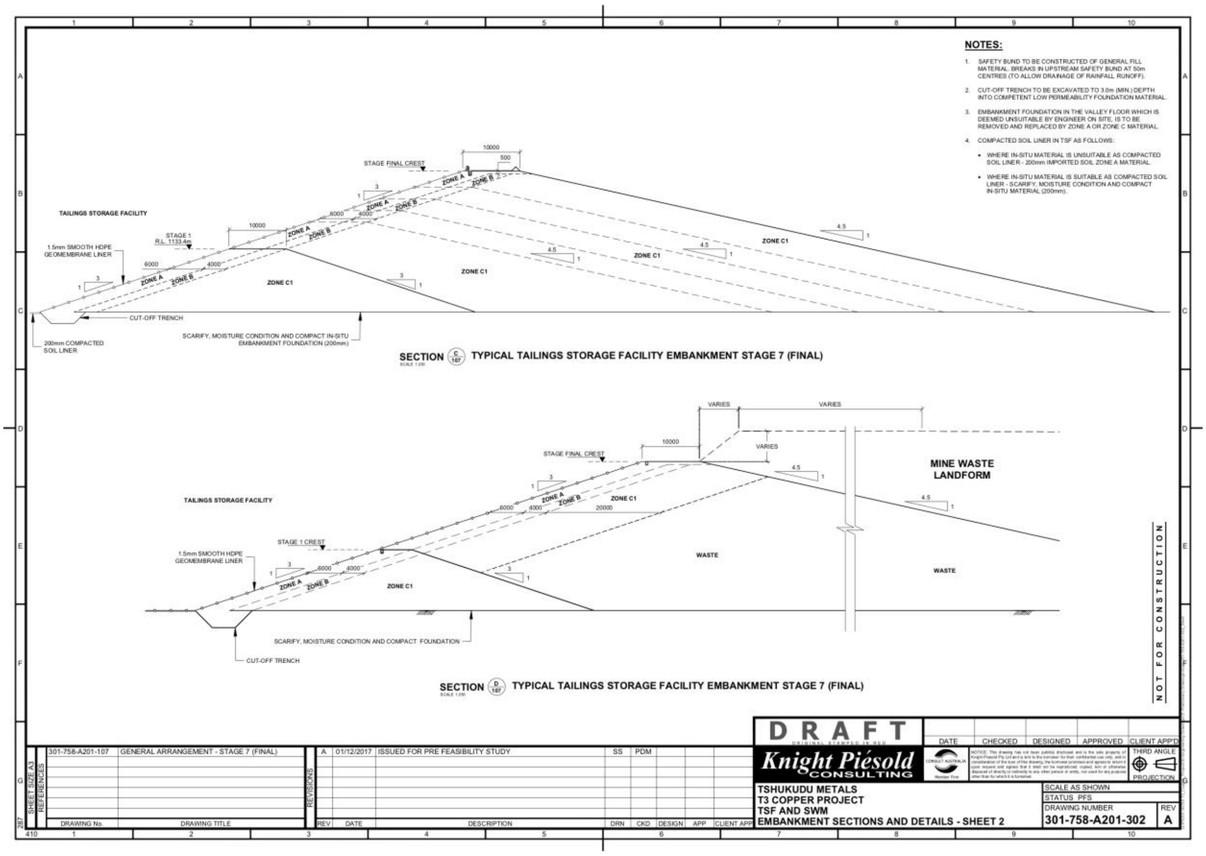


Figure 2.13: Plan and section view of tailings disposal facility (Knight Piesold, 2018)

2.4.8 Blasting and explosives magazine

Explosives will be stored and manufactured on-site, during the life of the mine for the purposes of blasting. Both waste rock and ore are expected to be blasted as part of the mine operations. The Department of Mines through its offices in Gaborone and Francistown monitors handling and use of explosives throughout the country. Manufacturing of explosives will be part of the mine blasting activities and this will require storage of substantial amounts of ammonium nitrate and diesel on site. Explosives manufacturing in this case means combining ammonium nitrate and diesel or pumping emulsions (wet explosives) into drilled blasting holes.

This requires a written request by Tshukudu Metals and permission by the Department of Mines (DOM) and as such, consultations with the DOM Explosives Engineer are required. Explosives will be stored in an explosives magazine that will be constructed and managed in accordance with the requirements of the Explosives Act Cap 24:02 of Botswana.

The Explosives Magazine will be constructed at least 500m away from the mine offices and temporary camps, the open pit and the process plant and infrastructure Area. A 1.8m security fence and lockable gate will be installed around the explosives magazine.

Earth berms will be constructed around explosives magazine for protection against accidental detonations.

The following building specifications will be followed:

- Doors will be steel single door
- No windows are allowed for
- Floors will be screeded only
- Suitable ventilation with appropriate roofing and lightning protection will be installed.

2.5 Associated supporting infrastructure and facilities

The mine development and operations will require water and electrical power. There will also be a requirement for site offices, workshops, internal and external roads, water pipeline, power lines and these form part of the scope of the development. These components are detailed below.

2.5.1 Mine site fencing

The main mining area including the processing plant, workshop offices, waste disposal facilities, etc. will be fenced off for security and safety reasons and to keep domestic and wild animals away from the machinery and hazardous substances. The buffer zone around the mine area is 400m and is connected to the existing farm boundaries, which requires additional fencing.

The fencing and demarcation that will be installed for the T3 mine include:

- Beacons in a cleared strip along the edge of the mine lease boundary: concrete beacons/markers.
- Boundary fencing around the operational areas, including mine pit, dumps, processing plant and various dams: chain-link type fencing, compliant with Botswana mine regulations.
- Fencing along the access corridor (some fencing already exists): farm boundary type fencing.
- Internal fencing around dams, electrical equipment etc: type as suitable for the application.

A range of fence types will be constructed around the mine site and associated infrastructure. The Mining license boundary fence and the access road fences will be a game fence. An additional stock fence will be constructed as an inner fence, approx. 400m inside the mining license boundary. Gates and grids will be installed where required and additional security fencing will be installed to restrict access to the process plant and other sensitive infrastructure.

2.5.2 Power supply

A 220kV (220kV design but operating at 132kV initially for the first couple of years) transmission line is planned along the A3 road by Botswana Power Corporation (referred to as *North West Grid Transmission Connection Lot 4 project*[3]), scheduled to be available during the first quarter of 2020 (MOD Resources, 2017). The above-mentioned project is expected to supply the proposed mine with electricity, through:

[3] Not part of this project and this ESIA study

- An overhead connection line along the proposed service corridor (anticipated to be an overhead powerline, constructed to 220kV design levels, lattice tower design as currently employed by BPC.

It must be noted that during earlier ESIA stages a substation near the A3 road was anticipated, but this is no longer required as the 132/220kV line (BPC Lot 4) will be extended to site and voltage will be stepped down at the substation near the mine site. The infrastructure will be developed by Tshukudu Metals. The layouts of the substation were not available at the time of compiling this report, as the Project engineering studies are on-going. The power system requires two stations. A 132 kV switching station, which can be expanded to a 220kV/132 kV substation in the future if the main BPC transmission line is upgraded to 220 kV, located near the A3 highway and a second 132 kV/11kV substation located adjacent to the mine. It must be noted that the powerline and substation will be developed based on BPC specifications, and typical designs for the powerline and substations are illustrated in the sections and figures below.

2.5.2.1 Power line

The completed 220kV overhead line consists of lattice steel towers and aluminium conductors suspended a minimum of 10.5m above the ground level. No tall trees or permanent structures less than 4 metres below the conductors within the servitude would be permitted to ensure minimum statutory clearances are observed. Grass and low vegetation can remain within the corridor of the powerline. Since the line is proposed to follow the road reserve for most of the length, the vegetation clearance (on the road side) for the project will be limited, as vegetation has already been cleared in the road reserve. An example of the proposed tower structure is shown in Figure 2.14 below.

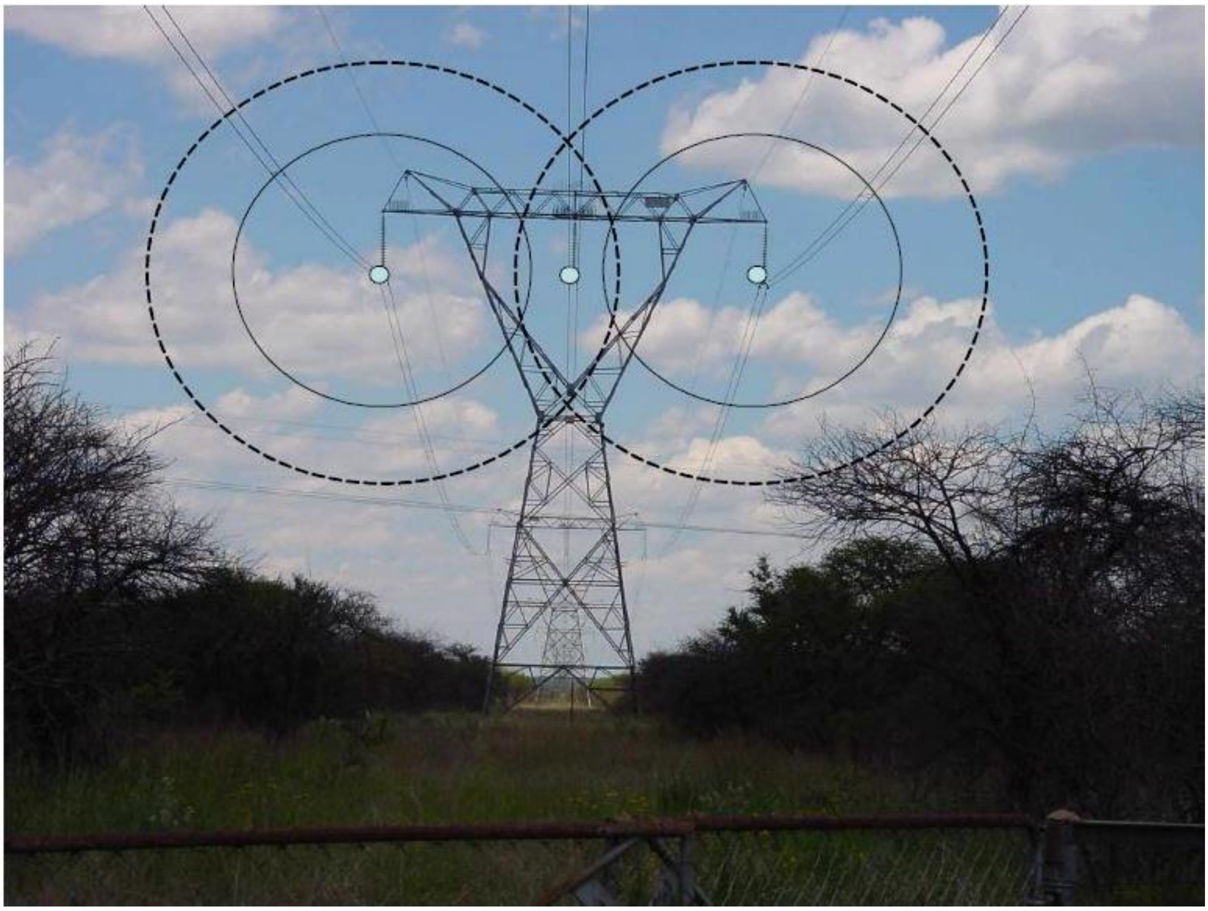


Figure 2.14: Example of tower as proposed for the line (indicating required clearance area)

The servitude width for the line will be 31m wide (15.5m from each side of centre line) for building restrictions but overlap with access road may be agreed with BPC. The approximate minimum vegetation clearance width is 8m (which will be maintained as required during the operational phase). The span between towers is typically 300m, like other BPC powerlines. The wayleave for the powerline is usually slightly wider than the required corridor width.

2.5.2.2 Substation at mine site

As indicated earlier, the power supply will require the development a substation near the mine site as part of the project scope, to enable connection to the BPC powerline currently under construction as part of the NWGTC project. Details of the substation as included in the project scope are summarised in the following table.

Table 2.5: Substations details

	Detail	Footprint (m)
1	220/11kV substation	100x100

The construction of the substation will include:

- Terrace work and drainage requirement
- Equipment foundations
- Building to accommodate secondary plant equipment
- Compacted road within substation
- Transformers erected within oil containment areas

Aside from the electrical equipment, the substations construction will include the following components:

- Stormwater drainage
- Access road and site perimeter fencing
- Control building

Layouts and detailed designs were not available at the time of this study, but will be according to BPC specifications, and similar substations have been used for assessment of impacts. A cross-section of a typical 220/33kV substation is shown in Figure 2.15a below, and a picture of a similar substation is provided in Figure 2.15b.

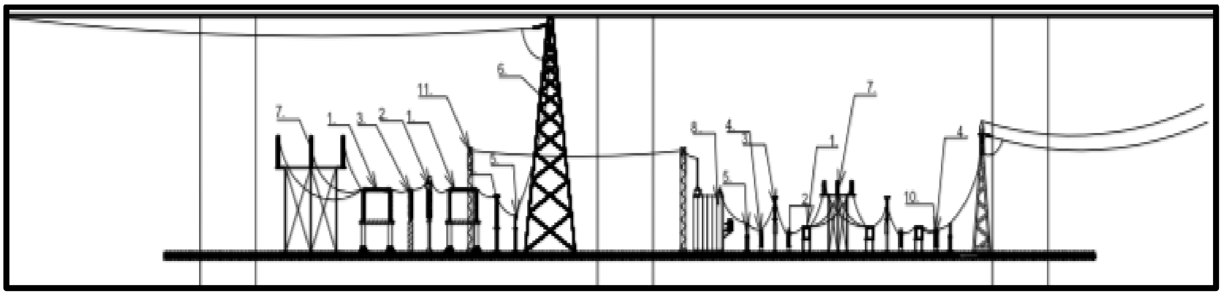


Figure 2.15a: Typical cross-section of substation (Source: BPC, 2017)

Figure 2.15b: Example of substation (Source: BPC, 2017)

2.5.2.3 On site power generation

The main source of power for the project will be grid power, from the new North West Grid Transmission Connection project. It is understood that the project will be commissioned by the first quarter of 2020. The transmission line project(s) are separate projects, and do not form part of this ESIA study, authorisations have been obtained by BPC prior to the commencement of construction. The self-generating power requirements are still being developed based on discussions with BPC and will depend on timing of completion of the grid power project. The below describes the anticipated on-site power generation.

As the power demand at the mine (for construction) will prior to the completion of the grid expansion, diesel powered generators will be installed at T3. The generators will supply power during the construction of the Project and will remain in place for back-up purposes once grid power is available. The generators form part of the Project scope and have been assessed within this ESIA study.

The power supply solution for the Project is summarised as follows:

- The use of diesel generators for the construction and commissioning (total installed capacity of approx. 15MW
- The proposed design would be to use a centralised diesel generator system complete with step-up transformers and supplying the process plant, and other load centres at 11kV.
- The power generation options (outsourced vs. owner operated) are currently being investigated, based on different power supply contracts
- Power generation capacity will require to remain on site after grid connection, for power supply back up during grid power failures.

There are two main components associated with the power plants:

- Fuel farm for diesel storage
- Power infrastructure, such as overhead lines and substation

The fuel storage will be further detailed in Section 2.5.5.

The power reticulation at the site includes:

- Substation with transformers and other electrical equipment (combined with the transmission line substation)
- Overhead lines (wooden poles, 11kV) to boreholes and other main power supply points within the site
- Underground lower voltage cabling for power distribution.

Within the mine footprint power reticulation will be developed, which includes overhead lines, underground lines, transformers, mini-subs and other electrical equipment as required. It is expected that most of the power reticulation within the plant area will be underground cabling, and that power supply to boreholes and other areas away from the plant will be by overhead (wooden pole) lines.

An example of diesel power generators and associated overhead powerlines is shown in Figure 2.16 below.

Figure 2.16: Example of on-site diesel power station (Source: APR Energy website)

2.5.3 Water supply

Ore processing as well as mining activities require significant quantities of water. A water resources investigation has been undertaken by Water Surveys Botswana. Various steps in the plants will require water for the processing of the ore. In addition to this, water is required for the mining activities as well as dust suppression in mining. A small quantity of water is also required for treatment and use as potable water. The plants will be designed such that all water will be recycled where possible, and water losses will be minimised. Anticipated water requirements for the water studies are summarised in the following table.

Table 2.6: Anticipated water requirements

	3.2Mt/a capacity (start-up)	3.5Mt/a plant (expansion
Raw water for plant	250 m^3/hr	300 m^3/hr
Potable water	12 m^3/hr	15 m^3/hr
Water for washdown and dust suppression	10 m^3/hr (24hr average)	15 m^3/hr (24hr average)
Assumed recovery from TSF	15%	15%
Total hourly requirement	272 m^3/hr	330 m^3/hr
Daily requirement	6,528 m^3	7,920 m^3

The base assumption (15% recovery as shown in Table 2.6) utilises a conventional thickened tailings, as per the FS.

Based on the current groundwater studies, water supply for the mine operation will be from boreholes within the 153-NL farm, mainly from dewatering process in combination production boreholes within the farm boundaries. Therefore, an external wellfield has not been assessed as part of the Project. The main project components related to the water supply include:

- Dewatering boreholes
- Pipes and power supply to boreholes
- Production boreholes (for back-up water supply)
- Water holding ponds within the plant area.

Based on the recently undertaken groundwater study work, there may be times where there is excess groundwater (recovered from bores around the pit to keep the pit dry). During the initial construction period, where waste is being mined from the pit (required to reach the mineralised zone) and the process plant and infrastructure is being built, limited water is required on site (for dust suppression, potable water, construction of roads, embankments, earthworks and commissioning activities), and not the full amount of water required to operate the plant.

In the case there is excess water, options including water reinjection into nearby bores or supply for irrigation in existing paddocks on farm 153-NL will be investigated. Additional water modelling is planned in 2019 to improve confidence levels in water modelling and develop options once the finalised site water balance is completed. Options will need to be finalised in consultation with the farmer and relevant Government departments.

2.5.4 Stormwater

A surface/storm water management plan has been developed by the design team (refer to Appendix C6). The plan aims to:

- Regulate activities to protect water resources
- Limit pollution of watercourse through management
- Establish the capacity of water infrastructure
- Separate clean/dirty water systems sized for 1:50-year flood event
- Develop management measures to protect watercourses containing runoff from polluting infrastructure.

Since there are no surface water channels or rivers in the project area, flooding and surface water concerns mainly relate to storm water events and protection from local ponding during times of extreme storm events.

2.5.5 Fuel

The mine equipment and diesel-generated power gen-sets will require a large amount of diesel fuel. To ensure approximately 4-8 days of diesel storage at the site, the storage capacity at the tank farm at the site is expected to be approximately 800-1200m^3, which is fuel storage dedicated to the power plant. In addition to the power plant fuel storage, separate fuel storage areas will be constructed for the open pit mining equipment. Although the exact size of each fuel tank has not been established, it is expected to be approximately 160-200m^3. Further diesel storage is expected at the explosives plant. All fuel storage at the proposed tank farms will be above ground.

Total anticipated fuel storage is summarised in Table 2.7 below.

Table 2.7: Anticipated fuel storage quantities

Location	Approximate total storage (m^3)
Power plant	800-1200
Mining equipment	160-200
Explosives	100
Office and workshops	100

The fuel storage facilities will be developed with the required spillage containment, oil/water separators, fire prevention equipment and spillage control pads (for plant fuelling). An example of fuel storage at a mine is shown in Figure 2.17 below.

Figure 2.17: Example of fuel storage (Source: Engen Botswana)

2.5.6 Reagents

The following reagents are used in the processing plant:

- Xanthate
- Frother
- Promotor
- Lime
- Floc, etc.

2.5.7 Associated facilities

Various site buildings will be constructed at the mine site. These will include:

- Mine offices
- Equipment workshops and washbays
- Site first aid facility* (see below)
- Training rooms
- Ablution facilities
- Sewage treatment plant
- Plant control room
- Assay/metallurgical laboratory
- Reagents storage area
- Warehouse
- Concentrate filtration and storage building
- Security building
- Weigh bridge
- General waste storage facilities.

*The Mine site is proposed to have a first aid facility. On site will paramedics (in-case of emergency). The aim of this facility is to provide patients with first aid and triage, prior to transportation to medical facilities either in Ghanzi or Maun depending on the nature of their conditions. The accommodation camp in Ghanzi will be provisioned with a clinic supported by nursing staff. This has been selected as the location for the facility as the work force will be based at the accommodation camp and will commute to the T3 mine site on a daily basis.

The location of these components within the mine site has been illustrated in the draft layout in Appendices (Technical Drawings). The designs of the facilities have allowed for spillage prevention where appropriate, such as oil/water seperators at the workshops and washbays, spoilage containment at the reagents storage areas and warehouse.

2.6 Site access and service corridor

A services corridor of approximately 12.5km and 100m width will be established from the A3 road to the mine site. The corridor will include:

- Overhead power line to be connected to the proposed NWGTC 220kV line[4]. The powerline has already been described in Section 2.5.2.1.
- Access road: Anticipated to be a gravel road, graded and shaped suitable for the anticipated mine traffic.
- Telecommunications: This will include a fibre optic cable, and possibly an extra communication tower located near the mine entrance
- Site security and access control at the mine entrance.
- Safe cattle crossing between farms will be provided.
- Signage: Installed at the A3 road and along the access corridor

2.7 Transport of materials to and from the site

Construction material, heavy machinery, fuel, reagents, and other equipment will be delivered to the mine using heavy trucks and haulage equipment which will utilise the access corridor. This is expanded upon in Appendix J.

Concentrate that is obtained at the site will be transported by truck from the mine site to Walvis Bay for export. The trucks will generally operate in daylight hours only and will consist of a truck and a trailer carrying approximately 35 tonnes of concentrate either in bags or in covered trailers. The trucks will observe all local speed limits and will be closely monitored.

2.8 Accommodation

An accommodation camp will be developed for the mine personnel near Ghanzi Township. The current camp (first phase) has been developed from mainly portable/prefabricated components and cabins, installed on slightly raised pillars and/or platforms at the site. The current camp allows for accommodation of 40 people (units), the camp development was authorised by DEA following a Project Brief submission. The current accommodation camp is shown in Figure 2.18 below.

[4] Proposed by BPC –not part of this assessment

Figure 2.18: Aerial view of accommodation village (Source: Tshukudu Metals, 2018)

The camp is proposed to be expanded to 400 capacity, with an additional 300 temporary capacity during construction (which is being assessed separately from this ESIA). In addition to this it is anticipated that approximately 100-150 people may be accommodated in a temporary camp at the mine during the construction period. This is temporary accommodation in the form of portable cabins and tented camps near the construction site, and will only be at the site during the construction period. During operation all workers will be accommodated at the camp on the outskirts of Ghanzi, or within the Ghanzi township.

2.8.1 Contractors camp

The temporary contractor camp that is to be located at the mine site will accommodate 200 to 250 personnel, predominately working on day shift only. Rosters will vary but will generally be 10+ hours per day and roster durations will vary dependent on the particular function. The camp will be fenced and will have access controlled via Security personnel with only camp residents permitted to have.

2.9 Employment

Tshukudu Metals is currently undertaking copper exploration activities at the study area, and has approximately 130 people working on the site (including drilling contractors). The employment numbers for the T3 project are currently estimated as follows:

- Current employment: approx. 130 people

- Employment during construction (peak): approx. 800-850 people
- Employment during operation (direct employment): approx. 450-550 people

The employment recommendations for the Project have been developed as part of the SIA studies (Appendix L). This includes recommendations on relation to employment strategies, local employment and skills development. It is recognised local skills in relation to mining are limited, and that skilled labour will be sourced nationally, expatriates will be engaged if these jobs cannot be satisfactorily filled locally.

2.10 Project schedule and phasing details

A draft schedule for the development of the overall Project is shown in Table 2.6.

Table 2.8: Project development schedule

Component	Details and dates
Exploration drilling, geotechnical drilling, water drilling	September 2018
Pre-feasibility study	Completed
Detailed feasibility stage	Completed
Mining license application	June 2019
Project Commence	Q3 2019
Operation	Q2 2021

2.10.1 Detailed feasibility study

The feasibility stage activities included:

- Detailed engineering/mine designs
- Detailed feasibility studies
- Geotechnical investigations
- Water investigations and modelling
- Metallurgical testwork
- Licensing and approvals.

2.10.2 Mobilisation

Mobilisation will commence in 2019 (subject to results from feasibility studies and licenses), as construction of the mine is expected to commence during the same year. This will include the following:

- Engagement of senior mine staff for the project.
- Completion of funding arrangements for the project.
- Procuring of equipment and services for the development of the project.
- Commence construction.
- Continue exploration activities on remainder of the prospecting licences.

2.10.3 Construction and commissioning

During this phase, construction of the mine and other associated facilities will commence, and the mine will be commissioned. Initial mining will commence during this phase, involving the clearing of vegetation, salvaging of topsoil and stripping of overburden by conventional open-pit mining of the ore using truck and shovel methods, all aimed to reach the orebody. No processing activities will take place during this phase.

2.10.4 Operational phase

Once the commissioning has been completed, full-scale operation of the mine will commence. Mining of ore will be undertaken by conventional open-pit mining of the ore using truck and shovel methods. Continued expansion of the pit and clearing of vegetation, salvaging of topsoil, stripping of overburden will also take place.

The current LoM is anticipated to be 12 years, based on the assumption that the expansion case will be implemented. The LoM is likely to be extended, but this is dependent on several issues:

- Results from further exploration drilling at other areas and deeper areas at T3
- The project economics, such as world copper price and cost of resources such as fuel and energy.

2.10.5 Decommissioning and rehabilitation

A conceptual mine closure plan was carried out by the specialist consultant, Rescology. The aim is to commence rehabilitation process as early as practicable and integrate closure planning into all phases of the project life cycle with due consideration to stakeholder engagement, optimal final landform design and progressive rehabilitation.

The conceptual final land use options for different infrastructure areas may include:

- Mine pit, ramp and abandoned bund:
  - Regional water reserve
  - Conservation area
- Waste dumps and TSF areas:
  - Habitat for fauna

  - Planting of medicinal plants, seasonal indigenous vegetables and thatching grass
- Processing plant and ROM areas:
  - Cattle grazing
  - Planting of indigenous vegetable and medicinal plants
  - Used for traditional or cultural activities
- Service corridor may be used for cattle grazing, indigenous vegetation planting or ownership may be transferred to another party.
- Water storage, power and telecommunication facilities may be retained, or the Client may transfer ownership to another party
- Accommodation camp can be partially retained, or ownership transferred to another party.

Development of final land use options is subject to stakeholder engagement and results of further studies, trials and investigations developed during the LoM.

3 Policy, Legal and Administrative Framework

This Chapter is intended to identify all policies, legislation, regulations, plans, guidelines, etc. which are relevant to the planning, development, operation and decommissioning of the proposed development. The key pieces of legislation that have a direct bearing on the successful implementation of the proposed development are highlighted below.

3.1 National legislation

The following are Acts and regulations relevant on a national level, which may affect the proposal in terms of the developer's obligations and legal requirements in carrying out the Project. The national legislation description has been organised into the following categories for ease of reference:

- Botswana constitution
- Land related legislation
- Environmental legislation
- Water related legislation
- Mining and energy related legislation.

3.1.1 Botswana constitution

The Constitution of Botswana is the supreme law of the land. Adopted at independence on 30 September 1966, the Constitution declares Botswana as a parliamentary republic, and identifies fundamental rights and freedoms of individuals in Botswana.

3.1.2 Land legislation

Botswana has three principal land tenure systems, each governed through specific laws and regulations regarding access, ownership, and the ability to transfer property. These comprise:

- Freehold land, which can be bought and sold on the market.
- Tribal land; which can be transferred through agreed mechanisms and which are in part governed by traditional systems.
- State land; which includes national parks, and much of what is defined as urban land, and freehold tenure in urban and rural areas (FinMark Trust, 2012).

Tribal land is most common, followed by state land. In overall, an estimated 72% of land is classified as Tribal land, 23% is classified as State land, and 5% is classified as Freehold (Mathuba, 2003). Tribal land is used for agricultural purposes (with uses including arable farming, wetland farming, mixed farming, and grazing), commercial agriculture, industrial use, residential and community.

3.1.2.1 State Land Act (1966) – amended in 1993

Botswana passed the State Land Act in 1966. It provides for the management of state land (urban land, parks and forest reserves) by the central government working with district and town councils. State land is allocated through Certificates of Rights, which are inheritable, perpetual and secure or, if converted, can fall under a Fixed Period State Grant leased for 99 years to residential use and 50 years for commercial and industrial use (see Bornegrim and Collin, 2010). The Sectional Titles Act of 1999 (USAID, 2010) largely governs land use in urban areas where an extensive land market has developed.

The State Land Act also provides for privately owned freehold tenure, where land is also inheritable, perpetual and transferrable, and which can be owned by individuals or companies. Privately owned land is found in urban areas for residential purposes, and an established market exists in this regard especially in Gaborone and Francistown. Since 1978 the government has stopped the allocation of new land as freehold tenure for agricultural purposes, and some freehold land has since been converted into tribal land and state land. The project site is entirely on freehold land.

3.1.2.2 Town and Country Planning Act (2013)

This Act requires development plans for all areas declared as planning areas and promotes environmental protection through the Development Control Code and the Urban Development Standards which establish planning controls over the development and use of land. The Act also requires local authorities to prepare development plans for all planning areas. However, according to the Act, the use of land for mining purposes (including ancillary activities) can be carried out without recourse to the planning authority or responsible authority. Expectation is that the works or change in the use of land shall be carried out or made in accordance with the mine lease and with the Mines and Minerals Act.

3.1.2.3 Other

The 1975 Tribal Grazing Lands Policy allowed the changing of tenure in tribal lands to allow exclusive leasehold rights regardless of tribal affiliation, with land boards responsible for such land allocation in rural areas. The 1977 Town and Country Planning Act govern the development of rural and urban land; setting forth plans for land planning.

The 1991 National Agricultural Development Policy allows for permit owners of boreholes to apply for 50-year leases to an area of 6,400 square hectares around their boreholes. Leaseholders are permitted to fence the area and have exclusive rights to all natural resources within that area. The 1999 Sectional Titles Act allows for the transfer of rights to sections of developments and properties, including for industrial developments.

The allocation of land by type of tenure is summarised in the following map:

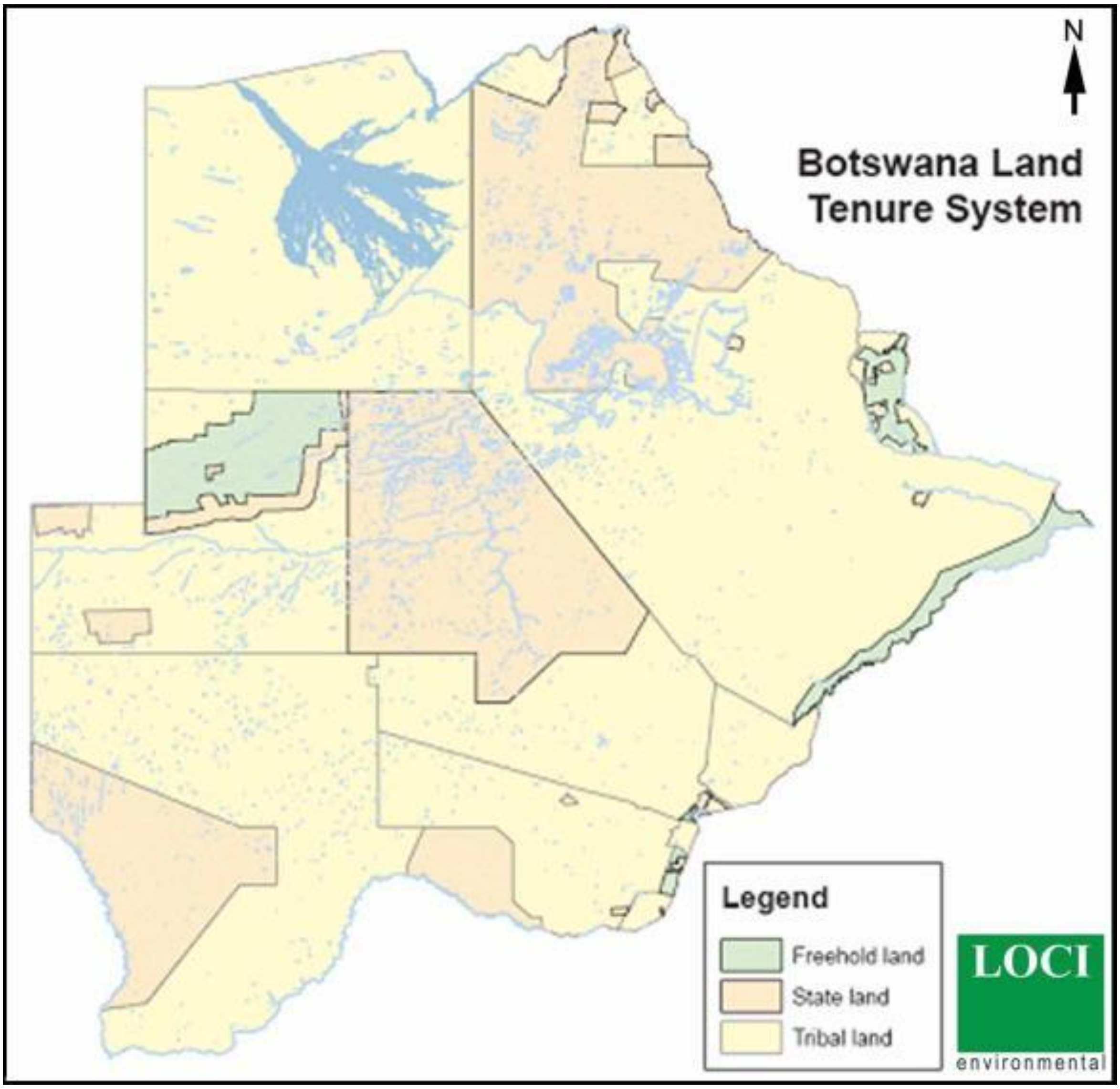


Figure 3.1: Map of Botswana Showing Tenure Categories (2009) (Source: Bornegrim and Collin, 2010)

The Project proponent must pay the land rights holder for the land that will be subsumed into the mining area. The possible impact area of the Project is located on freehold land on Farm 153-NL, and as mentioned in Chapter 1 agreement on land purchase has been reached with the farmer already.

3.1.3 Environmental legislation

The following sections summarise the environmental legislation relevant to the proposed project.

3.1.3.1 Environmental Assessment Act (2010)

The EA Act provides for Environmental Impact Assessments to be used to assess the potential effects of planned development activities; to determine and to provide mitigation measures for effects of such activities as may have a significant adverse impact on the environment; to put in place a monitoring process and evaluation of the environmental impacts of implemented activities; and to provide for matters incidental to the foregoing. Only after the competent authority, the DEA, has approved the Environmental Impact Statement can the project proceed. The EIA process entails:

- The identification of potential environmental impacts.
- The identification of measures to mitigate the adverse impacts and enhance the positive effects.
- Public consultations to inform and solicit the views and concerns of interested and affected parties about the proposed project.
- The development of an Environmental Management Plan that outlines the proposed measures to mitigate archaeological, environmental and social effects.

For the undertaking of environmental studies in compliance with the EA Act (2010), the Environmental Assessment Guidelines (2012) have been developed. These guidelines clearly outline the activities to be undertaken during each of the assessment stages, as well as the information and format to be submitted to the DEA for Review.

3.1.3.2 Monuments and Relics Act (2001)

Mining, particularly open pit mining is usually very destructive of the land surface, and this and collateral development is therefore likely to impact any archaeological or historic sites and other heritage that may exist in the proposed area. Immovable heritage is a non-renewable resource often with scientific, spiritual, economic and educational value. Therefore, an audit is required to be first undertaken for any impacted area, and if sufficiently important sites are discovered, a programme of mitigation to salvage material or information should be implemented prior to any construction work commencing.

All development in Botswana that are likely to change or disturb the land surface requires the permission of the Department of National Museum and Monuments, under the terms of the Monuments and Relics Act (2001), before such work can begin. This is usually granted after a pre-development impact study AIA has been conducted by a registered archaeologist to the satisfaction of the National Museum, the institution tasked with the responsibility of overseeing the Act. It may also be necessary to carry out mitigation work or have the development project modified before the permit is issued, depending upon the findings of the AIA.

The impact and mitigation studies are contributing to building up a comprehensive prehistory of the country as they frequently take place in under-explored parts of the country or unearth aspects of the heritage not previously studied. They also often contribute to improved planning of the proposed development by identifying potential snags and of course can obviate delays caused by unexpected discoveries that necessitate rescue archaeology.

This Act is of relevance to the proposed project, as an archaeological clearance is required before commencement of construction works. An AIA was undertaken for the T3 mining footprint in 2017, and it covered the proposed mining site (boundaries of farm 153-NL). This AIA was audited during the ESIA Stage of the project and extended to cover the service corridor and the housing camp. The ESIA work also included a cultural heritage assessment.

3.1.3.3 Conveyance of Dead Bodies Act (1933)

The conveyance of dead bodies' Act of 1933 establishes the procedure for the conveyance of dead bodies from one district to the other. The legal aspects in this act are normally applied in cases where human burial sites have been identified within the project area and there is need to exhume and re bury the remains. As a result, the act provides that authority must be sought from the district administration officer who shall satisfy himself/herself that such conveyance of dead bodies does not present a health risk to the community or places through which it traverses to its interment site. Further on the act provides that the re interment must be done within 24 hours of the arrival of remains at the reburial site.

This Act will be referred to for guidance in terms of transporting dead bodies if identified within the site during AIA survey or construction works (chance finds). A chance-find procedure and grave management plan has been developed for the Project.

3.1.3.4 Waste Management Act (1998)

"Waste" as defined by the Waste Management Act includes the following substances and any combination thereof which are discarded by any person or accumulated or stored by any person for recycling: undesirable or superfluous by-products; residue or remainder of any process or activity; any gaseous, liquid or solid matter. Waste is also defined by place of origin or generation (household, industrial, mining waste etc.). The Waste Management Act was promulgated to manage controlled waste and Section 45 of the Act incorporates the provisions of the Basel Convention. It addresses management of controlled and hazardous waste. This includes provision of waste management plans, identification of waste management sites and control of groundwater pollution.

The Act provides for the management of controlled waste, which includes general waste and clinical waste but excludes mining waste. The provisions of this Act require the project proponent to apply to the Department of Waste Management and Pollution Control (DWMPC) for a waste management licence for the facility to be run by the project proponent, if applicable. Should the waste management facility be located outside the mining lease area, the project proponent must obtain surface rights for the land in accordance with the relevant legislation.

The relevance of this Act to the proposed project is such that it is imperative to manage all waste generated by the Project, including construction waste, as well as waste generated during operational and decommissioning phases, which includes rubble, sanitation waste and general waste, in an environmentally responsible manner and as stipulated in this Act.

3.1.3.5 Atmospheric Pollution (Prevention) Act (1971)

Atmospheric Pollution (Prevention) Act is currently the only piece of national legislation, which is specifically directed at pollution prevention and control. The Act also provides for the prevention of the pollution of the atmosphere caused by industrial processes, and further provides for the appointment of pollution control officers as well as inspectors. Given the nature of mining operations, the provisions of this Act are such that the proponent cannot carry on any activities that would result in the release of atmospheric emissions before:

- The mining area is declared a controlled area by the relevant Minister.
- The company has been issued a valid registration certificate allowing the air emissions.

- The company has erected plants with equipment and technology that will abate and monitor the offensive emissions.

The Act represents a move to an air pollution control strategy that is based on air quality management. It focuses on the adverse impacts of air pollution on the ambient environment and sets standards as the benchmark for air quality management performance. At the same time, it sets emission standards to minimise the amount of pollution that enters the environment. The Act regulates the control of noxious and offensive gases emitted by industrial processes, the control of smoke and wind-borne dust pollution, and emissions from diesel vehicles.

The promulgation of the Act resulted in a shift from air pollution control based on source-based controls to decentralised air quality management through an effects-based approach. An effects-based approach requires the meeting of ambient air quality standards. Such standards provide the objectives for air quality management.

Multiple levels of standards provide the basis for both ‘continued improvements’ in air quality and for long term planning in air quality management. Although maximum levels of ambient concentrations should be set at a national level, more stringent ambient standards may be implemented by district and local authorities.

The control and management of all sources of air pollution relative to their contributions to ambient concentrations is required to ensure that improvements in air quality are secured in the timeliest, most even handed and cost-effective way. The need to regulate diverse source types reinforces the need for varied management approaches ranging from command and control methods to voluntary measures.

Tshukudu Metals must ensure adherence to local air quality standards where applicable and international standards such as the World Bank air quality guidelines. This is especially important in that the operations are to be periodically monitored by legally mandated air pollution control officers who will check for compliance. The Air pollution control officers also retain the power to request the registration certificate holder to take steps to improve the performance of the equipment in use or to request that the existing equipment be replaced with newer, more efficient equipment. Non-compliance is an offence that can result in legal action against the registration certificate holder.

3.1.3.6 Factories Act (1979)

The Factories Act is one of the few pieces of legislation primarily concerned with occupational health and safety in Botswana. The Act provides regulations to govern conditions of safety, health and welfare in the employment in factories and other places. It also provides regulations for the safety and inspection of certain plant and machinery and for incidental purposes. The definition of “Factories” according to the Act is essentially all premises where people are employed in manual labour, and is highly relative to the mining industry, although the mine itself is not considered a factory and is relevant to the safety regulations in the Mines and Minerals Act. Subjects relevant under the act include:

- Occupational Hygiene
- First aid
- Personal protection equipment (PPE)
- Notification of accidents, dangerous occurrences and industrial disease

- Cranes and other lifting machines and apparatuses.

The Factories Act is particularly relevant to the management of the health and safety aspects during the construction, mining, maintenance, and decommissioning phases of the Project. The requirements of the Act must be considered by the engaged contractors, when managing safety issues.

3.1.3.7 Herbage Preservation Act (1977)

This Act stipulates the creation of herbage preservation committees at national and district level to regulate the burning of vegetation, the construction and maintenance of firebreaks. The principal objective is to prevent uncontrolled fires. Such fires occur in the Ghanzi districts seasonally. This Act is of relevance in relation to controlling potential fires around the proposed Project development.

The Act states that "no person shall wilfully or negligently light a fire which by spreading damages or destroys, or threatens to damage or destroy, the property of another person." [4. (2)] "Every person, before burning vegetation on a land of which is the owner or on which is permitted or authorised to burn vegetation, shall give reasonable notice of his intention to do so and, as nearly as possible, of the time at which the burning is to begin to all owners or occupiers of adjoining land and, where reasonably practicable, to a police officer or headman." [6(1)]. As the proposal in question will comprise a significant expanse of vegetated land, this Act holds significant relevance in its attempt to protect the natural vegetation of the local environment.

Construction and maintenance of not less than 6m x 6m firebreaks on both sides of the mine site perimeter fence as a legal requirement in the Act.

3.1.3.8 Public Health Act (2013)

The Public Health Act (No. 23 of 2013) attempts to comprehensively address key public health concerns in Botswana by creating regulatory structures and setting normative standards on certain issues such as which diseases should be notifiable.

This Act addresses diseases and the spread thereof and provides a range of health measures including regulations on prevention, management and control of diseases as well as cleanliness and sanitation and the control of nuisances. The Act also provides for the welfare of all personnel and addresses working facilities related to sanitation, workshops and offices, stating that these must be cleaned regularly and free of litter, and free of any nuisances that are offensive, injurious to health and possible environmental pollutants.

Under the Act, proponents are prohibited from conducting operations such that any street, road or part of, any stream, pool, ditch, gutter, watercourse, sink, water tank, cistern, water closet, privy, urinal, cesspool, soak-away pit, septic tank, cesspit, soil pile, waste pipe, drain, sewer, garbage receptacle, dustbin, dung-pit, sewer, refuse pit, slop-tank, ash-pit or manure heap so foul or in such a state or so situated or constructed as in the opinion of a health officer to be offensive or to be injurious or dangerous. Additionally, the Act protects the quality of water used by the public, by controlling the disposal of polluted water and control of mosquito larvae.

3.1.3.9 Employment Act (1982)

The Employment Act as amended addresses minimum conditions of employment for employees, whether citizen or expatriate, employed in the private and parastatal sectors. An expatriate employee should be in possession of a valid work permit.

3.1.3.10 Worker's Compensation (1998)

The Worker's Compensation Act No. 23 of 1998 requires an employer to pay compensation to any employee who is incapacitated through a work-related injury or occupational disease. Employers are also required to take up an insurance policy to cover liability under the Act.

3.1.3.11 Forest Act (1968)

The Forest Act has been put in place to enable the declaration of State Land as forest reserve. The Act describes responsibilities for the relevant authorities involved when declaring a forest reserve. It also deals with protected trees, prohibited acts and relevant licensing, exemptions and fines.

The Act is relevant in terms of the Project as it specifies the protected tree species for Botswana. During the planning, design and construction of the project all regulations and guidelines in this Act must be considered during the impact assessment, specifically in relation to clearance activities.

3.1.3.12 Agricultural Resources Conservation Act (1974)

This Act makes provision for the conservation and improvement of Agricultural Resources and has established the Agricultural resource Board whose mandate is to include issuing conservation orders and stock controls. This Act is relevant, as some agricultural land will be acquired for mining purposes.

3.1.3.13 Tourism Act (2009)

The Tourism Act regulates the tourism industry to promote its sustainable development. The relevance of the Tourism Act to this project is demonstrated by the location of the proposed project, due to the proximity of the mining area to the Central Kalahari game Reserve (CKGR), which is a popular tourist destination in Botswana.

3.1.3.14 District Bye-laws

There are currently no Botswana Standards for industrial/mining noise assessment. However, in Botswana's National Environmental Health Policy, noise pollution is specifically mentioned as a problem faced by the country. Botswana considers noise control as a component of environmental health control. In view of the importance of noise pollution to Botswana's health care goals, the noise study was deemed an essential component of the ESIA. Botswana has not assigned specific numerical values to sound or noise levels. However, non-numerical noise regulations are contained in the Ghanzi District Council (Noise and Nuisance) Byelaws in Sections 33 and 34 (Source www.laws.gov.bw). In these regulations, the closest reference to mining noise is contained in Section 3(e) where reference is made to the following:

"(e) [No person shall…] between the hours of 12 midnight and 7.30 a.m. carry on any business, trade or industry involving the use of machinery which by reason of the noise created by it is offensive or

constitutes a nuisance or which disturbs the comfort or peace of the inhabitants of the neighbourhood".

The intention of the provision is clear, that noise from industrial activities (and mining is assumed to be included here), particularly at night is unacceptable. However, the regulation does not provide for a way to assess noise disturbance scientifically. Since there are no regulations or standards in Botswana governing the issues of the measurement and assessment of noise, reference is made to international standards and guidelines and South African standards.

3.1.4 Water legislation

The following sections summarise the water-related legislation relevant to the Project.

3.1.4.1 Boreholes Act (1956)

The Boreholes Act (1956) was enacted to ensure that the records for all boreholes are kept safely within the Botswana Geosciences Institute (BGI) formerly Department of Geological Surveys (DGS). In practice it is now common practice for all borehole drillers to submit and send borehole records and lithological samples to the BGI. Any drilling contractors subcontracted by Tshukudu Metals for the exploration and production borehole drilling will be expected to comply with the Act. This Act is primarily relevant to the new or existing boreholes used for water for the construction activities. It is likely that Tshukudu Metals may obtain some of the water for construction from boreholes, and these should be compliant with the requirements of this Act.

3.1.4.2 Water Act (1968)

The Water Act primarily provides for the prevention of the misuse and pollution of water through enforcement of penalties. The Act also addresses the ownership, protection and the rights to use "public water" and requires that the water resources within the project area and beyond should not be polluted by any matter derived from the mining operation. Under the Act, development proponents must first obtain water rights from the appropriate Water Apportionment Boards (WAB) before any act such as constructing a dam or proceeding to store, use or discharge any effluent into the public water. The process also includes applying for water rights that will provide the permission required to do such. The management of water resources will be facilitated by the provisions of both this Act and the Waterworks Act. Under these provisions it is an offence to pollute or foul any public water by either discharging any substance likely to pollute or by dumping any material in a place where water is likely to flow and carry the pollutants along. Such offences are liable to penalties to be paid by the polluter.

The Water Act and the Borehole Act outline the requirements for the drilling of boreholes and groundwater rights. The Water Act defines the ownership of any rights to surface or groundwater and grants permission for the use of water resources through the Water Appointment Board (WAB) under the Department of Water Affairs.

The Water Act (and the Water Utilities Act of 1970) will be relevant to the Project as it will include development of a water pipeline along the proposed service corridor. The Water Act enables authorities to acquire or curtail existing works in times of drought. The Water Utilities Act can be used to declare any demand centre as a waterworks area. However, the National Water Master Plan Review in 2006 recommended that a series of institutional reforms were required within the water sector. These are needed to meet the increasingly complex challenges facing Botswana in the development of water resources, the supply of water and overall management of the sector. Based on these recommendations, the Government initiated a comprehensive effort in April 2008 to upgrade and extend water and wastewater services throughout the country.

The Government enacted the first of a series of institutional water sector reforms in May 2009. These included the consolidation of all water and wastewater operations under the umbrella of the Water Utilities Corporation (WUC).

3.1.4.3 Waterworks Act (1962)

The Act provides for the establishment of Water Authorities mandated with the responsibility of supplying water and other waterworks in townships and areas designated by the Minister as Waterworks areas. The provisions of the Act are such that the water authorities have been given a wide range of powers that include the right to acquire rights to take water, to provide waterworks needed to supply water. They also have the authority to enter private property to reading water meters, inspecting, repairing, replacing or testing any service without giving prior notice to the owner, making it an offence to obstruct the inspectors/officers from carrying out their duties. The Act prohibits water pollution and promotes water conservation by also considering the following as offences:

- Pollute or cause risk of pollution to any water, or to allow any foul liquid, gas or other noxious matter to enter the waterworks or any pipe or fitting connected therewith;
- Deposit any foul, noisome or injurious matter, earth or excavated material in a manner that it can be washed off and carried into the waterworks;
- Undertake any activities that can result in silt, sand, gravel, sawdust, refuse or waste entering the waterworks or any pipe or fitting connected therewith; and
- Wilfully and purposefully waste water.

3.1.5 Mining and energy legislation

The following sections summarise the mining and energy related legislation relevant to the proposed project.

3.1.5.1 Mines and Minerals Act (1999)

The original Mines and Minerals Act of 1977 has been revised to incorporate changes designed to facilitate the issuing of exploration and mining licences and to make Government participation in new developments more attractive to investors. The new Mines and Minerals Act was passed in July 1999, and in accordance with this Act, Tshukudu Metals must obtain a mining licence from the Department of Mines prior to the commencement of operations. There are four types of mineral concession in Botswana (a prospecting licence, retention license, mining license or minerals permit). The rights may be granted to an individual or company as provided for in the Act. The Act also stipulates that the application for the mining licence must be accompanied by a completed EIS, which includes an EMP. The EMP must make specific reference to the actions that will be taken to address the environmental impacts throughout the project life cycle and after closure. After the enactment of the EA Act (2010), the issuing of the mining licence is subject to approval of the ESIA.

There is no specific mention in the Act of measures to be taken to identify and mitigate against Acid Mine Drainage (AMD). Section 65(1) of the Mines and Minerals Act states:

The holder of a mineral concession shall, in accordance with the law in force from time to time in Botswana and in accordance with good mining industry practice, conduct his operations in such manner as to preserve in as far as is possible the natural environment, minimize and control waste or undue loss of or damage to natural and biological resources, to prevent and where unavoidable, *promptly treat pollution and contamination of the environment and shall take no steps which may unnecessarily or unreasonably restrict or limit further development of the natural resources of the concession area or adjacent areas.*

The paragraph above requires the applicant to consider and address all polluting activities (fuel storage, sewerage, rock waste, land fill and explosives etc.), assessing the risk, potential impacts on the environment and prevent or mitigate such impacts.

Pursuant to Section 12.2 and 12.3 of the Mines and Mineral Act, the developer is advised to establish a localisation strategy under its recruitment.

3.1.5.2 Mines, Quarries, Works and Machinery Act (1978)

This Act is relevant to issues relating to the safety of mining, ancillary and quarrying operations and the safety, health and welfare of the site employees. The project proponent is required under the Act to put in place measures that will result in the compliance with the specifics summarised in the legal register. It is important that the project proponent acquaint themselves with the stipulations made regarding the construction and operation of facilities such as waste rock dumps, fines dumps and slimes dams. More importantly, they should obtain a Classified Dump Notice from the Department of Mines. In addition, the Act also specifies that a Mineral Permit must be issued by the Department of Mines for any borrow pit or quarry to be operated during the construction phase of the Project. The application for the Mineral Permit must be accompanied by a completed ESIA report for each borrow pit or quarry operated.

3.1.5.3 Explosives Act (1968) – amended in 1977

The Act falls under the Department of Mines and provides for “the control of the manufacture, importation, sale, transport, storage, use and disposal of explosives and for matters incidental thereto.” The Explosives Act is relevant to this development since mining often involves the use of explosives for blasting of rock.

3.1.5.4 Electricity Supply Act (1973)

The Act provides for clear rules, regulations and responsibilities related to the supply of electricity. It specifies minimum requirements for electrical installations to adhere to, as well as licensing regulations. The electrical installations covered in the act include standard low voltage systems, high voltage (overhead) lines and installations other than consumer installations (such as substations). The regulations include:

- Technical requirements for materials, conductors, testing and overloading;
- Safety requirements for fencing, maintenance, inspections and wind pressure; and
- Fire precautions and clearance instructions.

This Act is relevant for the design and safety aspects of the electrical infrastructure components of the Project, and needs to be considered during all design and construction phases.

3.2 Policies and Standards

The following are policies that have been put into place in Botswana for the holistic development of the country from a variety of perspectives. Where national standards were relevant to the work of the consultants on the ESIA, these are also mentioned below.

3.2.1 Vision 2036 (2016-2036)

Vision 2036 was developed in 2015 and published in 2016, following a nationwide consultative, analytical and international benchmarking process led by the Presidential Task Team (Presidential Task Team, 2016). Noting the challenges and accomplishments experienced during the past Vision 2016 period (1996 to 2016), the objective of Vision 2036 is to transform the economy of Botswana from middle class income to high-class income by year 2036. It is anchored on four pillars which are:

- Sustainable economic development
- Human and social development
- Sustainable environment
- Governance, peace and security.

The goals of Vision 2036 are aligned with key national, regional and global frameworks for sustainable development. At national level, Vision 2036 will be implemented concurrently with four National Development Plans (NDPs), beginning with NDP 11, aimed at ensuring an inclusive economic growth, realisation of employment creation and poverty eradication highlighted in the vision document. To facilitate international trade and investment, as well as peaceful co-existence with neighbouring countries, the goals of Vision 2036 remains consistent with regional and global sustainable development frameworks such as:

- Agenda 2030 on Sustainable Development that seeks to strengthen universal peace.
- Sustainable Development Goals aimed at eradicating poverty and hunger, and improving health and education.
- Paris Agreement on Climate Change (2015) aimed at combating climate change.
- Africa Agenda 2036 that seeks to accelerate the implementation of past and existing continental initiatives for economic growth and sustainable development.
- Southern African Development Committee's (SADC) Regional Indicative Strategy Development Plan (2015 to 2020) designed to provide clear strategic direction with respect to SADC programmes, projects and activities.

In line with the above frameworks, the overall key priorities of Vision 2036 document are as follows:

- Eradicating extreme poverty and reducing inequality.
- Ensure greater realisation of citizens' potential.
- Ensures prosperity for all citizens.
- Improve health and education outcomes to build a productive workforce.

- Manage trade-off between income and environment to achieve socio-economic growth.
- Strengthening the public sector to provide institutional foundation and enabling framework.
- Equip workforce with available and suitable advanced technology.
- Strengthening human development outcomes.
- Generating export-led and diversified economic growth and employment.
- Strengthening democracy, governance and security for all citizens.

Under the pillar of a sustainable economic development, the goal is to have a sustainable, vibrant and diversified mineral sector that is integrated into other sectors of the economy. The government aims to promote and pursue initiatives that ensure continuous social and economic activities in previous mined areas, after decommissioning of the mining projects.

The successful implementation and operation of the Project has potential to contribute to the goals of the vision through generation of employment and entrepreneurship opportunities in Ghanzi District. The Vision and its commitments will need to be considered during the development of future corporate strategies by the Client.

3.2.2 Revised National Policy for Rural Development (2002)

Given the rural nature of the Project areas and surrounding settlements, the “Revised National Policy for Rural Development” (Government Paper No. 3 of 2002, Ministry of Finance and Development Planning, 2002) is of relevance. The 2002 revised policy is based on a review of the 1973 Rural Development Policy that focused largely on the transfer of finances from mining activities into rural development initiatives. While successful in transferring resources to rural areas and rapidly expanding both productive and social services on an unprecedented scale, the emergent situation required a different focus that would place more emphasis on local initiative (BIDPA, 2001), and strengthen the process of rural development that would overcome the perceived disempowering approach of resource transfer.

Government policy on spatial development in terms of population and settlement is the 1998 National Settlement Policy (Government of Botswana, 1998), and the 2004 Revised National Settlement Policy (Government of Botswana, 2004). The Policy identified four planning regions and three ecological zones to guide planning and management of population growth and distribution, as well as urbanisation, regional settlement patterns, land use and land tenure, social and physical infrastructure, and natural resource use and protection. For remote areas, most remote communities were classified as “tertiary IV”, with populations ranging from 250-499 persons (covering 55% of existing Remote Area Development Programme (RADP) settlements). “Other settlements”, broken into two groupings (population ranging from 150-249, and population ranging up to 150 persons). A concern of the policy was the proliferation of settlements with fewer than 500 persons, with consequent high costs for social service delivery. Later changed to 250 persons, the intention of the policy was to concentrate populations so that services could be delivered more efficiently. Settlements of 250 or more persons were classified as settlements eligible for gazetting and the provision of basic services, although smaller settlements are sometimes provided with similar services under special programmes.

The RADP is of relevance to Ghanzi District, where a substantial portion of the population is provided with a variety of services through the programme. The RADP had its origins originally in initiatives for Khoe and Bakgalagadi communities in sandveld communities. Over time, the focus has remained sandveld communities, with over 40,000 people reached across sixty-four settlements. The RADP has provided considerable infrastructure to remote settlements in sandveld locations in Ghanzi District, and has also provided technical and financial support for small-scale enterprise initiatives. As an ungazetted settlement belonging to Ghanzi Township, however, for example Kuke has historically been unreached by the programme, while Qabo has been reached for several years. Recently, however, Kuke was declared a “tertiary IV RAD settlement”, making it eligible for RADP support (Ghanzi District Council, 2009).

3.2.3 National Settlement Policy (2004)

This Policy aims to provide a comprehensive set of guidelines for national physical planning and to provide a framework for guiding the distribution of investment in a way that reflects the settlements size, population, economic potential, level of infrastructure and their role as service centres. Protection of the environment through sustainable land use planning is provided specifically through this policy that aims to:

- Provide guidelines and long-term strategy for development of human settlements
- Rationalise and promote the optimal use of land and the preservation of the best arable land
- Provide guidelines for the development of transportation networks to strengthen the functional linkages between settlements.

The policy is specifically relevant to the Project in relation to the location of the construction camp in Ghanzi Township. During the construction and operation, the project will assist in enhancing the economic activities of the township by creating additional market for goods and services provided at the area.

3.2.4 National Policy on Land Tenure (1983)

In 1983, the pre-existing Land Tenure practices that were instated prior to independence were reviewed. The Commission appointed by the Government for the review found no reason for large-scale overhaul of the policy in use, deeming it appropriate in terms of the nature and rates of change that it adopts. The following suggestions were, however, incorporated into the policy (Adams et al., 2003, pg.7):

- “Commercial and industrial leases on tribal land should be modified to allow for duration of 50 years; automatic right of inheritance should be granted; land board consent should no longer be required for a sale of a common law lease to a citizen; the consent of the land board to transfer or sale should not be unreasonably withheld.
- Common law leases for residential plots, for mortgaging residential buildings, should remain as 99 years; the lessee should be allowed to apply for reversion to customary allocation at any time, subject to it not being mortgaged.
- Fixed-Period State Grants and Certificate of Rights were deemed to be the most suitable form of land tenure on state land in urban areas. The Commission called for changes to allow lending against a Certificate of Rights offered as security. Amendments to the Deeds Registry Act were proposed to stop land fronting.”

This policy carries significance for this Project since the proposed mine is will be located within a freehold farm, and is expected to ultimately have a large impact on the land tenure system that is in place.

3.2.5 Community Based Natural Resource Management Policy (2007)

The Community Based Natural Resource Management Policy (CBNRM Policy) of 2007 was the result of a series of innovations, that began in 1995, aimed at giving community representative institutions authority over resources that were proximate to the community (see Johnson, 2009). The Policy itself included provisions to overcome a problem associated with the mal-distribution of revenues from CBNRM activities, improve accountability, and strengthen monitoring and oversight. This bears relevance to the Project since the greater study area is host to many different natural resources, as well as to a few rural communities. Therefore, the current CBNRM initiatives (if any) that are in place in the area must be identified, and the client must be aware of the development's impact on such.

3.2.6 National Policy on Resource Conservation and Development (1990)

One of the primary relevant policies includes the 1990 National Strategy on Natural Resources Conservation and Development (also called "National Conservation Strategy" or NCS). It aims at promoting conservation of natural resources in the country such as fresh air, water, vegetation, wildlife, soils and archaeological features. This Policy was formulated by Botswana Government and approved by the National Assembly on the 17th December 1990. The conservation goals of the Policy relevant to the water regime are:

- The conservation of all main ecosystems, wildlife and cultural resources.
- The control of the depletion of exhaustible resources.
- The prevention and control of pollution.

This policy's relevance under this ESIA involves seeking assurance that the Project will not use up a finite non-renewable resource and maintains the quality of the resource for future generations.

3.2.7 National Policy on Gender and Development (NPGAD) 2015

The NPGAD provides a framework for including the gender perspective in all activities of Government and other sectors, as well as civil society, thereby promoting the full and equal participation of women and men in a transformative development process. The NPGAD has at its core, a recognition and appreciation of the differences between women and men; differences that are based on physiological and biological; as well as social realities. The long-term goal of the NPGAD is to reduce inequalities in the opportunities and outcomes of social, economic, cultural; and legal development for both men and women.

The specific objectives of the NPGAD are to:

- Create a conducive environment for gender equality and women's empowerment by addressing factors that contribute to gender inequalities and inequities in Botswana.
- Advocate for the development of an effective National Gender Machinery and ensure that significant partners and stakeholders are enrolled in the programming and activities of the machinery.
- Promote gender mainstreaming in the processes of development planning, policy formulation, legislation and implementation thereof.

- Establish gender analysis as a precursor for policy formulation, programme for policy formulations, programme development and interventions.
- Promote evidence-based research to inform programming.
- Establish a framework for implementing and institutionalising gender equality initiatives, with strong mechanisms for coordination, monitoring, evaluation and accountability.

The National Policy on Gender and Development provides guidance, direction, coordination and facilitation on gender and development programming. It is anticipated that this will improve the implementation of Botswana's commitment to international obligations for the achievement of gender equality and National Development Plans. The approach employed by this policy highlights with greater focus, the expectation of national commitment to provide development and improved wellbeing to women, men, girls and boys on an equal and non-discriminatory basis.

3.2.8 National Mainstreaming Strategy for Botswana: Framework for Mainstreaming in Development (2012)

The purpose of the National Mainstreaming Strategy is to provide a framework for addressing one or more crosscutting issues as an integral function of all sectors. The strategy emphasises democracy, development, dignity, discipline and delivery, as well as humanity and social justice for all. It further promotes the principles of multisectoralism, inclusiveness and participation, innovation, and rights based approaches. Within the world of work, the guiding principles are service excellence for clients and customers on the one hand, and development and welfare of workers on the other.

3.2.9 Revised National Policy on Destitutes (2002)

The Revised National Policy on Destitutes (Government of Botswana, 2002) outlines support to households unable to meet their own needs. Support to destitute households has proven of considerable importance to communities covered by the RADP, which have a high proportion of destitutes. Packages amounting to just over BWP500 per month are provided, and provision is made to support improved shelter, medical care, and exemption from certain fees (service levies, taxes, water costs, street licences, school fees, equipment related to rehabilitation support, and related fees). The previous Destitutes Policy focused on service provision to individual destitutes. The revised policy recognised that benefits were shared within households, and even across households in extended family situations. The importance of this Act to the proposed development lies in the communities that are affected near the study area. It may be beneficial for the Client to become aware of the various income types of neighbouring communities.

3.2.10 Botswana Bureau of Standards (BOBS) Water Standards

BOBS has issued two standards that define water quality requirements:

- BOS 93:2012, 2nd Edition. Waste Water – Specification. This specifies physical, microbiological and chemical requirements for wastewater discharged into a sewer, a watercourse and open environments.
- BOS 32:2009, 2nd Edition. Drinking Water – Specification. This specifies two classes of water that are suitable as drinking water, defined in terms of physical, organoleptic, chemical and microbiological constituents. Class 11 specifies requirements that are the maximum allowable for short-term consumption.

The upper limits of acceptability of physical and chemical determinants[5] for discharge of wastewater into an ephemeral watercourse will be used as a standard during the detailed assessment. The Class 11 drinking water quality standard will also be considered.

3.2.11 Wildlife Conservation Policy (1986)

The policy provides a framework for the conservation and sustainable utilisation of wildlife by realising the full potential of any wildlife resources and developing a commercial wildlife industry to create economic opportunities such as jobs, income and increasing the supply of game meat for commercial, subsistence and nutritional purposes. This policy bears significance for the proposed mining development because the project site is located approximately 45km from the western boundary of the CKGR. It is possible that poaching may increase because of the Project, and this Act addresses this.

3.2.12 National Ambient Air Quality Standards

These standards make provision for the setting and formulation of national ambient air quality standards for substances or mixtures of substances, which present a threat to health, well-being or the environment. These standards prescribe the allowable ambient concentrations of pollutants, which are not to be exceeded during a specified period in a defined area. If the air quality standards are exceeded, the ambient air quality is poor and the potential for health effects is greatest.

Table 3.1: National standards ($\mu g/m^3$) for compliance

Pollutant	Averaging period	Concentration
Sulphur dioxide (SO_2)	24-hr average	300
	Monthly average	160
	Annual average	80
Nitrogen dioxide (NO_2)	1-hr average	400
	Annual average	100
Carbon monoxide (CO)	1-hr average	40,000
	8-hourly running average	10,000
Particulate Matter (PM_{10})	Monthly average	200
	Annual average	100

3.2.13 National Policy on HIV/AIDS of 2012

This policy describes the problem of HIV/AIDS in Botswana, the problems facing those who are infected and affected, and outlines the response including considering the gender dimensions of the response.

The objectives of the National Policy on HIV and AIDS are to:

[5] Determinants are chemical substances, microbiological organisms, or some other characteristic of the water that can be measured.

- Prevent the spread of HIV infection and reduce the socio-economic impact of this disease.
- Create a policy environment for the provision of adequate and equitable care and support to those infected and affected by HIV and AIDS.
- To reduce HIV and AIDS related stigma and discrimination towards persons infected with or affected by HIV and AIDS and draw attention to the compelling public health rationale for overcoming stigmatisation and discrimination against them in society.
- Promote coordination to enhance implementation of the National Response to HIV and AIDS.
- The relevance of this policy to the Project is in Provide platform to support legislative and legal reform that recognises the impact HIV and AIDS has on individual and community rights.

The relevance of this policy to the Project is in relation to the mine policy on HIV and AIDS, which the company must develop.

3.2.14 The Second Botswana National Strategic Framework for HIV and AIDS, (2010-2016)

The Second National Strategic Framework for HIV and AIDS, (NSF II) serves as a roadmap for the national response over the next seven years and makes an important contribution to the successful implementation of the 10th National Development Plan and ultimately Vision 2016. The purpose of NSF II is to outline national priorities for the national response to HIV and AIDS for the period 2010-2016. These priorities are based on evidence accumulated locally and are augmented by international best practices. To maximise the impact over the next seven years, the following priorities must be the focus of the national response:

- Priority Area 1: Preventing new infections
- Priority Area 2: Systems strengthening
- Priority Area 3: Strategic information management
- Priority Area 4: Scaling up treatment, care and support.

The relevance of this policy is as discussed in Section 3.2.13.

3.2.15 National Policy on Education (1994 - revised)

The policy notes that education is a fundamental human right and that, as affordable to the state over time, education should be free. The policy also notes a focus on basic education and ensuring that education is consistent with national development objectives associated with economic diversification and employment creation.

The relevance of this Policy on the proposed project is that, its successful implementation will generate revenue for the Botswana Government, which may be used to fund educational programs for its citizens.

3.2.16 Disability Policy (1996)

The policy outlines services for disabled persons and describes implementation structures. Relevance to the Project is mainly in hiring practices. The proponent will comply with this policy by developing hiring practices that are consistent with this policy.

3.2.17 National Youth Policy (2010) and the National Action Plan for Youth (2001)

This policy describes the challenges and opportunities facing the youth, and notes their needs in terms of business development, education, employment, health, crime, protection from violence, substance abuse, and recreation. Tshukudu Metals may choose to consider the policy in the development of its CSR strategy.

3.2.18 National Policy on Culture (2001)

This policy aims at preserving and protecting the country's cultural heritage. Relevance to the Project is that appropriate measures must be implemented to ensure preservation of the cultural and historical resources of the Project affected communities. A cultural heritage assessment was undertaken for the project as part of the ESIA study, to identify cultural and historical resources likely to be affected by the project. The findings of the study are provided in Chapter M.

3.2.19 National Gender Policy (1995)

This policy outlines Government's intentions to overcome negative gender roles and support women's social and economic empowerment.

The relevance of this Policy in relation to the project is as follows:

- The project employment/hiring processes must not favour or marginalise people based on their gender. The proponent must give men and women equal opportunities to participate in the project employment and entrepreneurship activities.
- The proponent must include men and women in the decision made regarding the Project activities.
- The ESIA/SIA study considered gender related issues during the assessment process. Both men and women were included in the ESIA stakeholder engagement/consultations undertaken for the Project.

3.2.20 Poverty Eradication Guidelines - Implementation of Packages (2012)

Because of the continued gains made in reducing poverty, Botswana has shifted from a poverty reduction strategy to a poverty eradication strategy. Ghanzi District is currently characterised by high poverty incidence and this has been associated with limited economic activities, high unemployment rate and lack of infrastructure development. The successful implementation and operation of the Project has potential to contribute to the goals of this Policy through generation of significant employment and entrepreneurship opportunities in Ghanzi District.

3.2.21 National Policy for Wastewater and Sanitation Management (2001)

This policy's purpose is: "to promote the health and well-being of the people of Botswana through the provision of appropriate and sustainable wastewater/sanitation management and to introduce mechanisms for the protection and conservation of water resources." (National Master Plan for Wastewater and Sanitation 2003). The Policy is relevant to this project due to the inclusion of a wastewater management plant within the scope.

3.2.22 Wildlife Conservation Policy (1986)

The Policy provides a framework for the conservation and sustainable utilisation of wildlife by realising the full potential of any wildlife resources and developing a commercial wildlife industry to create economic opportunities such as jobs, income and increasing the supply of game meat for commercial, subsistence and nutritional purposes. The policy also advocates for the conservation of wildlife resources outside protected areas. This Policy bears significance for the proposed mining development due to its proximity to the CKGR, located approximately 45km east of the project site.

3.3 Development Plans

The development plans for the study area have been considered during this study. Those of relevance include the NDP 11 and Ghanzi District Development Plan 7 (2009-2016).

3.3.1 National Development Plan (NDP 11)

The plan covers a six year period from April 2017 to March 2023 and comprises of two volumes. Volume I deals with policies and strategies, while Volume II articulates on projects and programmes, earmarked for implementation during the plan period. The theme for NDP 11 is "Inclusive Growth for Realisation of Employment Creation and Poverty Eradication". This theme is premised on the fact that, though concerted efforts were made during NDP 10 to achieve the goals and aspirations of Vision 2016, Botswana continues to grapple with three main development challenges namely, poverty, unemployment and income inequalities.

NDP 11 also includes a brief review of progress towards the Millennium Development Goals (MDGs). Largely consistent with Vision 2036, Botswana has made progress on most MDGs. The policy objectives for NDP 11 being:

- Economic efficiency.
- Energy and security.
- Social equity.

The proposed development will play a major role in the realisation of these efforts through:

- CSR initiatives adopted
- Creation of employment and business opportunities
- Growth of the national economy and Government revenues.

3.3.2 Ghanzi District Development Plan (GDDP 7)

The plan is intended to guide development in the Ghanzi District. The plan gives a brief overview of the district, describes physical and social infrastructure, and gives an overview of cultural and demographic characteristics. The plan includes a series of problem statements reflecting key development challenges in the district, notably continued high levels of HIV seroprevalence (15.6% in 2009), groundwater contamination, land degradation, an increase in land use conflicts and the expansion of livestock herds into new areas, including the CKGR, and high levels of poverty. The plan also notes limited progress through the RADP, and a more recent initiative under the RADP to secure farms for landless populations.

GDDP7 highlights opportunities associated with CBNRM interventions, the expansion of the tourist sector, and expanded small-scale enterprises. The two major goals of economic growth and poverty alleviation can be divided into seven separate, but complementary objectives as follows:

- Promote livestock and arable development.
- Promote industrial and commercial development.
- Promote tourism development and sustainable natural resources utilisation.
- Improve living conditions of remote area dwellers.
- Reduce the effect of remoteness on the development of the district.
- Provide adequate social services.
- Strengthen extension services.

To address these issues, the GDDP 7 has the following plans:

- To strengthen the livestock sector through the provision of services such as vaccinations, artificial insemination and extension.
- To promote dry land farming through the provision of farm implements.
- To accelerate the development of industrial and commercial sites.
- To develop support services from the industrial and commercial sectors.
- To draw up a Ghanzi Tourism Development Strategy.
- To improve wildlife education at the village and district levels.
- To develop a district strategy for the integration of rural area developments into the mainstream society.
- To improve assistant programmes regarding education, income generating activities and employment creation.
- To ensure adequate potable water in all settlements.
- To upgrade the quality and adequacy of health facilities including primary hospital in Charles Hill village and a district hospital in Ghanzi.

Although the proposed development may not exceed the medium term (long term sustainability of mining and related activities is unexplored at this stage), the potential diversification and development of additional infrastructure to support mining that would contribute net benefit to the regional as a whole. The project is expected to also contribute to improved skills and literacy of the workforce by internal training and awareness to support mining. This may support the literacy programs implemented at the District, subsequently promoting the socio-economic development of the region.

3.3.3 Ghanzi District Settlement Strategy (2009-2033)

To implement the National Settlement Policy at the district level, the Ministry of Lands and Housing has been involved in the preparation of District Settlement Strategies (DSS). The overall goal of DSS is to provide "an integrated spatial plan for the district which addresses issues affecting the growth of settlements in the district." Each of the Strategies addresses issues specific to each of the districts; the GDSS addresses issues particularly pertaining (but not limited) to:

- Opportunities (hydrology, natural resources and wildlife)
- Land Tenure and Land Use (freehold, game reserve and WMAs)
- Population Structure and Characteristics (migration)
- Economic Activity and Employment (agriculture)
- Physical Infrastructure (energy supply, communication and sanitation services)
- Social Services (education, health and recreation)
- Issues (natural environment, hydrology and winds)
- Natural Resources (minerals and wildlife).

The proposed mining project has the potential to bring a significant investment into the District, and it is expected that both directly related, and indirectly related development will take place. The District is home to a number of different groups/communities including the San community. Within the social assessment to be undertaken for the Project, an appraisal of how the various communities can equally benefit from the Project must be made.

3.3.4 National Master Plan for Wastewater and Sanitation 2003 (Master Plan)

This Master Plan forms part of the National Development Planning process and is aimed at increasing living standards and achieving certain goals. These objectives include Agenda 21 (an international plan guided by the principle of sustainability) and Vision 2016 (a set of goals to be achieved Nationally that deal with social and environmental issues). The Master Plan provides approaches to manage wastewater and sanitation in a sustainable way. The document is a tool for implementation of the National Policy for wastewater and sanitation management. This Master Plan is relevant to the management of the wastewater plant that is included within the scope of this development. The planning and design of such a plant should be guided by the design manual.

3.3.5 Revised National Water Master plan (2006)

The National Water Master Plan Review in 2006 recommended that a series of institutional reforms were required within the water sector. These are needed to meet the increasingly complex challenges facing Botswana in the development of water resources, the supply of water and overall management of the sector. Based on these recommendations, the Government initiated a comprehensive effort in April 2008 to upgrade and extend water and wastewater services throughout the country.

The planning and design of water supply to the Project should be guided by this plan.

3.3.6 National Master Plan for Wastewater and Sanitation (2003)

This Master Plan forms part of the National Development Planning process and is aimed at increasing living standards and achieving certain goals. These objectives include Agenda 21 (an international plan guided by the principle of sustainability) and Vision 2016 (a set of goals to be achieved nationally that deal with social and environmental issues). The National Master Plan for Wastewater and Sanitation (2003) provides approaches to manage wastewater and sanitation in a sustainable way. The document is a tool for implementation of the National Policy for Wastewater and Sanitation Management. This Master Plan is relevant to the management of the sewerage that will be produced throughout the life of the proposed project. The planning and design of wastewater management should be guided by the Botswana National Wastewater and Sanitation Planning and Design Manual (2003).

3.4 International Conventions

There are several international conventions and agreements that Botswana has contributed to, which may have relevance to the proposed project. A summary is provided within the following sub-sections.

3.4.1 Basel Convention

The Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal is the most comprehensive global environmental agreement on hazardous and other wastes. The Convention has 170 parties and aims to protect human health and the environment against the adverse effects resulting from the generation, management, trans boundary movements and disposal of hazardous and other wastes. The Basel Convention came into force in 1992 (Basel Convention Website: www.basel.int).

In Botswana, there are no suitable waste management facilities to treat hazardous waste. Therefore, hazardous waste must be transported elsewhere for treatment and disposal. The Convention requires that the mining company requests the Government of Botswana to provide a written notice to transit states and the destination country importing its hazardous waste. These countries would then be required to issue prior written consent before any export could take place. Each approved shipment would then accompanied by a movement document. Hazardous waste from the Project is expected to consist of used oil from construction and operational activities.

3.4.2 Kyoto Protocol

The United Nations Environment Programme (in the publication “The Kyoto Protocol, the Clean Development Mechanism, and the Building and Construction Sector”, 2008) defines the Kyoto Protocol treaty as a legally binding agreement under which 37 industrialised countries will reduce their collective emissions of greenhouse gases by 5.2% compared to the year 1990 (but note that, compared to the emissions levels that would be expected by 2010 without the Protocol, this target represents a 29% cut). The goal is to lower overall emissions from six greenhouse gases - carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, HFCs, and PFCs - calculated as an average over the five-year period of 2008-12. National targets range from 8% reductions for the European

Union and some others to 7% for the United States, 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland (Kyoto Protocol website, 2005).

The Kyoto Protocol is generally seen as an important first step towards a truly global emission reduction regime that will stabilise GHG emissions, and provides the essential architecture for any future international agreement on climate change. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. 180 nations have ratified the treaty to date. Under the Treaty, countries must meet their targets primarily through national measures. However, the Kyoto Protocol offers them an additional means of meeting their targets by way of three market-based mechanisms.

The Kyoto mechanisms are:

- Emissions trading – known as “the carbon market"
- The Clean Development Mechanism
- Joint Implementation.

These mechanisms help stimulate green investment and help parties meet their emission targets in a cost-effective way. Although the protocol is not binding for developing countries, such countries must ensure that they act responsibly and avoid greenhouse gas emissions at levels that have been found to be undesirable. Bearing this in mind, it is accepted that the mining industry should assess and consider the concept of individual carbon dioxide footprints and emission levels, in the development of new mines.

3.4.3 Convention on Biological Diversity 2006 (CBD)

The CBD has three main objectives:

- The conservation of biological diversity
- The sustainable use of the components of biological diversity
- The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.

The Convention recognised for the first time in international law that the conservation of biological diversity is "a common concern of humankind" and is an integral part of the development process. The agreement covers all ecosystems, species, and genetic resources. It links traditional conservation efforts to the economic goal of using biological resources sustainable. It sets principles for the fair and equitable sharing of the benefits arising from the use of genetic resources, notably those destined for commercial use. It also covers the rapidly expanding field of biotechnology through its Cartagena Protocol on Biosafety, addressing technology development and transfer, benefit-sharing and biosafety issues. Importantly, the Convention is legally binding; countries that join it (“Parties”) are obliged to implement its provisions.

The convention reminds decision-makers that natural resources are not infinite and sets out a philosophy of sustainable use. While past conservation efforts were aimed at protecting particular species and habitats, the Convention recognises that ecosystems, species and genes must be used for the benefit of humans. However, this should be done in a way and at a rate that does not lead to the long-term decline of biological diversity.

3.4.4 Convention on International Trade in Endangered Species (CITES)

Unregulated trade in wildlife has become a major factor in the decline of many species of animals and plants. In 1975 an international convention was established to prevent international trade from threatening species with extinction. This treaty is known as the Convention on International Trade in Endangered Species (CITES).

CITES has established a worldwide system of controls on international trade in threatened wildlife and wildlife products by stipulating that government permits are required for such trade. Security paper and stamps are often used for these permits to prevent forgery.

CITES places species into three categories based on their conservation status and the risk from trade. Lists of species in each category are compiled as three separate appendices to the Convention. Species listed under CITES will be assessed as part of the ESIA.

3.4.5 United Nations Framework Convention on Climate Change (UNFCCC)

The Convention entered into force in Botswana on 27th January 1994. The UNFCCC sets an overall framework for inter-governmental efforts to tackle the challenge posed by climate change. It recognises that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The convention enjoys near universal membership, with 192 countries having ratified including Botswana.

Under the Convention, governments gather and share information on greenhouse gas emissions, national policies and best practice. Members also collaborate to launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries and cooperate in preparing for adaptation to the impacts of climate change.

3.4.6 The Vienna Convention for the Protection of the Ozone Layer

The ultimate objective of the Convention is to protect human health and the environment against adverse effects resulting from human activities, which modify or are likely to modify the ozone layer and urges the Parties to take appropriate measures in accordance with the provisions in the Convention and its Protocols which are in force for that party. To achieve the objectives, the parties, within their capabilities, are expected to:

- Cooperate to better understand and assess the effects of human activities on the ozone layer and the effects of the modification of the ozone layer.
- Adopt appropriate measures and cooperate in harmonising appropriate policies to control the activities that are causing the modification of the ozone layer.
- Cooperate in the formulation of agreed measures for the implementation of this Convention.
- Cooperate with competent international bodies to implement effectively this Convention and protocols to which they are party.

3.4.7 The Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol)

This protocol controls production of ozone depleting substances: The Montreal Protocol is a protocol under the Vienna Convention. The Protocol controls the production and consumption of the most commercially and environmentally significant ozone-depleting substances - those listed in the Annexes to the Montreal Protocol. One feature of the Protocol which makes it unique, is Article 6 that requires the control measures to be revised at least every four years (starting 1990), based on the review and assessment of the latest available information on scientific, environmental, technical and economic aspects of the depletion of the ozone layer. Based on reports of assessment panels appointed by the parties and taking into consideration the needs and situation of the developing countries, the Montreal Protocol has already been adjusted and amended twice.

At present, 191 nations have become party to the Montreal Protocol. The Montreal Protocol is an international treaty designed to protect the ozone layer by phasing out the production of several substances believed to be responsible for ozone depletion. The treaty was opened for signature on September 16, 1987 and entered into force on January 1, 1989 followed by a first meeting in Helsinki, May 1989. Since then, it has undergone seven revisions, in 1990 (London), 1991 (Nairobi), 1992 (Copenhagen), 1993 (Bangkok), 1995 (Vienna), 1997 (Montreal), and 1999 (Beijing).

3.4.8 The Stockholm Convention on Persistent Organic Pollutants (POPs)

The Stockholm Convention is an international legally binding agreement on persistent organic pollutants (POPs). In 1995, the governing council of the United Nations Environment Programme (UNEP) called for global action to be taken on POPs, which it defined as “chemical substances that persist in the environment, bio-accumulate through the food web, and pose a risk of causing adverse effects to human health and the environment”.

Following this, the Intergovernmental Forum on Chemical Safety and the International Programme for Chemical Safety (IPCS) prepared an assessment of the 12 worst offenders. Known as the Dirty Dozen, this list includes eight organo-chlorine pesticides: alien, chlordane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene; two industrial chemicals: hexachlorobenzene and the polychlorinated biphenyl group; and two groups of industrial by-products: dioxins and furans.

The negotiations for the Stockholm Convention were completed on May 23rd 2001 in Stockholm, Sweden. The convention entered into force on May 17th, 2004 with ratification by an initial 128 parties and 151 signatories. Co-signatories agreed to outlaw nine of the "dirty dozen" chemicals, limit the use of DDT to malaria control, and curtail inadvertent production of dioxins and furans. Parties to the convention have agreed to a process by which persistent toxic compounds can be reviewed and added to the convention, if they meet certain criteria for persistence and trans boundary threat. Several other substances are being considered for inclusion in the Convention. These are: hexabromobiphenyl, octaBDE, pentaBDE, pentachlorobenzene, short-chained chlorinated paraffin’s, lindane, α- and β-hexachlorocyclohexane, dicofol, endosulfan, chlordecone and PFOS.

The Convention sets out several objectives including:

- The elimination from commerce of identified POPs and others that may be identified in the future.
- Encouraging the transition in commerce to safer alternatives.
- Identifying additional POPs.

- The clean-up of old stockpiles and equipment containing POPs.
- Encouraging all stakeholders to work towards a POP-free environment.

3.4.9 International Concerns Around Mercury

There are international initiatives to address mercury but to date no international policy has been developed. A recent programme backed by the United Nations (UN) that aims to reduce the health and environmental impacts of mercury includes a two-year period of voluntary action to reduce emissions and an evaluation to determine whether an international treaty is necessary. It aims to develop partnerships between government, industry and other key groups to reduce emissions.

3.4.10 Various Human Rights related conventions

Of the various international conventions described, the set likely to be of relevance to the Project are associated with human rights, specifically of indigenous populations. Botswana is a signatory to a few international conventions designed to protect the rights of its population. These include the African Charter on Human and People's Rights, the International Covenant on Civil and Political Rights, the Convention on the Elimination of all Forms of Racial Discrimination, the International Covenant on Civil and Political Rights, the Convention on the Elimination of all Forms of Discrimination Against Women, the Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment and a series of related protocols (see www.adh-geneva.ch).

The human-rights situation in relation to indigenous people in the CKGR has led to missions being conducted to Botswana by the African Commission's Working Group on Indigenous Populations/Communities, and similar agencies falling under the United Nations. There has been scepticism within the Botswana Government in relation to conventions on "indigenous" persons, and has argued that all Batswana are indigenous to the country. This is a key reason why it has not yet ratified the International Labour Organisation Convention 169 on Indigenous and Tribal Peoples, among others. Hesitancy in considering ethnicity when reporting living situations has meant that data disaggregation across ethnicity is not possible (see for example the difficulties faced by Laird, 2008) in considering progress across ethnic groups against the Millennium Development Goals.

3.4.11 Equator Principles (2013)

According the Equator Principles, the ESIA report is required to addresses:

- Baseline environmental and social conditions
- Requirements under host country laws and regulations
- Applicable international treaties and agreements
- Sustainable development and use of renewable natural resources
- Protection of human health, cultural properties, and biodiversity, including endangered species and sensitive ecosystems
- Use of dangerous substances
- Major hazards, occupational health and safety, fire prevention and life safety

- Socio-economic impacts, land acquisition and land use, involuntary resettlement, impacts on indigenous peoples and communities
- Cumulative impacts of existing projects, the proposed project, and anticipated future projects
- Participation of affected parties in the design, review and implementation of the project
- Consideration of feasible environmentally and socially preferable alternatives
- Efficient production, delivery and use of energy, pollution prevention and waste minimisation, pollution controls (liquid effluents and air emissions) and solid and chemical waste management.

3.4.12 International Finance Corporation (IFC) Performance Standards of 2012

IFC has 184 member countries, and co-ordinates its activities as a member of the World Bank Group, although it remains legally and financially independent (www.ifc.org). It provides financing for a wide variety of initiatives through loans, equity, trade finance and structured finance, aimed at poverty reduction in developing countries. It also offers advisory services to support private sector enterprise development and overcoming obstacles to growth in developing countries.

The corporation has developed a series of policies, standards and guidelines meant to offer best practice standards for environmental management, including the social environment. In January 2012 IFC issued an updated Policy on Environmental and Social Sustainability (IFC, 2012a). The policy commits IFC to respect for human rights, gender equality and women's empowerment, stakeholder engagement across social class, and mitigating the impacts of climate change. Like many development agencies, the corporation categorises the environmental and social risks associated with investments (it also has separate criteria for those investments financed through financial intermediaries):

- Category A: Business activities with potential significant adverse environmental or social risks and/or impacts that are diverse, irreversible, or unprecedented.
- Category B: Business activities with potential limited adverse environmental or social risks and/or impacts that are few, generally site-specific, largely reversible, and readily addressed through mitigation measures.
- Category C: Business activities with minimal or no adverse environmental or social risks and/or impacts.

Environmental and social risk is noted as a combination of the probability of certain hazard occurrences and the severity of impacts resulting from that occurrence. The associated impacts referred to "any change, potential or actual, to (I) the physical, natural, or cultural environment, and (ii) impacts on surrounding community[ies] and workers, resulting from the business activity to be supported" (IFC, 2012a, Performance Standard 1, page 1) [6].

The Policy is linked to eight Performance Standards on environmental and social sustainability, and these are shown below:

[6] As each performance standard in the document has its own pagination, the section is also referenced when quotes are provided, and not just the document reference.

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

Performance Standard 1 applies to all developments that would have environmental impacts, while the remainder would apply circumstances. Five objectives are noted, involving the identification and evaluation of risks and impacts, the integration of environmental risk management in planning and operations, the effective engagement of affected communities in a manner that mitigates risks, enhances opportunities and gives people a voice in decisions that affect their lives, and respond to grievances from affected communities and stakeholders. An additional objective was to establish the most important factors that needed mitigation and, where residual impacts remained, compensation to workers, affected communities, and the natural environment.

For those seeking IFC financing, the standards require that the borrowing organisation establish a policy defining environmental and social objectives and the principles that guide the intervention to achieve sound environmental and social performance. The policy and strategy would be set forth within an Environmental and Social Management System (ESMS). The ESMS would elaborate the legal requirements for performance under national laws, and international obligations.

Should it be required, the intervention would subscribe to internationally recognised standards, certification schemes, or codes of practice, which would be elaborated within the policy. In implementing the policy, the borrowing organisation is expected to conduct itself in a manner 'consistent with good international industry practice, thereafter defined as "the exercise of professional skill, diligence, prudence, and foresight that would reasonably be expected from skilled and experienced professionals engaged in the same time of undertaking under the same or similar circumstances globally or regionally" (IFC, 2012a, Performance Standard 1, page 3). Where the borrowing organisation can reasonably exercise control', the identification of risks and mitigatory actions would extend to those involved in the 'primary supply chain'. Mention was made of vulnerable groups or 'disadvantaged populations', noting that "where individuals or groups are identified as disadvantaged or vulnerable, the client will propose and implement differentiated measures so that adverse impacts do not fall disproportionately on them and they are not disadvantaged in sharing development benefits and opportunities" (IFC, 2012, Performance Standard 1, page 4).

Under 'organisational capacity and competency', Performance Standard 1 noted that "the client, in collaboration with appropriate and relevant third parties, will establish, maintain, and strengthen as necessary an organisational structure that defines roles, responsibilities, and authority to implement the ESMS. Specific personnel, including management representative(s), with clear lines of responsibility and authority should be designated. Key environmental and social responsibilities should be well defined and communicated to the relevant personnel and to the rest of the client's organization". Performance Standard 1 also highlights the importance of monitoring implementation and assessing the effectiveness of implementation and engaging with third parties as required to ensure effective implementation and mitigation.

Performance Standard 7 regarding 'indigenous peoples' are noted under Performance Standard 1 as requiring the following: "for projects with adverse impacts to Indigenous Peoples, the client is required to engage them in a process of [Informed Consultation and Participation] ICP and in certain circumstances the client is required to obtain their Free, Prior, and Informed Consent (FPIC)". Performance Standard 7 notes that it is difficult to offer a universally accepted definition of 'indigenous peoples'. This has been a problem in Botswana, where Government notes that all people from Botswana were indigenous, and therefore did not agree with San communities being considered indigenous and others not. The Standard noted that it might be necessary for a client to "seek inputs from competent professionals to ascertain whether a particular group is considered as Indigenous Peoples" vis-à-vis Performance Standard 7 (IFC, 2012: Performance Standard 7 page 2). For guidance, they offered the following description of characteristics of indigenous peoples as those who belong to a 'distinct social and cultural group' as follows (IFC, 2012: Performance Standard 7 page 2):

- "Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others.
- Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories.
- Customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture.
- A distinct language of dialect, often different from the official language or languages of the country or region in which they reside".

Performance Standard 2 refers to labour and working conditions, Performance Standard 4 refers to community health, safety and security, and Performance Standard 5 refers to land acquisition and involuntary resettlement. Where relevant, these are noted under impacts and mitigation below where relevant issues are considered. Here it is important to note that Performance Standard 4 refers to the impacts on neighbouring communities of project developments, recognising that "project activities, equipment, and infrastructure can increase community exposure to risks and impacts" (IFC, 2012a: Performance Standard 4, page 1), and advocating that projects consider the establishment of preventive and control measures consistent with international practice, including the World Bank Group Environmental, Health and Safety Guidelines. Performance Standard 4 draws parallels with workplace safety and the safe handling of hazardous materials, arguing that these standards must also be met as they affect neighbouring communities.

The EHS guidelines for mining specifically refer to ARD prediction, management and monitoring, stating:

Mining operations should prepare and implement ore and waste geochemical characterisation methods for proper routing of potentially acid-generating materials and ARD management programmes that include the following elements:

- *Conducting a comprehensive series of accelerated leaching tests from feasibility study stage onwards, to evaluate the potential for ARD in all formations foreseen to be disturbed or otherwise exposed by the mine according to internationally recognized methodologies*
- *Conducting comprehensive ARD/ML testing/mapping on an on-going basis with decreasing block size as formations are transferred from long- to medium- and short- term mining plans*
- *Implementation of ARD and ML preventive actions to minimize ARD*

- *Controlled placement of potentially acid generating materials (including wastes) to provide permanent conditions that avoid contact with oxygen or water.*

Guidance requests that risk assessments be part of the design process for TSF and waste rock dumps, where the risks to downstream economic assets, ecosystems and human health and safety are considered. Risks to both water quality and to the resource are to be considered with the use of natural or synthetic liners to mitigate excessive risks.

For the social environment, some of the IFC guidelines are specific to the establishment and operations of the mine itself, specifically occupational health and safety matters, and community health and safety matters that affected a broader area, including transport routes and work camps off site. The Guidance Note 1 on environmental and social assessment outlines key issues needing consideration in the conduct of an ESIA, elaborating levels of impact and geographical scope, and offering links to tools of relevance under particular circumstances. Of specific relevance to the Project is the discussion of “disadvantaged or vulnerable groups”, the recently-developed Guide to Human Rights Impact Assessment and Management, and means of stakeholder engagement that go beyond public meetings. In 2009 the IFC also issued a handbook focused on addressing project-induced in-migration that is of specific relevance to surrounding settlements (IFC, 2009).

3.4.13 International Labour Organisation Recommendation 200 – HIV and AIDS and the World of Work

The Recommendation aims to guide governments, organisations of employers and workers, public and private enterprises, employers and workers to promote healthy workplaces, by defining their roles and responsibilities at all levels of policy and decision-making processes, implementation, and evaluation of programmes on HIV and AIDS in the workplace. The Recommendation has a broad scope of application, covering: (1) all workers in all workplaces, including persons in any employment or occupation, trainees, interns and apprentices, volunteers, jobseekers and job applicants, and laid-off or suspended workers; (2) private and public sectors, including formal and informal economies; and (3) the armed forces and uniformed services.

3.4.14 Integrating HIV and Gender-Related Issues into Environmental Assessment in Eastern and Southern Africa

The Guidelines for Integrating HIV and Gender-Related Issues into Environmental Assessment in Eastern and Southern Africa was published jointly with the International Labour Organization (ILO), International Organization for Migration (IOM), and the Southern African Institute for Environmental Assessment (SAIEA), and launched at a technical meeting hosted by the African Development Bank.

The Guidelines for Integrating HIV and Gender-Related Issues into Environmental Assessment in Eastern and Southern Africa call for governments to recognize HIV risks and take the necessary steps to mitigate them in developing large infrastructure projects and mining operations.

The guidelines aim to help countries address barriers to implementation of existing environmental, health, gender, and labour policies, laws and regulations in the planning and execution of large infrastructure projects. Such barriers can include legislative and institutional weaknesses, poor environmental assessment practices, weak mitigation plans, and insufficient monitoring of HIV and gender-related interventions. The guidelines also call for infrastructure developers, contractors, and suppliers to consider health as wealth, and urge them to dedicate enough resources to community-based HIV prevention and gender empowerment programmes.

3.5 Summary of requirements prior to the mine construction and operation

Prior to the construction and operation of the Project, a large number of approvals and requirements are to be met, under the legislation described earlier in this Chapter. The following table provides a summary of the requirements, to be completed before implementation of the Project.

Table 3.2: Summary of legal requirements

	Detail	Authority	Relevant legislation	By when
1	Mining Licence	Department of Mines	Mines and Minerals Act (1999)	Before Project construction start
2	ESIA approval	Department of Environmental Affairs	EA Act (2010)	Before application for Mining Licence
3	AIA approval and development licence	Department of National Museum and Monuments	Monuments and Relics Act (2001)	Before ESIA approval
4	Water borehole registration	Department of Water Affairs	Boreholes Act (1956)	When drilling boreholes for the Project
5	Water rights	Department of Water Affairs	Water Act (1968)	Before Project construction start
6	Working conditions - construction	Department of Labour, Department of Mines	Factories Act (1979), Mines, Quarries, Works and Machinery Act (1978)	Before Project construction start
7	Working conditions - operation	Department of Labour, Department of Mines	Employment Act (2001), Mines, Quarries, Works and Machinery Act (1978)	Before Project operation start
8	Work Permits and Residence Permits	Department of Labour	Employment Act (2001)	As and when needed
9	Storage of Explosives	Department of Mines	Explosives Act (1968)	Before blasting activities
10	Obtainment of surface rights	Deeds Registry	Tribal Land Act (1968), State Land Act (1966)	Before application for Mining Licence
11	Permission to generate power for own used by gen-sets	Department of Energy	Electricity Supply Act (1973)	Before operation of power gen-sets
12	Permission to connect access roads to existing roads	District Council, Roads Department	Road Traffic Act (1981)	Before access road construction
13	Licences (mining and EIA approval) for borrow pits	Department of Mines, DEA	Mines and Minerals Act (1999), EA Act (2010)	Before excavation of any materials for construction
14	Extension of Prospecting Licences	Department of Mines	Mines and Minerals Act (1999)	Before PL expires
15	Waste storage facilities (design) and transport	Department of Waste Management and Pollution Control	Waste Management Act (1998)	Before construction

4 Methodology

This chapter provides a brief background in relation to the EIA process, and lists the specialist studies included in the ESIA, the geographical scope and methodologies for each of the studies and the terminology used in the report.

4.1 ESIA process

A general overview of the process of preparing the ESIA, as per the EA Act (2010) and the Environmental Regulations (2012) was provided in Figure 1.4 on page 10.

Prior to embarking upon this environmental impact assessment for the T3 mine project, as per the EA Act of 2010, a Project Brief (screening document) was completed and submitted to the Department of Environmental Affairs for review. The Project Brief was submitted on the 16th November 2017, and correspondence in response to the document was received from the DEA on the 23rd November 2017 (DEA reference no. DEA/BOD/GH/EXT/MINE 009 I (2).

The response letter from DEA required that:

- Implementation of the proposed project would require undertaking and approval of a detailed Environmental Impact Assessment.
- Public consultation should be undertaken in accordance with section 7 (2) of the EA Act No. 10 of 2010 as part of the scoping exercise, to identify the salient issues to be addressed by the ESIA study.
- A practitioner who has been duly certified by the Botswana Environmental Assessment Practitioners Association (BEAPA) must be engaged to undertake the study.
- Two hard copies and a soft copy of the Scoping report and draft Terms of Reference should be submitted to the DEA for review and approval before proceeding with the detailed assessment.
- Upon submission, the reports must be accompanied by a fee for review as prescribed in Schedule 3, Regulation 4 of the Environmental Assessment Regulations, 2012.

As per the EA Act (illustrated in Figure 4.1) the next step in the environmental assessment process after the Project Brief is the Scoping and ToR stage, where the environmental ToR for the ESIA study is approved by the DEA, to provide certainty for the DEA and other stakeholders that the important issues will be addressed to the depth needed during the ESIA stage. Scoping also includes collection of the initial baseline environmental conditions as well as extensive consultations.

The Scoping and ToR report for the T3 project was submitted in March 2018, and approval was received from DEA (reference DEA/GH/BOD/EXT/MINE 009 (5) dated 2nd August 2018.

4.2 Previous studies

The exploration activities for T3 project were initiated early 2017 to establish an updated resource estimate for the copper at the site, which was used for the development of a pre-feasibility study for a copper mine development. The exploration activities were authorized by DEA 26th October 2017 (DEA reference no. DEA/BOD/EXT/MINE 002 (7)).

An authorisation was also acquired for the first phase of the development of the accommodation camp (located near Ghanzi) following submission of a Project Brief to DEA. The Project Brief was submitted on the 14th September 2017, and correspondence in response to the document was received on the 14th September 2017 (DEA reference no. DEA/GH/BOD/TOUR/CMP 011).

The authorisation was granted for accommodation of 40 people, and Tshukudu Metals is now planning to expand the camp to accommodate approximately 400 personnel. The application for the camp expansion is handled under a separate application (distance from the mine site is approximately 70km) but some of the associated impacts (social, traffic) have been assessed within this study.

4.3 Prediction and assessment of impacts

In the ESIS, individual impact assessment methodologies will be outlined within each section pertaining to distinctive areas of study. This section of the ESIS will explore the individual methodologies proposed to be used in the ESIA.

Each specialist study (e.g. ecology, archaeology, et al) included the undertaking of a baseline studies and site investigation, to provide a description of environmental character of the area of the proposed project and its surroundings. Desktop studies were already undertaken by EIA specialists during earlier scoping phase. To this end a series of field investigations were initiated, with the primary aim of these exercises to enable an assessment of the environmental impacts that forecasted activities may have on each specialist area of the receiving environment. This provided the context for the assessment of impacts associated with the proposed development. Detailed environmental site surveys and analysis are recommended to allow the impacts of the proposed development to be clearly identified and allow mitigation steps to be established to reduce impacts.

Based on the findings from scoping studies, it has been identified that environmental impacts are likely to occur in the following fields/parameters, and therefore the specialist studies that have been undertaken, included:

- Biodiversity (Flora and Fauna) assessment
- Cultural heritage assessment including archaeological impact assessment
- Groundwater and geochemical studies
- Air quality assessment
- Noise assessment
- Traffic impact assessment
- Landscape and visual assessment
- Waste management assessment
- Health impact assessment
- Qualitative and quantitative socio-economic impact assessment.

4.3.1 Terminology used

Methodologies used in the assessment of environmental impacts vary between scientific disciplines and consultants. Often predictions of impacts are based on best practice and appropriate experience, and in some cases, models or tests are run on the characteristics of the existing environment. Such methodologies are highly dependent upon the nature of the development and the scientific discipline being examined. For this reason, in the Project ESIS, individual methodologies will be outlined within each section pertaining to distinctive areas of study, when specific models and tests are utilised.

Notwithstanding this, the general method followed for undertaking an ESIA conforms to the philosophy that the product is relevant to the specific characteristics of the project and to the environmental features likely to be affected by it.

There is no specific definition in the Botswana environmental guidelines of what constitutes significance of impact in this context, but the following factors will be considered and applied during the ESIA process by the various specialist studies:

- The relative importance of the environment i.e. is it of national, regional, district, local, or site-specific importance.
- The scale of the change e.g. positive, neutral, or adverse (refer to Table 4.1).
- A degree to which the environment is affected e.g. enhancement or impairment (refer to Table 4.2)
- Whether the effect is temporary or permanent and if temporary its duration (refer to Table 4.3)
- The degree of mitigation that can be achieved, and how.

Impacts may be wide-ranging in nature. This includes the potential to be direct or indirect, secondary, cumulative, short, medium or long-term, permanent or temporary, positive or adverse effects. Therefore, to construct a methodology for impact assessment terminology, Loci uses the following scales when referencing nature of impact:

Table 4.1: Description of scale of change to be used in impact assessment

Scale of Change	Description of Scale
Adverse/Negative	A change that reduces the quality of the environment
Neutral	A change that does not affect the quality of the environment
Positive	A change that improves the quality of the environment

Table 4.2: Description of severity levels to be used in impact assessment

Severity Level	General Description
Insignificant/ Negligible	Environmental parameter will remain largely unaffected by positive or adverse impact. Impact unnoticeable in general.
Slight	Environmental parameter minorly affected by the positive or adverse impact, to a point whereby the impact may or may not be noticed by the receptors affected. Mitigation can alleviate all or most slightly adverse impacts.

Severity Level	General Description
Moderate	Development causes a degree of impact that will cause a noticeable change in the environment by most receptors affected. Mitigation measures should overcome most moderately adverse impacts.
Significant	Potential change in the daily experiences of all receptors due to the impact caused by the development. The impact would require a significant change in management practices with associated costs. This level of impact would require considerable mitigation measures and not all adverse effects may be overcome.
Profound	Impact affects 100% of receptors, with no mitigation measures applicable. An environmental parameter may be completely obscured, made void or invalid, or destroyed completely, due to profound adverse effects.

Table 4.3: Description of change duration to be used in impact assessment

Duration	Approximate Length of Impact Predicted
Temporary	Predicted to occur for approximately one year or less
Short-Term	Predicted to occur for approximately 1 - 9 years
Medium-Term	Predicted to occur for approximately 10 - 19 years
Long-Term	Predicted to occur for approximately 20 - 60 years
Permanent	Predicted to occur indefinitely

This ESIS has been written in clear terms, to be understandable to the general public as much possible. However, where unavoidable, any complex scientific and environmental issues addressed using necessary technical language and have been defined and explained within a glossary addressing any technical words and acronyms.

4.3.2 Geographical extent of the ESIA

During the scoping stage of the ESIA, the consultants limited their studies to the project site environment, as well as the regional environment in some cases. Some of the development's impacts may extend beyond the boundaries of the project area, and these were considered at a regional and national scale during scoping.

The scoping phase also identified the geographical study area upon which the ESIA will focus. It was established that the geographical zone studied in each specialist environmental parameter within the ESIA would be unique to that parameter due to the individuality of the varied environmental impacts that are predicted to arise due to the implementation of the project.

The following list (Table 4.4) applied to the individual environmental parameters assessed by the environmental consultants during the ESIA.

Table 4.4: Geographical extent of the ESIA study area

Environmental Parameter	Geographical Zone
Hydrogeology and Geochemical Pollution	Mining area, mine industrial area, stockpile areas and dumps, and tailings storage facility
Air Quality	An assessment will be made of the closest receptors to the sites, and typically a radius of 3-5km from the site is used.
Noise	Processing plant: provisionally 10km radius around the site. Blasting impact: provisionally 10km radius around the site.
Landscape and Visual Amenity	The Zone of Visual Influence relates to the boundaries of the project area (exact figures can only be established during the detailed ESIA stage of the project, once the full technical details are known. Based on existing mining operations a zone of +/- 15km will be used as guideline.
Waste Management	Mine area and nearby villages
Biodiversity	The project area and a zone of +/- 1km outside site boundaries/corridor (flora) and 5 km (fauna).
Traffic	At specified locations along the A3 road.
Archaeology	The impacted footprint plus 500m additional radius around the site as per National Museum, Monuments and Art Gallery (NMMAG) guidance
Socio-Economic Environment and health assessment	Settlements proximate to the mining area and Ghanzi Township.

4.4 Specialist Studies

This Section presents the specialists studies to be undertaken during the detailed ESIA stage. Consistent with the IFC standards (Standards 6), competent professionals (specialists) have been engaged during the impact identification and analysis process for the Project, as per the details provided in Table 1.4 on page 13.

The methodologies applied for the specialist studies undertaken for the Project are discussed in the following subsections.

4.4.1 Water resources

As there are no local surface water channels in the study area, the Knight Piesold engineering/drainage report and drawings showing diversion channels and sediment control dams have been used for the ESIA, which included pollution control measures.

4.4.1.1 Groundwater modelling and prediction

A conceptual groundwater model was developed during the PFS phase of the project (and presented in the environmental scoping report). The detailed ESIA work has developed this work significantly to increase confidence levels. The groundwater specialist work has:

- Undertaken the drilling of four groundwater boreholes outside the mine area (called "production boreholes") to test groundwater conditions outside the mine footprint
- Undertaken the drilling of eight groundwater boreholes within the mine area (called "mine dewatering boreholes" to test groundwater conditions inside the mine footprint
- Undertaken test-pumping of the new boreholes
- Undertaken a borehole census to identify all surrounding boreholes
- Commenced with a monthly groundwater monitoring programme
- Update of the flow model
- Update of the contaminant transport model
- Review of model
- Further development of mitigation measures and monitoring measures to minimise impacts on groundwater.

4.4.2 Geochemical characterisation

The geochemical laboratory analyses for the T3 Mine constituted the static testing of waste rock and stockpiled material. The undertaking of geochemical characterisation has followed the IFC Guideline for Mining (IFC 2007), which recommend, as good International Industry Practice that mining operations should prepare and implement ore and waste geochemical characterisation methods for proper routing of Potentially-Acid- Generating (PAG) materials and ARD management programs that include the following elements:

- Identification of the potential source materials: waste rock, tailings, ore (both high grade and low grade) and pit wall materials
- Design of sampling and testing regime to assess ARD potential
- Sampling of core and tailings for laboratory analysis
- Assessment of laboratory results to determine potential for ARD and ML generation, potential pit lake and tailings leachate quality
- Assessment of potential impacts on the site and regional environment
- Determination of prevention and mitigation measures for ARD risk reduction for mine planning and operation.

The International Network for Acid Prevention (INAP, an organisation of international mining companies dedicated to reducing liabilities associated with sulphide mine materials) sponsored the development of the Global Acid Rock Drainage (GARD) guide by international experts, which outlines the current international best practice for the prediction, prevention and management of acid rock drainage. Laboratory tests to predict the potential of rock samples to produce Acid Rock Drainage and metals leaching are generally grouped into two categories, static and kinetic tests. The static tests are relatively simple, inexpensive and rapid, whereas kinetic tests may take several months. Kinetic tests are typically carried out if the results of the static tests are not conclusive or kinetic reaction rates are required for detailed assessments or geochemical models.

4.4.2.1 Sample selection

Selection of representative samples are key to developing a geochemical characterization study with acceptable confidence levels. A detailed sample selection study was conducted by the specialist to determine appropriate intervals for geochemical analysis. Initial sampling intervals were selected during a meeting between the Client and the specialist.

The initial selection consisted of 69 sample intervals selected from 53 drill holes. However, two samples were missing from the consignment on arrival of the shipment in Perth. The samples were all selected from within the design pit shell and provide a good geographical spread across the deposit, as shown in Figure 4.1.

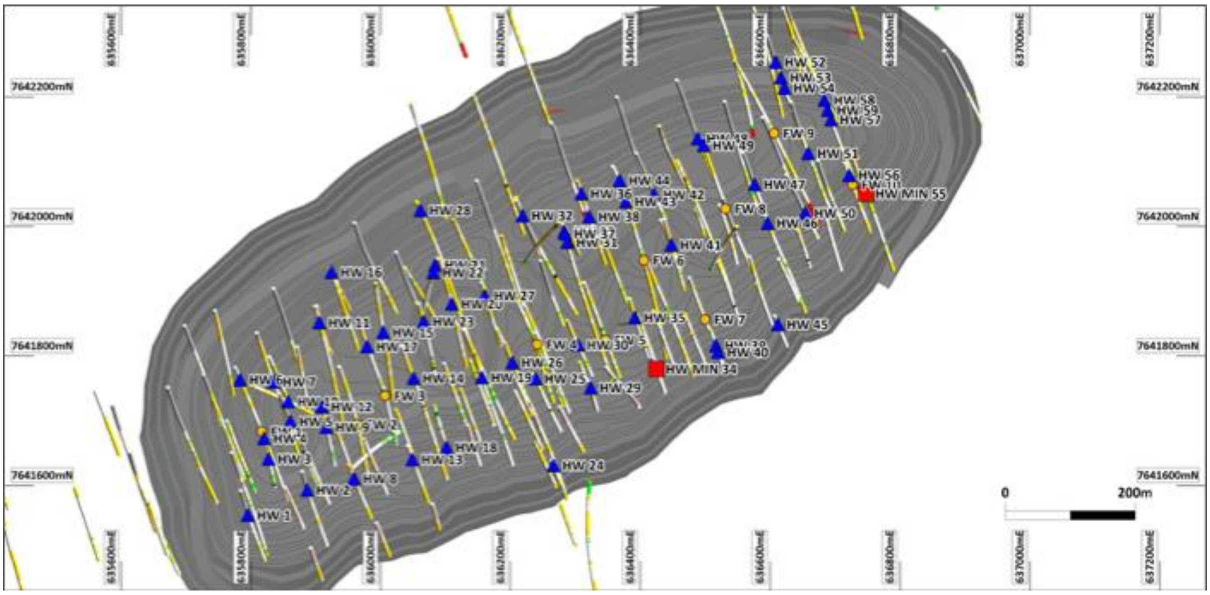


Figure 4.1: Sample locations for geochemical sampling (Knight Piesold, 2018)

Around half the samples (33) were selected from the lead/silver/zinc halo which is immediately overlying the copper mineralisation. This was a deliberate bias in the sampling strategy to focus on a zone which was perceived to represent a greater geochemical risk. For these intervals, silver, copper, molybdenum, lead and zinc assay data was available, as well as sulfur for ten of the intervals. The assay data was plotted on a range of histograms to ensure the samples selected were representative.

For the remaining 36 intervals where no assay data was available, the sampling points were generally selected as the midpoint within the interval. However, site personnel were requested to adjust the actual sampling point if needed to ensure that the samples were representative of the interval as a whole.

The sample selection according to lithology is presented in Table 4.5. The tonnage of each waste rock lithology to be mined is not yet known, however, the sampling allocation is thought to be broadly representative of the deposit.

Table 4.5: Sample allocation by lithology

Lithology	Code	No. samples
Sandstone	SST	22
Siltstone	SLT	21
Mudstone	MST	18
Marl	MARL	5
Calcrete	CLC	1
Calcite / Quartz Vein	CQV	1
Limestone	LST	1
Total		69

Details of the selected samples are provided in the geochemical specialist report in Appendix C2.

The selected samples were then subjected to the following assessments:

- Acid Base Accounting
- Net Acid Generation (NAG)
- Acid Forming Potential
- Multi-Element Analysis
- Distilled water extracts (leaching potential)
- Reference to water quality standards (BOBS)

Detailed description of the above assessments and methodologies are also provided in the specialist report in Appendix C2.

4.4.3 Air quality assessment

The Air Quality Impact Assessment includes a Baseline Assessment for the site, an impact assessment and the development of an air quality management plan. The scope for each of these stages included:

4.4.3.1 Baseline assessment

To contextualise the study, a baseline assessment was conducted comprising the following:

- Identification of neighbouring sensitive receptors, including adjacent communities and residential areas.
- Identification of any neighbouring sources. Emissions from these sources will not be included into the dispersion model, but a discussion on how they may contribute to the cumulative air quality conditions will be included;
- Assessment of baseline conditions at the proposed mine including:

- Existing air quality conditions (ambient air quality monitoring data was not available)
- Meteorological conditions with the use of three years data procured for the nearest local weather station and the purchase of three years MM5 prognostic data (required for AERMOD) for the period January 2014 – December 2016.
- Review of all applicable National and International legislation and policies.

4.4.3.2 Emissions inventory

The emissions inventory accounts for all significant releases to atmosphere in the form of point, line and area (fugitive) sources. Where required, emissions will be calculated using the United States Environmental Protection Agency's (EPA) AP42 emission factors. The AP42 emission factors have been compiled since 1972 and contain emission factors and process information for over 200 air pollution source categories. Where AP42 emission factors are not available, emission factors from the Australian National Pollution Inventory (NPI) will be utilised.

A detailed emissions inventory was compiled to assess emissions associated with the construction and operation of the proposed mine.

4.4.3.3 Dispersion modelling

The AERMOD dispersion modelling platform has been utilised to assess the dispersion of pollutants from the proposed mine. AERMOD is a recommended Level Two dispersion model as per the South African Regulations Regarding Air Dispersion Modelling (GNR 533, 11 July 2014), and is typically recommended for impacts that are in the order of a few kilometres downwind (<50 km).

The dispersion modelling focussed on pollutants related to the proposed mine, for which there are National and/or International ambient air quality standards, namely Total Suspended Particulates (as dust fallout), PM_{10} and $PM_{2.5}$.

The AERMOD software is well equipped to simulate the dispersion of emissions from the mine and has the following capabilities:

- It is a new generation air dispersion model designed for short-range dispersion (<50 km) of airborne pollutants in steady state plumes.
- It incorporates air dispersion based on boundary layer turbulence structure and scaling, including treatment of both surface and elevated sources and both simple and complex terrain.
- It uses hourly sequential meteorological files with pre-processors to generate flow and stability regimes for each hour that cumulatively offer long-term ambient concentrations whilst also capturing short-term peaks.

The following dispersion modelling scenarios have been assessed:

- Incremental impacts associated with activities at the proposed mine.
- Cumulative impacts - background ambient air quality monitoring data are used for this purpose, as a detailed emissions inventory was not available for surrounding existing sources.

4.4.3.4 Impact assessment

On completion of the dispersion modelling, an Air Quality Impact Assessment report was compiled presenting the baseline assessment, emissions inventory, dispersion modelling predictions and associated impacts. The results will be assessed against the relevant National (Botswana) and International (South African and World Health Organisation) Ambient Air Quality Standards.

4.4.4 Noise assessment

The noise assessment methodology for the T3 mine ESIA is discussed in the following sections.

4.4.4.1 Baseline assessment

To contextualise the study, a baseline assessment was performed comprising the following:

- Identification of sensitive receptors (noise receivers) near the proposed site.
- An assessment of the existing noise climate near the proposed site through baseline noise monitoring.
- Day and night-time noise monitoring was conducted at various predetermined on-site and off-site monitoring locations. All sound level measurement procedures was undertaken according to the relevant South African Code of Practice, SANS 10103:2008. Sound level measurements will be undertaken using a CasellaTM Type 1 Integrating Sound Level Meter. Monitoring will be conducted in fifteen-minute intervals, with the day-time monitoring occurring between 06:00 and 22:00, and the night-time monitoring between 22:00 and 06:00.
- Assessment of monitored results against the relevant guideline rating levels as provided in SANS 10103:2008.

4.4.4.2 Environmental acoustic inventory

A detailed inventory of all potential noise sources, for both the construction and operational phases, associated with the proposed project was developed and sound pressure levels for each of these proposed sources was sourced from the Noise NavigatorTM sound level database (Berger et al., 2010) and other alternative literature.

4.4.4.3 Environmental acoustic modelling

Noise levels at receptor locations associated with the construction of the proposed mine was determined using noise propagation calculations. Resultant noise levels were assessed against the existing (monitored) noise levels to determine any changes.

Noise levels associated with the operational phase of the proposed mine were determined using an acoustic model. Environmental acoustic modelling was conducted using the internationally accredited noise modelling software, CadnaA (Computer Aided Noise Abatement). The CadnaA software provides an integrated environment for noise predictions under varying scenarios and calculates the cumulative effects of various sources. The model uses ground elevations in the calculation of the noise levels in a grid and uses meteorological parameters that influence the propagation of noise. CadnaA has been utilised in many countries across the globe for the modelling of environmental noise and town planning. It is comprehensive software for 3-dimensional calculations, presentation, assessment and prediction of environmental noise emitted from industrial plants, parking lots, roads, railway schemes or entire towns and urbanized areas.

The noise source inventory detailed above was utilised as input for the CadnaA model. Gridded outputs from CadnaA were the input into ArcGIS to provide a visual representation (isopleth output) of noise levels throughout the region. The noise contribution of the proposed facility to the existing noise levels (monitored data) were calculated, with comparisons being made to relevant national/international guidelines.

Blast over pressure and vibration was not included in the noise assessment, since the area has a very low population density and nearest residence are at a significant distance from the mine. In addition, blasting will be undertaken in the pit.

4.4.5 Landscape character

In assessing how a mine development may affect the existing landscape, the following factors were considered in the Landscape and Visual Assessment within the ESIA:

- The extent to which the mine and associated infrastructure will be visible in the landscape.
- Baseline information on the character of the existing landscape and its capacity to accept changes of the type and scale proposed (based on site visits).
- The extent to which impacts can be integrated into the landscape.

In assessing how the proposal affects the existing landscape, the impact on the following aspects of the visual environment has been assessed, considering any proposed landscape mitigation measures:

- Landform and how the proposed mining development affect the appearance of the underlying structure of the landscape.
- Noteworthy landscape elements and features such as buildings, monuments, structures, earthworks or trees.
- Existing landscape character, potential for adverse impact due to addition of uncharacteristic elements, traffic, secondary effects such as farm severance and land use, or removal of important constituents of the existing landscape.
- Development of mitigation measures to mitigate landscape and visual amenity impacts.
- Light pollution.
- Input into the mine closure plan (final forms/shapes of dumps). Focus has been on indicating the waste rock profiling, characterisation and engineered storage facilities for such waste.

Consideration has also been given to the visibility of the scheme, considering the level of the mine features relative to the existing ground level, any access roads, structures, signage, lighting, and traffic as potential visual intrusions.

4.4.5.1 Visual amenity assessment

The visual assessment, or “visual amenity” aspect of the study, addresses the impacts of the proposed mine upon the visual amenity within the study area, by looking at the “composition of available views because of changes to the landscape, to people’s responses to the changes, and to the overall effects with respect to visual amenity” (LI/IEMA, 2002). In describing the visual impacts yielded by the proposal on the environment, these may arise under categories of:

- “visual intrusion” - the impact on a view without blocking the view and
- “visual obstruction” - where there is an impact on a view involving blocking of it.

Visual baseline analysis was undertaken to identify the extent and nature of the existing views from pre-identified viewpoints and to locate potentially sensitive visual receptors for use in representative viewpoint analysis. Assessment was also made of the general visual amenity or scenic character of the study area and greater region. Existing scenic resources are described and assessed in terms of landscape character, scenic quality, and sensitive views in the surrounding landscape.

As per best practice in ESIA, the likely visual impacts related to the proposed expansion of the mine and its main visual components are described herein. The significance terminology assigned to the visual effects identified is influenced by the visibility, scale, appearance and expected duration of the proposed mine expansion, the context of the existing landscape, the sensitivity and number of viewers.

Information collected during the scoping stage of this ESIA and through desktop studies was confirmed in the field, through site visits taking place in the winter when vegetation cover was minimal where present and could provide a “worst-case scenario” example of visual screening (by vegetation) in the region. The fieldwork included ground-truthing of the satellite mapping used in baseline data collection during the scoping phase, to ensure that the aerial photography used was not substantially out of date, and that no new receptors would be affected aside from those already identified.

4.4.6 Waste impact assessment

The main objective of the waste management component of the ESIA was to develop a waste management plan for the proposed Project and all its associated activities.

The following key queries were made and addressed as part of the waste specialist study:

- What is the relevant existing/draft legislation related to waste management in Botswana, and how does it relate particularly to waste management within the mining sector?
- Who are the mining officials who are currently overseeing the waste management at similar scale mines in the area and how are they doing it?
- What are the potential impacts that the increased population (due to the mining project) may have on the waste management system at the local town/village?

The following methodology was used assess the waste management specific impacts as part of the ESIA:

- Review the relevant Botswana legislation. Waste management legislation provides clear directives, guiding the line of thinking when a waste management plan is developed for the mine.
- Review of the expected conditions on site by visiting existing mines or similar operations.
- Site visits to the areas where waste is generated, following the waste stream through its life cycle of containerisation, storage, transport, transfer (where applicable), treatment (where applicable) to final disposal will provide useful information on situations where similar waste management processes may put the environment at risk, for inclusion within the ESIS.
- Examine existing mines in the area and explore the possibility of regionalisation of waste management facilities.
- Study of engineering development plans for the proposed mine and evaluate the proposed site.
- Meetings with District Council officials to determine the impact of increased domestic waste generation resulting from the increased population, on existing municipal service delivery. Based on an evaluation of the current situation at the local municipality, recommendations were made to ensure adequate human and physical resources for environmentally sound waste management.

As part of the overall ESIA Environmental Management Plan, a waste management plan was developed for the proposed mine with a cross cutting waste management plan for the local town/village. The waste management plan has identified the expected waste streams, as well as potential environmental impacts associated with each phase of the proposed project.

4.4.7 Biodiversity

A detailed assessment, using literature review, field observation and key informant interviews was applied to determine whether the project will result in bio-physical eco-system changes. Bio-physical indicators include population numbers, habitat condition and ecosystem function, carrying capacity (including cattle), biodiversity, and quality parameters for water, soil and air.

Field observations and professional judgment and expertise was applied in assessing the type and importance of the identified bio-physical resources in the ESIA study area, both at the species and ecosystem level, and consider the potential impacts of project-related activities.

4.4.7.1 Site visit and field survey

A biodiversity assessment (wet and dry season) had been undertaken by the Client prior to the commencement of the ESIA, and this report was used as the main source baseline data, and was further developed during the ESIA work. The biodiversity report has noted three distinct vegetation biomes (grassland savannah, scrubland savannah, and open canopy savannah) within the study area. For the purposes of monitoring, these sites were selected for permanent transects. A wet season fauna camera trapping by CCB (Cheetah conservation) to complete the dry season fauna camera trapping work carried out to date.

A site visit and field survey was also undertaken for the proposed service corridor. These areas were traversed on foot and on field vehicle. Biota and habitats were also assessed. All flora and fauna/avifauna) species present were identified either by observation or evidence of their passage

The site visit, results from the camera trapping survey and review of data for the project area have enabled the biodiversity team to identify the endangered wildlife species in the affected area, and develop mitigation and monitoring procedures to manage any possible impacts on these species. This excluded the accommodation camp in Ghanzi and the considered proposal to irrigate 100 ha of pasture during initial dewatering. Liaison was also be undertaken with Raptors Botswana in relation to sensitive avifauna species in the project area.

4.4.7.2 Impact assessment and development of mitigation measures

The predicted ecological impacts of the proposed projects were assessed following the field visits. Directed, indirect and cumulative impacts were assessed across the construction, operations and decommissioning phases of the Project along the access road, the project site itself and the surrounding areas. The severity of the impacts and duration were also be predicted, including any residual impacts.

Following the identification of the impacts, appropriate mitigation measures and a best practice plan was devised to limit the severity of the impacts. Certain impacts have been identified as direct result of the proposed project e.g. the copper mining will impact vegetation - and cause disturbance to the sites soil substrate layers. However, a plan was devised to mitigate other indirect impacts which may be because of the primary impacts, to reduce the total severity of the mining activities. After the closure of the mine, these areas can then be mitigated and rehabilitated.

4.4.7.3 Monitoring

A monitoring plan for various indicators (based on impact assessment) was compiled devised. Impacts such condition of vegetation, biodiversity loss, establishment of invasive flora, water pollution, air pollution and soil erosion would have to be monitored. Thresholds were identified, and action plans were established should thresholds be exceeded.

The areas with transects can be used as analogue sites to monitor progress of revegetation and rehabilitation towards closure objectives. It must be noted that some transects were done in the disturbance footprint, and others may be cleared by farmers in future.

4.4.7.4 Rehabilitation

A rehabilitation plan was developed to guide rehabilitation of affected areas for mine closure. Local provenance species will be selected based upon suitability of the landform and final land use options. Successful rehabilitation will reduce the severity of direct impacts of the mining activities.

4.4.8 Health Impact Assessment

Assessment of health on a mining project is usually divided into two main areas:

- Occupational Health Risk Assessment (OHRA) – employee and contractor work health.
- Health Impact Assessment (HIA) - the impact (both positive and negative) that the mining project may have on community health.

The scope of the proposed Comprehensive Health Assessment therefore included an OHRA and HIA and then the combining of the two assessments to inform a Comprehensive Health Management Plan (CHMP) for the T3 Copper Project.

This health assessment was informed by guidelines written by organisations such as the International Finance Corporation and the International Council on Mining and Metals. This assessment also complies with prevailing Botswana regulations.

An overview of health issues was undertaken. Visits were made to the project site and local health facilities. Important stakeholders on site and in the community were consulted and key informants interviewed. T3 Copper Project Site Management, Health, Safety and Community Relations staff were consulted and involved in the health assessment process. There was close liaison with the Social Impact Assessment team, to ensure there was constant sharing of information and that duplication of work was avoided.

T3 Copper Project health issues were identified and a preliminary qualitative assessment of each was be undertaken. From an OHRA perspective, the focus was on the following:

- Emergency medical response
- Primary health care
- Risk-based medical surveillance (that is initial, periodical and exit medical examinations)
- An overview of occupational hygiene risk assessment and control
- Contractor health
- Expatriate employee health
- Absentee management
- Alcohol and substance abuse
- Public health in the camp (water, sanitation, food).

From an HIA perspective the focus was guided by the IFC's Environmental Health Areas including:

- Vector-related diseases
- Respiratory and housing issues
- Veterinary medicine and zoonotic issues
- Sexually transmitted infections
- Soil and water-sanitation related disease
- Accidents and injuries
- Exposure to potentially hazardous material
- Social determinants of health
- Cultural health practices

- Health services infrastructure and capacity
- Non-communicable diseases.

A draft prioritisation of health issues (from both the OHRA and the HIA) together with draft recommendations have been captured in a spread sheet. The more important health issues with corresponding draft recommendations, were described in the specialist report. The spread sheet and report were discussed with T3 Copper project management to align with company policy.

A final report was then compiled by the specialist consultant, comprising a list of health issues and the agreed prioritisation and recommendations. As such, this will comprise the recommended Comprehensive Health Management Plan for the T3 Copper Project.

4.4.9 Traffic impact assessment

The Traffic Impact Assessment for the Project was undertaken in accordance with the following:

- Botswana EA Act of 2010.
- Botswana Environmental Assessment Regulations (2012).
- Environmental Protection Guidelines.

4.4.9.1 Status quo assessment of existing conditions

A field study was conducted, and the following items were assessed to establish the status quo of the area conditions:

- Visual inspection of site and definition of study area.
- Assessment of Existing Road Network.

4.4.9.2 Traffic impact assessment

The assessment of the Project on the traffic of the study area involved:

- Analysis of the existing traffic conditions.
- Establishment of the impacts of mine fleet/traffic on study area road network.

The study has produced the following outputs:

- Traffic Impacts and Level of Service Analysis including Construction Traffic Impacts.
- Proposed mitigation measures.
- Recommendations for Safety and Traffic Management Plan.

4.4.10 Cultural heritage

An AIA survey has already been undertaken for the T3 mine site and the AIA report has been compiled to present the study findings and obtain a development permit from the Department of National Museum and Monuments. However, the survey did not include the proposed service corridor.

A desktop study has been conducted by the archaeology team and it entails summarising existing knowledge of the area, including prehistory, historical attributes of the region, potential importance of scientific research in the project area, specific details of the development and its potential damage to the archaeology of the area. This was achieved by:

- Conducting an inventory of historical and archaeological resources in and around the project area.
- Collation and documentation of existing written reports and oral information
- Identification of areas of maximum sensitivity.

Fieldwork and further impact identification was conducted in the following manner:

- Review of the AIA (and update if required) report for the proposed mine site.
- Foot survey of the proposed service corridor route, utilising GPS, aerial photographs and available maps.
- Identification of individual threats to the cultural, historical, and archaeological resource.
- Assessment of the proportion of sites to be impacted.
- Assessment of the direct and indirect impact on the resource.
- Oral interviews conducted.

Finally, data analysis and reporting was undertaken by the specialist team in accordance with the requirements from the Department of National Museum and Monuments, and includes:

- Designation of identified sites with numbers upon concurrence.
- Production of scaled photographic documentation of the resources.
- Assessment of the significance of potential impacts.
- Evaluation and interpretation of the findings according to the National Museum grading system:

  1 = Preserve at all costs

  2 = Preserve if possible, otherwise extensive salvage work

  3 = Test excavation, or in the case of natural monuments, sufficient specific sample is submitted to determine whether further work is necessary

  4 = Systematic representative sampling sufficient

  5 = No further archaeological work is required.

4.4.10.1 Development of archaeological induction procedure, chance-find procedure and grave management.

Within the assignment of a grade, consideration was given to the current degree of damage, how common the sites are, uncertainty of its status or importance, likely development impact, research potential, and whether the find is of national or regional importance.

The specialist report contributes essential input into the overall project ESMP, particularly addressing means of impact avoidance and mitigation measures for implementation if artefacts or sites are found during the construction phase of the project. An archaeological induction procedure has been developed for the Project, including chance-find procedure and grave management plan.

The final report was submitted to the National Museum and endorsement was received (refer to Appendix M)

4.4.11 Socio-economic assessment

The Social Impact Assessment has focussed on the directly affected villages and residents at each of the project areas.

4.4.11.1 Key informant interviews

National level key informant interviews were held with government institutions such as Department of Environmental Affairs, Department of Mines and NGOs in Gaborone as well as the National Mine Workers Union. This included interviews with District authorities and civil society such as District Council, Farmers Associations and Tourism associations in the District. The work included updated mapping of directly affected communities such as freehold farms occupied at the time of the scoping exercise and in immediate proximity of the proposed mining areas, and in immediate proximity of the proposed service corridor route and accommodation camp.

Following materials assembly and review, key informant interviews has taken place as follows:

- National level key informant interviews in Gaborone: To solicit data and insights on possible mine impacts with institutions such as Department of Environmental Affairs, Department of Mines, Ditshwanelo, Kalahari Conservation Society, Botswana Mine Workers Union etc.
- A field visit and survey to directly and indirectly affected villages and the proposed mining areas This field visit comprised the following:
  - District Level Key Informant Interviews: Such as District Council, Water Affairs, Land Board, Farmers Associations.
  - Local Level Key Informant Interviews (LLKII): Local authorities and local leaders.
  - Mapping of directly affected households: Farms within and near the proposed mining area as well as in proximity of the main access routes. Local knowledge and assistance was utilised to locate and record GPS coordinates of all directly affected farms and cattle posts within and in immediate proximity of the proposed mining areas as well as the possible access routes. These were all revisited during the SIA for one-on-one interviews.
  - Data compilation (quantitative and qualitative materials).

As with the national key informant interviews, the rapid appraisal in the field included consideration of impacts of mining in the proposed mining areas, service corridor camp site due to these operations.

4.4.11.2 Social impact assessment and management plans

The Social Impact Assessment (SIA) took place immediately after the fieldwork described above. The main activities for the SIA included:

- One-on-one interviews with directly affected households: identified and mapped during the first field visit.
- Quantitative household survey.
- Data entry, validation of qualitative questionnaires.
- Data compilation.
- Preparation of the SIA specialist report on the Social Environment.
- Integration of social environment issues into the main report for the ESIA.
- Inputs into the Environmental Management Plan.

All field instruments solicit a mix of information of relevance to the Project, information on skills profiles of persons in the affected area, and opinion data on mine impacts and opportunities. In terms of the latter, while this provided information of relevance to the SIA, it also supported extension of public participation consultations to sub-groups who would normally not have a voice in larger public participation meetings.

4.5 Presentation of mitigation measures

Mitigation measures will be identified within the ESIA, and these will seek to find preferred ways of undertaking activities to minimise or eliminate negative impacts and enhance and maximise positive impacts on people and the environment. Mitigation measures are described in terms of the nature of the impacts, their duration and magnitude. The timing and duration of mitigation measure implementation is also important and must be given. Timing refers to project phases and duration can be short term, medium or long term.

4.6 Assumptions and limitations encountered

This Section summarises the assumptions made during the Impact assessment process, as well as the limitations encountered during the work undertaken. It is important to list these limitations within the context of the ESIA study, as they have influenced the baseline data gathering work, which is a record of the pre-development environmental conditions.

4.6.1 Assumptions

Aspects that may be related to the Project, but have not been assessed in as part of the technical project scope within this ESIA study, include:

- Power transmission lines, upgrades and substations developed by BPC to supply power to Ghanzi from Maun (North West Grid Transmission Connection project).
- Exploration activities in the overall exploration licences.
- Future mining activities outside the T3 area, in areas such as T1 or other deposits in the T3 Dome area.
- Future underground mining at T3.
- Development of the accommodation camp on the outskirts of Ghanzi (separate assessment).
- Any developments on farm 153-NL undertaken by the farm owner, outside the mine footprint.
- Smelting activities (not anticipated).

There are several technical assumptions, which are critical for the environmental and social impact assessment process. Although many of these have already been described in Chapter 2, they are summarised as follows:

- Accommodation for employees will be at the accommodation camp at Ghanzi during operations based on a rotational system, and no housing of mine staff will be located in D'Kar or Kuke. During construction some temporary housing will be located at the mine.
- The project will be developed within the agreed footprint on a section of farm 153-NL, and the farmer (Mr Lemcke) will remain at the homestead and will continue farming on the remainder of 153-NL and surrounding farms.
- Purchase of the land for the project (farms 153-NL for the mine and 111-NL and 110-NL) has been agreed based on commercial land negotiations and is sold to Tshukudu Metals voluntarily. No resettlement is required for the project development.
- The project will consist of open pit mining only.
- Concentrate will be transported from the mine to Walvis bay port facilities, in Namibia.
- Social and community impact assumptions, which include:
  - That the Client will take a long-term view of social impact mitigation and enhancement, and that short-term mitigatory actions will build on a longer-term plan.
  - That the Client will consider financing CSR interventions at levels sufficient to have desired impacts.

4.6.2 Limitations

The following limitations were noted for some of the specialist studies during this ESIA.

4.6.3 Biodiversity

Considering the scale and complexity of the proposed project, it is expected that there may be study limitations and knowledge gaps within certain aspects of the biodiversity studies. The knowledge gaps and study limitations encountered are outlined below:

- Cumulative impacts on fauna relocation and behaviour because of the T3 mine: the cumulative impact of the T3 mine will have upon the local fauna cannot be fully understood without more information on their movements. The camera trapping surveys by CCB have provided valuable data and have shown that there is little significant difference in mammal occurrences between wet and dry seasons. However, to fully understand the effects of the disturbance that the T3 mine will to bring to the fauna communities a fauna management plan is required which guides further work in relation to a trans-location program for small and medium mammals, prior to clearing for construction. This involves scouting the areas for clearing and recording den locations, etc. It then involves relocation to suitable site through liaison with DWNP and by qualified people.
- Movement of elephants and their potential attraction to a possible pit-lake after closure (refer to hydrogeology specialist study: the current status of elephant movements through Botswana is not fully known or understood. Elephant sightings in the CKGR are increasing (based on specialist experience and verbal feedback), and their occurrences within the Ghanzi farming region seems also be increasing, however the accuracy and reliability of reports are inconclusive. It has been hypothesised that Elephants are gradually moving Southwards through Botswana. This could be possible and in terms of suitable habitat they were historically found within the Ghanzi and Kgalagadi regions, and it could be possible that they may yet be returning to attempt to occupy these areas (Elephants Without Borders – personal communication). Regardless, without more conclusive information of Elephant movement patterns in exist Botswana, the risk of them being attracted to the T3 mine lake cannot be reliably assessed. This is a knowledge gap that is likely to be more informed with time in collaboration with conservation agencies and others. In Chapter 7 and the biodiversity specialist report, elephant behaviour in relation water sources is explored to provide some additional context to the issue.
- Vegetation transects: It is possible that a number of sites (at least 4) may be lost during clearing for mine construction. However, it was imperative to establish transects within the project site to quantify the vegetation that may be lost to aid future rehabilitation. Some species were more commonly found within the project area compared to the rest of the farm, thus this gave an indication of species composition in the project site. The farmer on T3 (Callie Lemke) has expressed the intention to clear areas on the farm for future cultivation of lands but has not confirmed the exact locations. Therefore, it is uncertain which sites may be compromised in the future and it is possible that other transect site may indeed be lost. Additional transects may need to be set up within the farm and possibly neighbouring farms (adjacent to the mine site) for future monitoring and to account for any transects that are lost.

4.6.4 Air quality

The following assumptions were made for the assessment:

- The proposed mine is operational 24 hours a day, 7 days a week apart from blasting which is during the day-time only.
- To determine the $PM_{2.5}$ emission rates from wind erosion, a factor of 15% was applied to the PM_{10} equation. A control efficiency of 50% for watering was applied to all stockpiles and tailings facility (NPI, 2012).
- Control efficiencies of 70% and 50% for water sprays and miscellaneous transfer points were applied to the various material handling activities.
- To determine the PM_{10} and $PM_{2.5}$ emission rates from drilling activities, a factor of 52% and 3% was applied respectively to the TSP equation. A control efficiency of 70% was applied to emissions from drilling.

- To determine the $PM_{2.5}$ emission rates from crushing, a factor of 30% was applied to the PM_{10} equation. Controlled efficiencies of 50% for water sprays were applied to the crushing activities (NPI, 2012).
- A 75% control efficiency for watering (wet suppression) was applied to haulage (NPI, 2012).
- The impacts in this assessment are limited to incremental impacts as long-term ambient monitoring data was not available.
- Housing near Ghanzi is part of a separate assessment. Further, the Walvis bay transport and handling has not been included.

4.6.5 Noise study

In the Acoustic Impact Assessment, various assumptions were made that may impact on the results obtained. These assumptions include:

- Construction and operational phase noise sources are based on estimated quantities using sound level data from the Noise Navigator$_{TM}$ sound level database (Berger et al., 2010) where applicable.
- During each construction phase, the noisiest equipment was assumed to be operational simultaneously. Furthermore, to represent a worst-case scenario, it is assumed that one of each piece of equipment will be operational simultaneously at a location on the copper mine project area in closest proximity to each sensitive receptor. Such a worst-case scenario is unlikely to occur.
- A travel speed of 60 km/h was applied to the trucks travelling on the gravel roads.
- Housing near Ghanzi is part of a separate assessment. Further, the Walvis bay transport and handling has not been included (It must be noted that this, however, will be audited by the Client).

4.6.6 Soils

The following assumption and limitations were encountered during the soil chemistry baseline assessment:

- The number of samples analysed was considered enough for a site with such homogeneity in vegetation. Although a larger sampling pool can provide more statistically significant data, it was outside of the scope of the assessment to gather such detailed information.
- The study did not include a physical soil survey but some information on the physical soil properties can be derived from the analyses results (such as texture).
- Water infiltration rates were not determined in situ and an estimation of this as well as the soil structure was used for the calculation of the maximum slope at which soil can be stockpiled.
- Samples were not analysed for microbiological organisms that is another strong indicator of the topsoil stockpile fertility as it plays an important role in the soil nutrient cycles such as the nitrogen, carbon and phosphorus cycle.

4.6.7 Hydrogeology

In relation to the groundwater studies for the project, the following limitations were noted:

- A considerable amount of work has been undertaken as part of this ESIA study to gain a good understanding of the groundwater conditions, including the drilling and test pumping of 12 new hydrogeological boreholes. This, in addition to the information gained from boreholes drilled and pumped during the pre-feasibility study and first phase conceptual groundwater model, have formed the basis of the groundwater assessments.
- Monthly groundwater monitoring commenced in March 2018 for the project area, and at time of completion of the assessment a full year dataset had not been obtained.
- One dewatering borehole was abandoned (MO-G-WB11) at 160m due to the drill string being stuck in the borehole, which could not be fished and was replaced with MO-G-WB20.
- The test pumping works comprised of the following tests:
  - Calibration test of six (6) to eight (8) fifteen-minute steps to assess borehole drawdown and yield and to allow the contractor to set engine rpm.
  - Step test of up to six (6) two-hour (120 minute) steps to determine a rate for the constant rate test (CRT) and to determine borehole hydraulic parameters.
  - CRT of 72hours duration followed by up to 95% or 24hours recovery, to allow calculation of aquifer hydraulic parameters and determination of a recommended abstraction yield.
  - Monitoring of selected observation boreholes during the CRT.
- Generally recommended (sustainable) borehole abstraction yields are assessed to not detrimentally affect the aquifer i.e. deliberately dewater productive zones and this principal was used with respect to the water supply boreholes, whereby the first major water strike was used as the available drawdown in the borehole. With respect to the dewatering boreholes a pump water depth of 120m was used.

  The calculated abstraction rates should be viewed bearing in mind the following limitations and assumptions:

  - Both methods assume no interference effects in their calculations, which as shown by the project CRT's is not the case.
  - Calculated yields do not consider the dewatering of fractures because of direct drainage into the pit.
  - Dewatering borehole yields are based on a 1-year projection with boreholes pumping 20hrs per day to obtain a maximum water level of 120m.
  - The water supply borehole yields are based on a 10-year projection pumping 20hrs a day and maintaining water levels 2m above the first major water strike.
  - Pumps are assumed to be electrical submersible pumps.
  - Pumps have been set at 150m for the first year for the dewatering boreholes, thus giving the option to install deeper or allow a smaller pump to be installed, given that yields will probably decline below this level and the initial pump capacity may be too

large to be able to pump efficiently for potentially significantly lower yields, because of fracture dewatering.

- Water supply pumps have all been set at 200m, even though the 1st major water strikes are less than 100mbgl.

4.6.7.1 Modelling

A numerical groundwater model that attempts to replicate observed/measured responses and predict responses under different and usually highly stressed scenarios will have uncertainties in the simulation results. Uncertainties consist of conceptual uncertainties and parametric uncertainties. Conceptual uncertainties include not being able to model the hydrogeologic environment in its entirety. This is mainly due to the lack of data and complete understanding of the hydrogeological processes. Assumptions are usually made to simplify this to varying degrees. Parametric uncertainties are associated with scale of representation of the hydraulic parameters.

The modelling approach undertaken is in accordance with 2012 Australian groundwater modelling guidelines. The confidence level classification of the model is ‘Class 1’ due to the limited amount of data available for model calibration. A Class 1 model is often developed when there is insufficient data to support conceptualisation and calibration when observations are sparsely distributed, when transient predictions are made when calibration is in steady state only. A Class 1 model can be used to provide first-pass estimates of abstraction rates required for mine dewatering.

The numerical model developed is based on the current understanding, hydrogeological data available and interpretations with technical assumptions made where information is unavailable. This model is for the estimation of water supply and potential drawdown impacts. The groundwater model is a simplified representation of the underlying geology outside the mine area and the actual drawdowns incurred may therefore differ from those predicted.

The model was calibrated in steady state due to there being insufficient data to conduct a transient calibration. Without a transient calibration, the storage properties of the aquifer have not been refined. The steady state calibration has a root mean square error of 1.3 m which is deemed acceptable taking into account the accuracy of the reference point elevations for the groundwater level measurements. For a model of this nature, a value of less than two would generally be considered acceptable.

As more time series groundwater level data becomes available, the water model should be recalibrated in transient mode which will allow aquifer storage parameters to be used in the calibration process and give more confidence in the model output.

4.6.8 Geochemical

The initial selection of geochemical samples consisted of 69 sample intervals selected from 53 boreholes. However, two samples were missing from the consignment on arrival of the shipment at the lab in Australia. The samples were all selected from within the design pit shell and provide a good geographical spread across the deposit.

Around half the samples (33) were selected from the lead/silver/zinc halo which is immediately overlying the copper mineralisation. This was a deliberate bias in the sampling strategy to focus on a zone which was perceived to represent a greater geochemical risk. For these intervals, silver, copper, molybdenum, lead and zinc assay data was available, as well as sulphur for ten of the intervals. The assay data was plotted on a range of histograms to ensure the samples selected were representative.

For the remaining 36 intervals where no assay data was available, the sampling points were generally selected as the midpoint within the interval. However, site personnel were requested to adjust the actual sampling point if needed to ensure that the samples were representative of the interval as a whole.

It should be noted that the recommendations provided in the specialist assessment are based on a limited number of samples and future design stages will require additional geochemical analysis and characterisation to develop a robust waste management plan. This will likely comprise additional acid base accounting and distilled water extract tests to verify that these samples are representative of the overall waste rock to be mined. Consideration should also be given to kinetic testing to assess the water quality of leachate generated by the waste rock in response to oxidation and weathering, which can differ to those indicated by the distilled water extract test.

4.6.9 Waste

One of the two important limitations encountered was the unavailability of recycling businesses in and around Ghanzi. In addition to statements by the municipal official to that effect, it was confirmed by a private waste management contractor working in the area that there are no recycling activities undertaken in Ghanzi. Although it is reasonable to expect that long transport distances to recycling industries in South Africa and Botswana will be the reason for this, the absence of financially viable recycling operations will make compliance with the waste hierarchy very difficult.

The second limitation is the fact that there was no information available on systems proposed for environmentally sound management and disposal of hazardous waste previously transported to South Africa for disposal. This is because of Botswana not having developed its own treatment and disposal facilities for hazardous waste generated in the country; and regulating authorities in South Africa no longer allowing disposal of hazardous waste from neighbouring countries on any of South Africa's waste treatment and / or disposal facilities. The Botswana Chamber of Mines however invited expressions of interest from experienced waste management companies in the SADC region for the development and operation of a hazardous waste disposal facility in Francistown, Botswana.

4.6.10 Traffic

Through liaison with Roads Department a detailed road condition survey and detailed traffic counts are recommended to establish when the road should be rehabilitated/re-constructed (by Roads Department) to meet the current traffic loading. Up-to-date information on the year of construction of the A3 road and any available traffic counts has been requested from Botswana Roads Department and was not available at submission of this report

4.6.11 Social

The following assumptions have been made regarding the study:

- Census and district data used for baseline information is assumed to be reflective of the current situation (i.e. employment, household services, etc).
- Primary data collected (i.e. issues raise) is assumed to be representative of sentiments of broader stakeholders and communities near the site.

Limitations for the SIA consisted of the fact that some key informants could not be reached for consultation. Considerable effort was made to make contact but unfortunately these efforts were unsuccessful. However, the consultations undertaken as part of the SIA (various surveys, meetings, methodologies) have met or exceeded the requirements under the EA Act. Technical scope is based on prefeasibility study and feasibility study is still in development. Some social impact already caused during exploration activities.

4.6.12 Archaeology and cultural heritage

The archaeological assessment for the T3 mine footprint consisted of walking on the site at 20 meters transects as well as 20 meters outside the project boundary. Ground visibility was relatively poor as the vegetation cover was very dense with vegetation around the project site mostly consisting of *Terminalia* woodland and shrubs.

The project site has deep Kalahari sands with thick bushes which makes it hard to locate or see archaeological artefacts. The weather conditions were not conducive for a site survey due to rainfall and the thick bushes at the site.

The survey for the access corridor was undertaken at a different time, and although there was a good grass growth, visibility was good and the vegetation not too impenetrable for walking. A small middle section was not surveyed by foot due to concerns of wildlife in the area and safety reasons in remote areas (based on other survey work no artefacts or sites are expected at this section).

5 Baseline Environment

This Chapter describes the current receiving environment, which will likely be affected by the proposed mining project. The baseline environment is the inventory of environmental features present in the study area. Assessing the environmental setting prior to commencement of a development is critical as it identifies points of sensitivity examined, as well as potential mitigation measures and alternatives that have been investigated throughout the ESIA process.

To meet the requirements of the IFC Performance Standard 6, a comprehensive biodiversity study was undertaken for the Project, to support assessment of impacts likely to be caused by the proposed development during the detailed ESIA study. This included collection of comprehensive biodiversity data in the project area, as presented in Section 5.9.

5.1 Current site conditions

The study area is in the Ghanzi District of Botswana. The proposed mining operation, (including the on-site mining infrastructure development) will be undertaken within the boundary of Farm 153-NL, located approximately 70km north east of Ghanzi Township and 200km southwest of Maun. Access to the site will be developed from the Ghanzi-Maun A3 road, within the section of Farms 110-NL and 111-NL and along the boundary of Farm 112-NL before it reaches the mine entrance at Farm 153-NL. The accommodation camp for the Project is being developed on the outskirts of Ghanzi Township, near the A3 road (not part of this assessment)

The following section describes the conditions of the development areas, as noted during environmental impact studies undertaken for the project.

5.1.1 Existing farm development

The proposed mining operations will be undertaken within a section of Farm 153-NL, which is a freehold farm owned by Callie and Amanda Lemcke. The site is located on the south western of the farm and covers approximately one third of the farm footprint. The farm is located within the Ghanzi farming block and measures approximately 5,000ha. It is located approximately 10km east of the Ghanzi-Maun A3 road, and can be easily accessed via the existing gravel track connected to the A3 road. It is neighboured by freehold farms, namely farms 100-NL,111-NL, 112-NL, 117-NL, 154-NL, 158-NL and 159-NL.

Farm 153-NL is located along the Ghanzi ridge which is a mixed sedimentary and volcanic formation some 100km to 150km wide, with water trapping limestone. Therefore, there is a relatively good underground water supply near the surface. There are five private boreholes within Farm 153-NL and these are mainly used for livestock watering. For modelling purposes, it was estimated that each borehole pumps 10m^3/day (Water Surveys Botswana, 2017).

Purchase of the land for the project (farms 153-NL for the mine and 111-NL and 110-NL) has been agreed based on commercial land negotiations and is sold to Tshukudu Metals voluntarily. No resettlement is required for the project development. Existing developments noted at the farm are discussed in the following subsections.

5.1.1.1 Residential and farming developments

The farm (153-NL) is currently used for cattle farming activities. The Lemcke homestead is located in the north-western corner of the farm and consists of several covered structures for storage of vehicles and equipment, as well as cattle kraals and uncovered parking/storage areas.

Figure 5.1 below shows some of the farm buildings identified during this study.

Figure 5.1: Farm buildings at farm 153-NL

The homestead also includes the family house, which is the primary residence for the family. The house is a modern clay-brick built house surrounded with landscaped gardens. Water to the homestead is supplied by boreholes from the farm, and power is provided from generators and solar facilities installed. The Lemcke family has resided at the homestead for several generations. Figure 5.2 shows the family house at farm 153-NL.

During the quantitative survey (consultation with the farm owner), the consulting team recorded one disabled personnel with the farm area. Due to his health conditions, he is likely to be more vulnerable to air quality impacts, which the farm owner believes may have occurred during the exploration phases. However, due to the distance of the homestead from the development areas, this impact is not likely to be experienced. This has been assessed in detail in Air Quality and Health Impact Assessment reports attached as Appendix J and K whereby the homestead was a receptor for these impacts.

Figure 5.2: Farm house at farm 153-NL

In addition to the above-mentioned homestead, there are two other houses/homesteads within the farm boundaries. In addition, there are 10 houses for farm workers located on the farm, which are situated near the homestead. Drilling activities and drillers camp

Some of the T3 drilling activities were undertaken within the footprint of this farm. The drill holes are RC holes, diamond core holes, hydrogeological holes and geotechnical holes. Figure 5.4 below shows the location of some of the already completed drill holes.

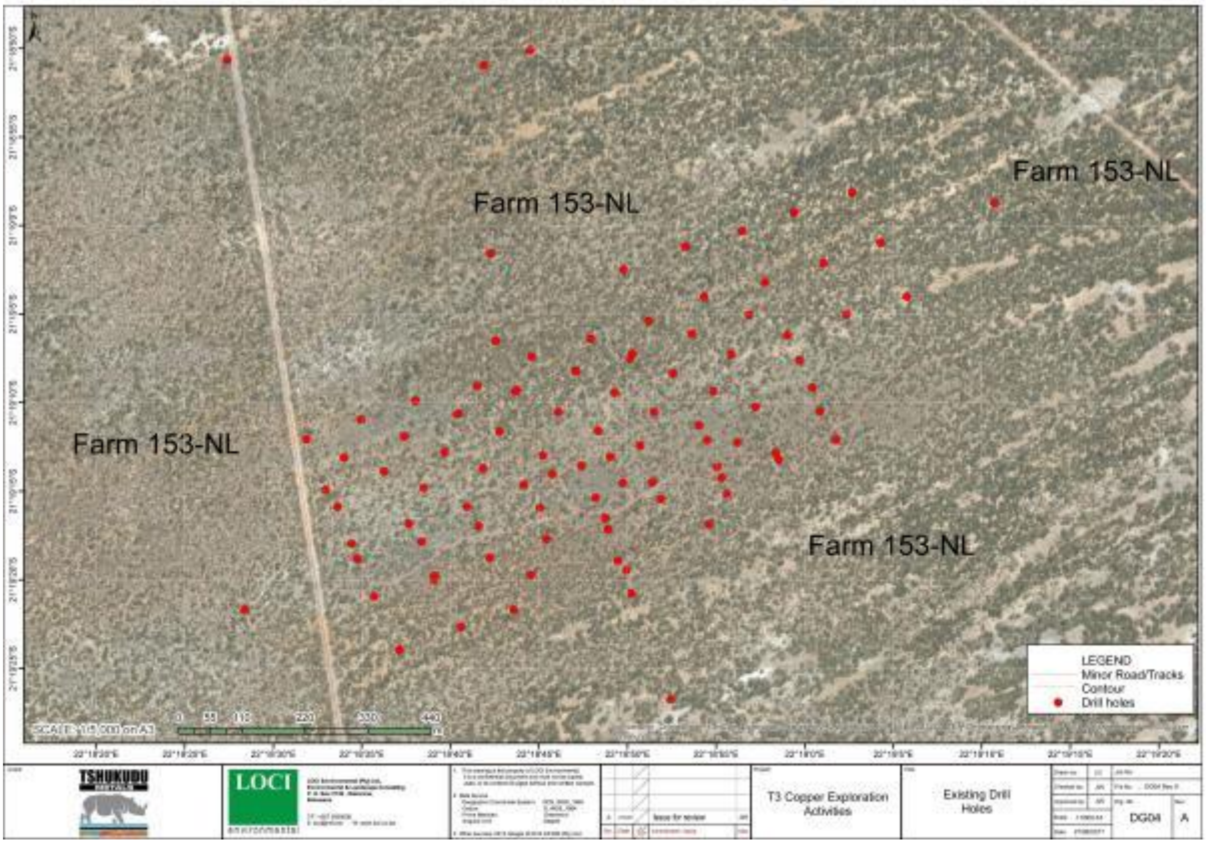


Figure 5.4: Existing drill holes

When the drill holes are completed, the following has been undertaken:

- Capping of the drill-hole
- Placement of small concrete base at the drill hole
- Placement of markers and number on the drill hole
- Full rehabilitation of the drill site.

An example of a rehabilitated drill site is shown in Figure 5.5 below.

Figure 5.5: Completed and rehabilitated drill hole

5.1.1.2 Internal tracks

The previous drilling activities have led to development of a few tracks to gain access to drill sites. Therefore, there are several internal tracks for access to sections of the farm. These tracks are unpaved tracks for use by tractors or 4x4 vehicles. One of these existing drill tracks is shown in Figure 5.6.

Figure 5.6: Existing tracks within farm 153-NL

5.1.1.3 Drillers camp

As the drilling activities have taken place at the farm as part of the exploration and project development, a drillers camp has been established. The camp is located south-east of the farm homestead, and centrally in the exploration drilling area. Figure 5.7 below shows the current condition of the camp. Although most of the drilling for the T3 project is completed at this stage, the drillers camp remains operational as it is supporting regional explorations works for the T3 Dome area.

Figure 5.7: Existing driller's camp

The camp is within the proposed mine footprint, and as such will need to be removed when the mine development starts.

5.1.2 The proposed service corridor route

The proposed access route to the site branches from the A3 road. It transverses through northern sections of Farms 110-NL and 111-NL, and along the boundary of Farm 112-NL. This is an existing road which has been used for access to the exploration activities by the Client in the study area. Originally, another existing track cutting through farms 110-NL and 111-NL was used for access to the T3 site, but in liaison with the farmers, access was diverted to the track along the farm boundaries, to minimise the disturbance of the farm activities. The heavy drill rigs and other equipment have affected the road condition on the tracks during the drilling works, and the Client undertook some maintenance to ensure the damage was repaired and the smaller farm vehicles were able to drive through the road safely. The access track through farm 110-NL and 111-NL is still being used for access to farms 111-NL, 153-NL and 110-NL, but no longer for access to the T3 project. The current condition of the track and the junction at the A3 road is shown in Figure 5.8 below.

Figure 5.8: Existing access road to T3

5.1.3 Accommodation camp site

As mentioned earlier, the accommodation camp is being developed near Ghanzi Township. The site is located along the A3 road, on the outskirts of Ghanzi Township. The site was previously used for farming activities and the Client has acquired it for the camp development. To date, 40 accommodation units, offices and support facilities have been constructed at the site (environmental authorisation was obtained). The site can be accessed via a gravel track from the A3 road.

The housing units currently completed cover a small portion of the site footprint. The Client proposes to expand this camp to approximately 400 person capacity, but this is subject to a separate (EMP) assessment, which is being prepared at time of completing this assessment.

5.2 Other projects near the study area

There are several other significant projects near the proposed project area, which may contribute to anticipated cumulative impacts such as groundwater use, increased influx of people, employment and availability of social services. For this purpose, they have briefly been described in the following sections.

5.2.1 Khoemacau copper mine

The Khoemacau project is the only other copper mine project in the area, and is located approximately 120km north of the T3 project. The proposed Khoemacau mine entails the development of an underground mine located east of the Kgwebe Hills (called Zone 5) and processing at an existing plant they acquired out of the provisional liquidation of the Discovery Metals Boseto Mine, located near Toteng. According to the company website, the Zone 5 Starter Project will average 50,000 tonnes per annum copper and +1.4 million ounces per annum silver. Zone 5 development is designed initially as a 10,000 tonnes per day / 3.6 Mt/a underground mine accessed by three interconnected underground mines along strike.

The mine will produce ore at an average fully diluted head grade of 1.75% Cu and 16 g/t Ag*, which will be hauled to Boseto for processing. The Boseto concentrator will be upgraded from its current 3.0 million tonnes per annum nameplate capacity to 3.6 million tonnes per annum to process the Zone 5 ores. The concentrate will be road hauled to port for shipping and sale on the international market (www.cupriccanyon.com). The company announced commencement of construction (early works) is planned before the end of 2018. This started project is comparable in scale with the proposed T3 project, with the biggest difference being that the Khoemacau project will be an underground mine, and T3 will be an open pit mine. As with the T3 project, the Khoemacau project also has a planned expansion phase, to expand the production at the mine.

In addition to the above described started project at Zone 5, the company holds a mining license in an area called "Banana Zone". This area is understood to be considered for future project expansion phases. The Banana Zone is located approximately 25km north east of the T3 project, and mostly within the Ghanzi District as well.

5.2.2 BDF camp

The Botswana Defence Force is developing a camp facility on the outskirts of Ghanzi. Due to security sensitivities, there is little public information available in relation to the project, and attempted consultations have not provided any feedback in relation to the scale of their project. It is however understood that Botswana Housing Corporation (BHC) has been engaged by Botswana Defence Force (BDF) to develop their new site in Ghanzi, with a total size of the site of 688.7ha. The site is currently mostly undeveloped, but does host some temporary BDF camp facilities.

The proposed development involves the construction and operation of a fully-fledged military camp, which includes residential, operational, training and recreational areas. The associated infrastructure will include roads, storm water drainage, sewerage reticulation, water reticulation, electrical and telecommunication services. It is understood that the site has been allocated by the Ghanzi Land Board (BHC, 2015).

5.2.3 Other exploration

The proposed T3 project is the result of successful exploration drilling. It is believed that the Kalahari copper belt, in which the T3 project is located, has many other copper resources which may be economic to develop into mines. As such there are other exploration activities in the area, including:

- Tshukudu Exploration (Pty) Ltd (Tshukudu Exploration), owned by MOD (70%) and Metal Tiger Plc (30%) (MTR) is undertaking exploration on another 18 prospecting licenses in the area, with significant (drilling) work undertaken in the T3 expansion area (T3 dome) and T4/T23 area at the time of completion of this study. The licenses extend from the North West District all the way to the Namibian border in Ghanzi District.
- MOD Botswana is undertaking exploration works on the licenses near the T3 project, with most advanced works at the T1 project. Depending on the results of the exploration work, the T1 project could be linked to the T3 project, and supply ore to the T3 plant at a future stage.
- Kopore Metals own several licenses in the Ghanzi District and have commenced exploration works on the licenses following environmental authorization granted earlier in 2018 (www.koporemetals.com)

- Kalahari Metals is planning copper exploration works on two licenses located west of Kuke village, on the Ghanzi and North West District boundary.
- Khoemacau Banana Zone: The "banana zone" is an area located within the Ghanzi District, directly north of T3 and stretching to the north west corner of the CKGR. Khoemacau has undertaken a significant amount of exploration work on this area, and although the company is focused on the Zone 5 deposit, it maintains an exploration camp near Tsau gate and is expected to undertake further drilling in the area.

5.2.4 Farm developments

The farming operations surrounding the T3 project are mainly cattle farming operations. Nearer to Ghanzi, some large scale arable farming activities have commenced, with large areas developed under irrigation, growing crops such as onions and potatoes for the Botswana consumers. The operations are possible because of the good groundwater availably and high yielding boreholes in the area. It is understood (verbal communication) that the owner of farm 110-NL is planning to develop arable farming on the farm as well, with fruit trees being considered as one of the options. During the fieldwork for the T3 ESIA, it was observed that groundwater exploration was being undertaken on the farm. The ultimate scale of the farming on this farm is not yet know, and will depend on groundwater availability and finance availability.

5.3 Physical environment

The physical environment is the physical and chemical make-up of the study area. It includes the climate, rainfall, winds, soil, groundwater, noise levels etc., within the study area. The physical environment affects the organisms and people that live in study area.

5.3.1 Climate

In general, the climate of the southern part of Botswana is sub-tropical, semi-arid with concentrated summer rainfall. The following sections present detailed information about rainfall, wind and temperatures for the greater study area.

Climate is the long-term pattern of weather in a particular area. It is measured by assessing the patterns of variation in temperature, humidity, atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological variables in a given region over long periods of time. Climate is different from weather, in that weather only describes the short-term conditions of these variables in a given region. The climate of a location is affected by its latitude, terrain, and altitude, as well as nearby water bodies and their currents.

The T3 Project site is located within the Kalahari Desert, characterised by an arid to semi-arid region with cold dry winters and hot and relatively humid summers. Irregular rains fall mostly during thunderstorms often accompanied by strong winds between October and March. Due to its semi-arid environment, the rainfall is highly variable.

5.3.1.1 Surface wind field

Winds are mainly easterly in the summer and northerly during the winter. The average wind speed is 43km/h (Ghanzi District Development Plan 7). A windrose for Ghanzi (airport) is shown in Figure 5.9.

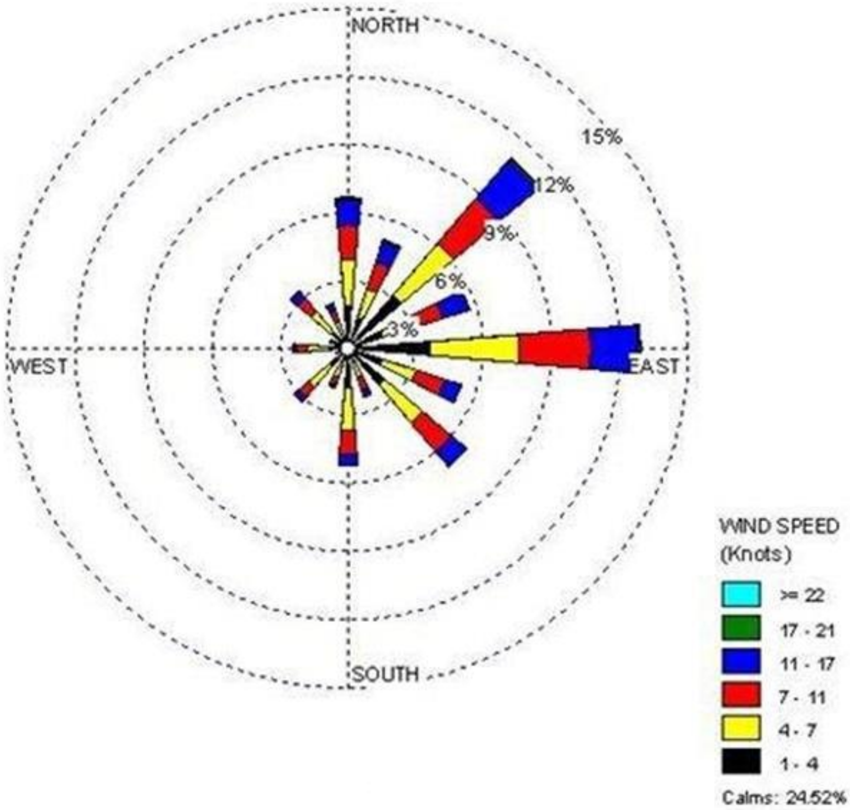


Figure 5.9: Windrose for Ghanzi airport (Source: Department of Meteorological Services).

5.3.1.2 Wind speed and wind direction

In the following wind roses, the colour of the bar indicates the wind speed whilst the length of the bar represents the frequency of winds blowing from a certain direction (as a percentage). Figure 5.10 presents the local wind conditions from modelled MM5 data for the period January 2015 to December 2017[7].

For the period, winds dominate from the north-east (12% of the time) and east (13% of the time). Wind speeds range from light (2m/s) to strong (8m/s). Calm conditions, defined as wind speeds less than 1m/s, occurred for 13.56% of the time. North-easterly and easterly winds are observed during all hours of the day as evident in the diurnal wind rose plots. During all seasons, winds originate predominantly from the north-east and east and vary from low to strong. Winds originating from the southerly direction is also evident in spring. An increase in wind speeds is observed during the spring and summer months. Calm conditions range from 10.10% to 16.17%.

[7] It must be noted that meteorological data must be from a period no older than five years to the year of assessment. Local wind conditions from measured data was not available for this period and as such, measured wind data has not been used for this assessment.

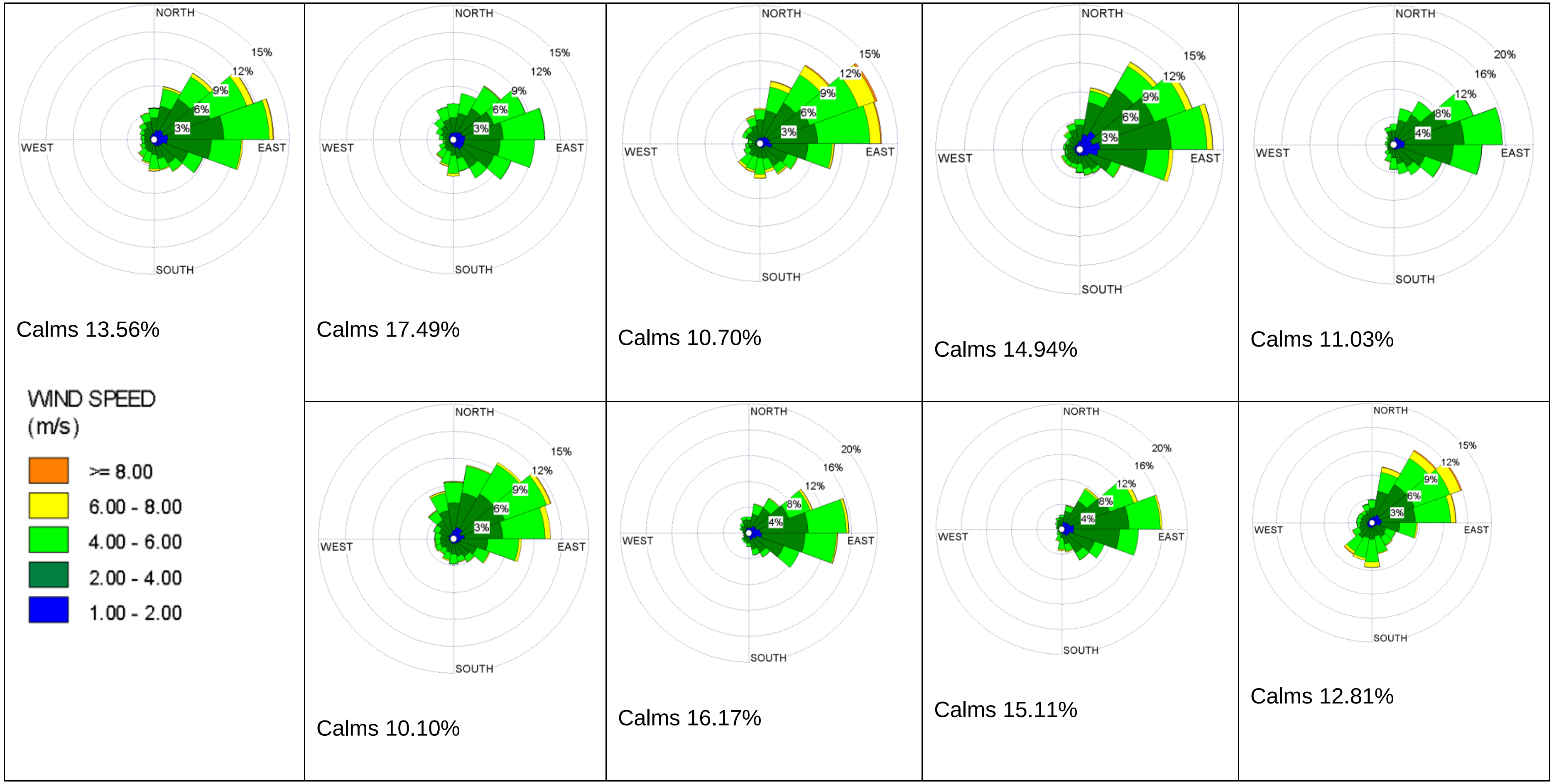


Figure 5.10: Local wind conditions for the proposed T3 Copper Mine region for the period January 2015 – December 2017

5.3.2 Current air quality conditions

The predominant land use within the project region is reserved for farming (freehold and leasehold) followed by Wildlife Management Areas and parastatal/residential zones within the south-western part of the Ghanzi District. The immediate area of influence in terms of air quality includes the 153-NL freehold farm as well as the neighbouring farms bordering 153-NL. Villages and settlements within the project´s surroundings are Kuke Village (30km North), D´kar (45km south-west) and the administrative centre of the District, Ghanzi, located 85km to the south-east. The project area can therefore be characterised as typically rural.

It is important to note that ambient air quality monitoring data was not available for the proposed T3 Copper Mine region to assess the current air quality situation. As such, concentrations presented in the assessment are incremental impacts from the proposed T3 copper mine only. It must be noted that air quality in Botswana is affected by drought, over grazing, desertification, limited fresh water, high average temperatures and burning of wood fuels. Land use around the mine are expected to contribute to this.

5.3.2.1 Sensitive air quality receptors

Sensitive receptors are identified as areas that may be negatively impacted on due to emissions from the proposed T3 copper mine project. Examples of receptors include, but are not limited to, schools, shopping centres, hospitals, office blocks and residential areas. The sensitive receptors identified in the area surrounding the proposed T3 copper mine are within a 5km radius of the proposed development (Table 5.1 and Figure 5.11).

Table 5.1: Sensitive receptors located in close proximity to the proposed T3 copper mine boundary

ID	Sensitive Receptors	UTM Coordinates mE	UTM Coordinates mS	Distance [8] from Site (km)	Direction from Site
Rec 01	Vorster homestead	628469.30	7644157.07	8.3	North-west
Rec 02	Farm 153-NL	635514.81	7643959.14	2.20	North
Rec 03	Workers homes north-east of Farm 153-NL	635670.00	7644086.00	2.34	North

[8] This is distance from centre of mine pit

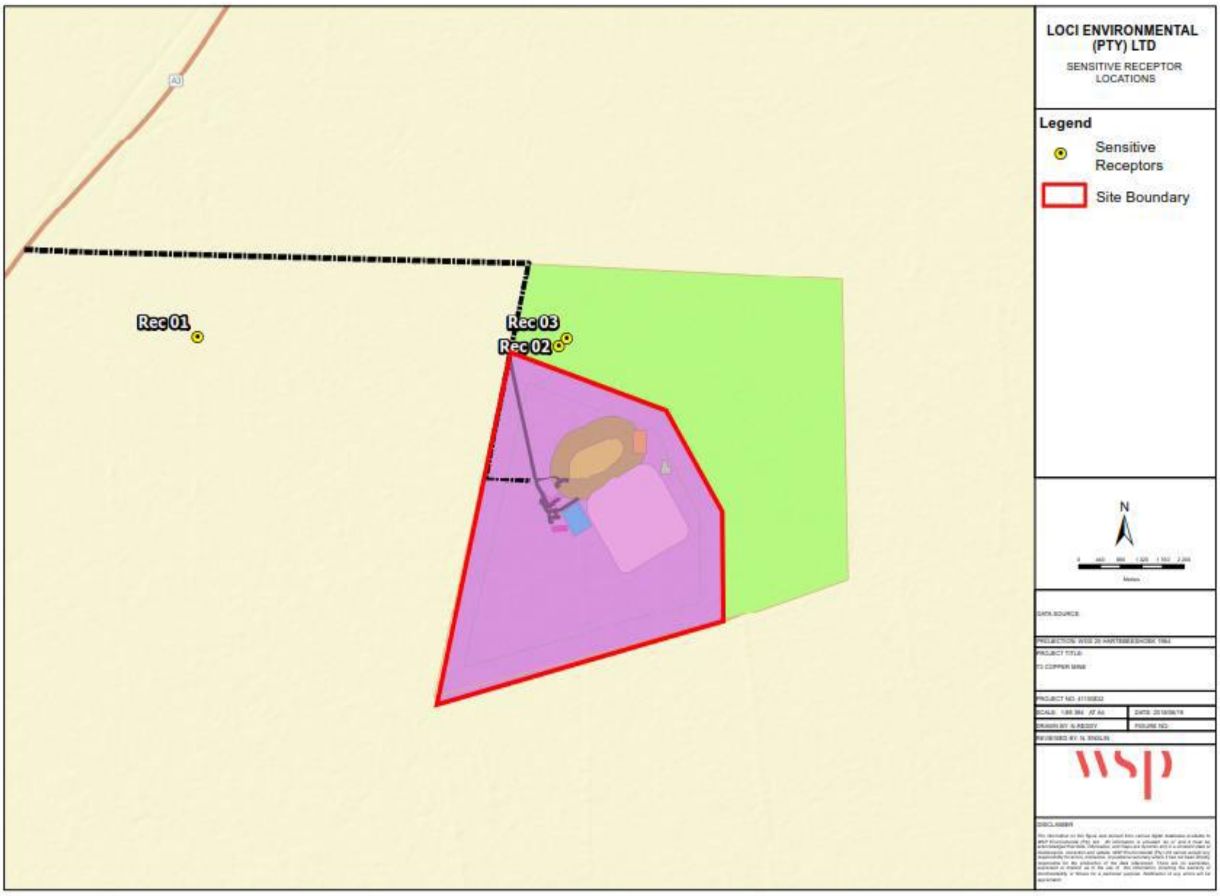


Figure 5.11: Location of sensitive receptors for the proposed T3 Copper Mine

5.3.2.2 Temperatures

The monthly mean maximum daily temperatures for Ghanzi are 30-33°C in January and 22°C in July. Minimum temperatures are 4-5°C during winter. Figure 5.12 below shows the temperatures during the year. It must be noted that frost occurs in the area at night-time, and this needs to be considered by the Client.

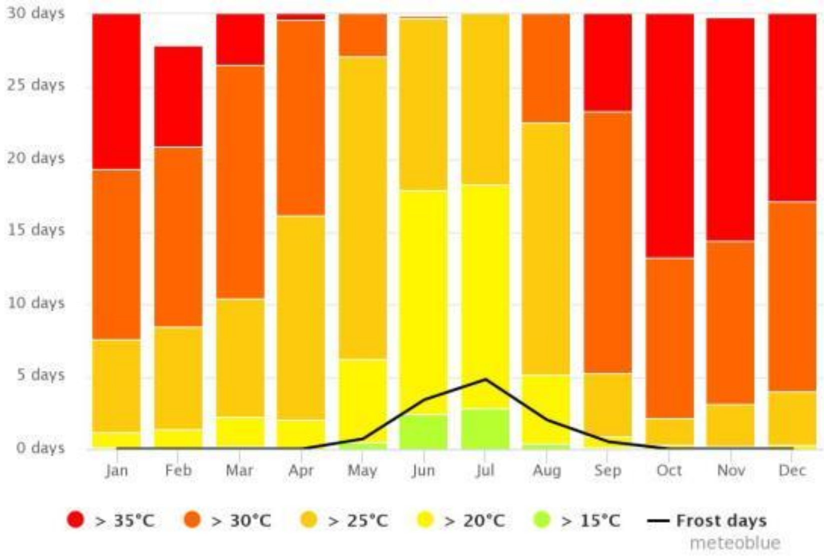


Figure 5.12: Average temperature for Ghanzi (1987-2017) (Source: Meteoblue.com)

5.3.2.3 Precipitation

Rainfall occurs during the summer rainy from November to March and is variable annually and daily and spatially, whilst the winters are dry. In general, mean annual rainfall decreases from the west to the east and most usually falls as high intensity storms. Annual precipitation for the Meteorological Department weather station at Ghanzi is shown graphically in Figure 5.13 for the years 1980 to 2017. The average rainfall for Ghanzi is 450mm/year and from Figure 5.13 the drought cycles can be seen (1982-89, 1994-96, 2001-05, 2012-13 and 2015-16). Departures from these average values may be extreme with up to 58% variation from year to year. Evaporation exceeds precipitation by approximately 93%. Average relative humidity is around 61%.

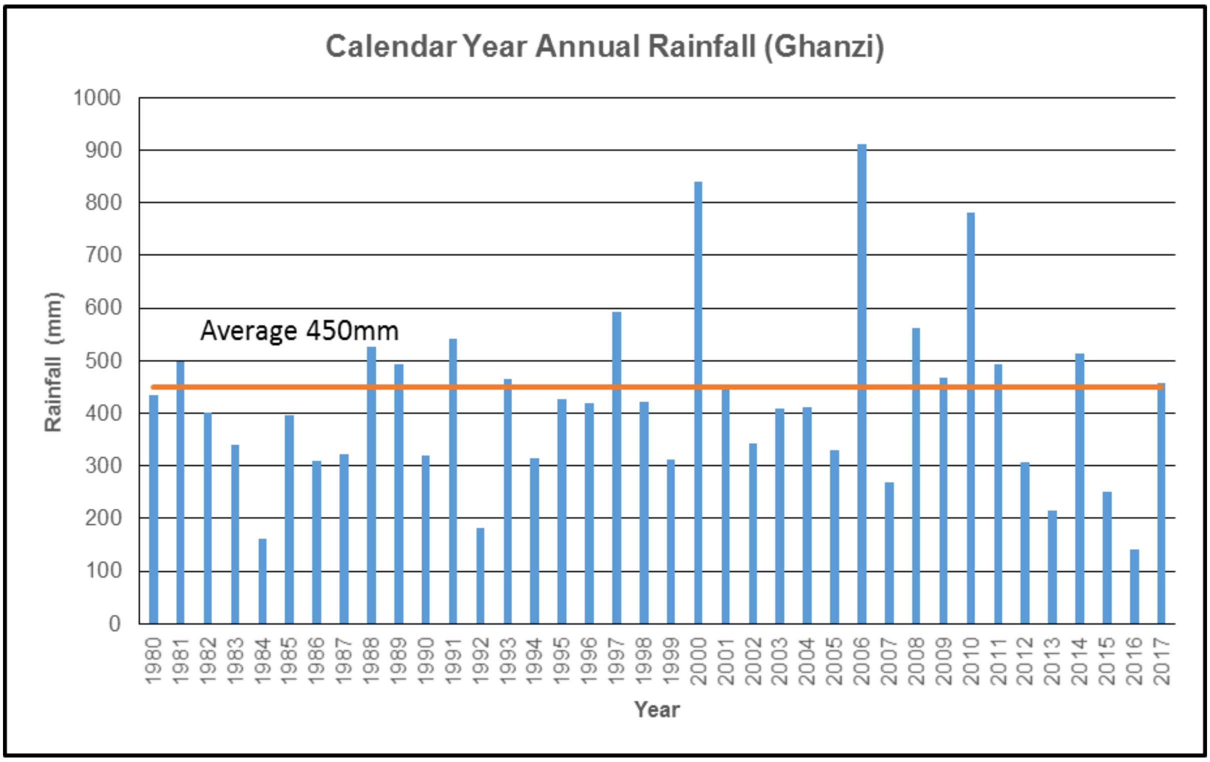


Figure 5.13: Ghanzi Annual rainfall for 1980 - 2017 (Source: Department of Meteorological Services, 2014)

5.3.3 Topography

The District's land surface, mainly consisting of gently undulating sandveld, lies between 1,100 and 1,230 metres above sea level. The Ghanzi Ridge consists mainly of fractured quartzites, shales, sandstones and limestones covered by shallow deposits of sand and calcrete. Soils derived from them are slightly better quality for plant growth than elsewhere. Apart from the Ghanzi Ridge, the other striking topographical feature is the valley systems. The Okwa fossil river system as well as the fossil rivers, or valleys, of Hanahai, Deception, Rooibrak and Groot Laagte are ancient drainage lines. These drainage lines run across the district's surface. They consist of sandy expanses with frequent out-crops of calcrete which form bluffs on the edges.

The District is also dotted with a number of pans. These pans are flat-floored depressions, which sometimes stretch over several kilometres. During the wet season, with good rainfall conditions, the pans' surface can remain covered with shallow water for a few months. Kalahari beds cover the remainder of the District. These beds consist of variable consolidated and thick sand, calcretes and silcretes. Most of the beds (cainozoic deposits) are flat and featureless. The sand varies in thickness from as little as 5 metres to as thick as 200 metres. Most of these areas are uninhabited due to the scarcity of water resources.

The site topography is quite uniform. A small amount of scattered open pans have been identified as well as a cluster of sandy dunes in the North-Western part running from North-East in a South-West direction. Contours were obtained from the Department of Surveys and mapping, and the local topography in the project area is shown in Figure 5.14.

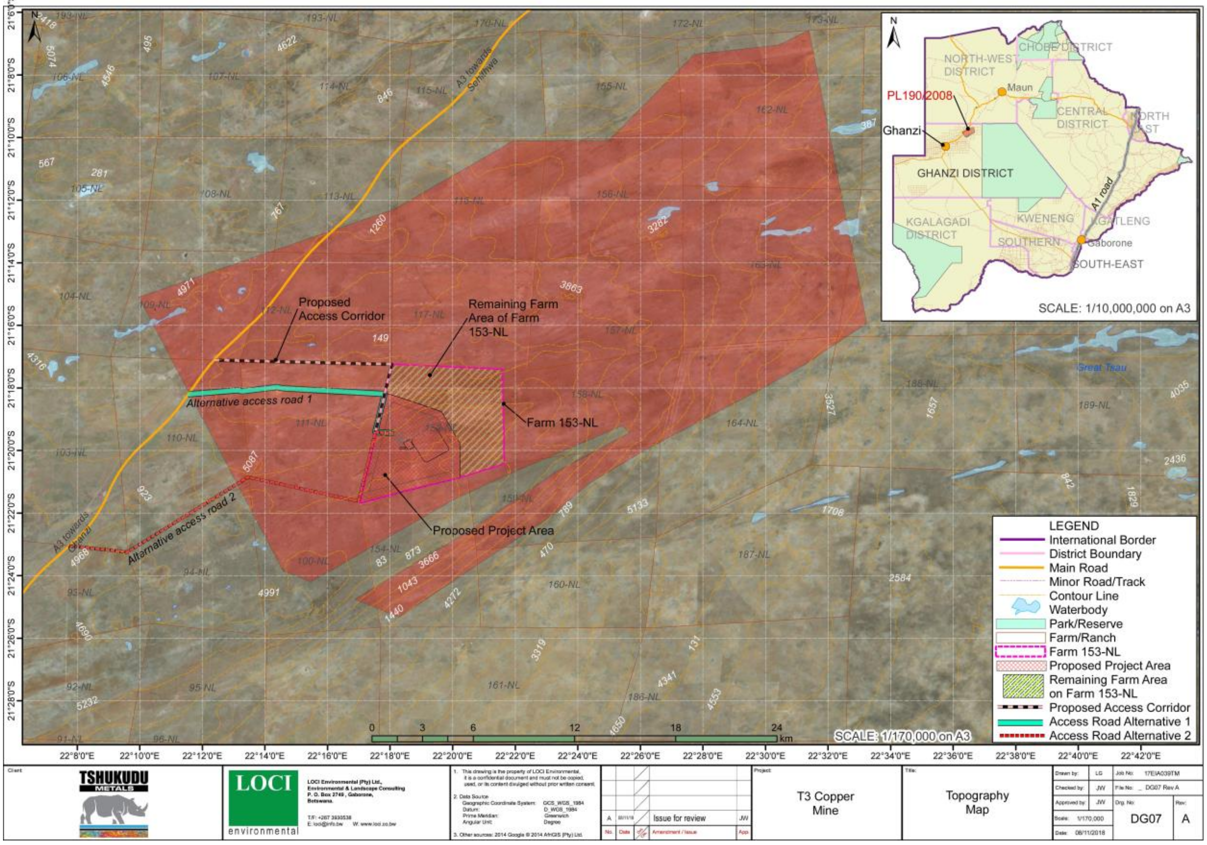


Figure 5.14: Topography in the project area

5.3.4 Geology and stratigraphy

The general understanding of the regional geology dates from the 1970s with minor modifications in areas that have been investigated for water supply or mineral exploration.

The Ghanzi Ridge is the expression of the 'Ghanzi-Chobe Fold Belt' - a highly faulted and folded tract of Late Proterozoic sediments and volcanics. Groundwater occurs along the ridge in moderate quantities and of good quality enabling the ridge to develop into the most populous and productive area in the Ghanzi District.

The ridge, which lies on the Ghanzi-Chobe Proterozoic Belt, which extends over 350 km towards Maun in the northeast. The geology of the area consists of a zone of highly sheared and folded Late Proterozoic sediments and volcanics belonging to the Damara Supergroup. These rocks crop out further north east in the Chobe Enclave area at the Gcoha, Chinamba and the Gubatsaa Hills.

The stratigraphic succession is presented in Table 5.2 and a geological plan of the area is given as Figure 5.15.

Table 5.2: Stratigraphic succession of the study area (Source: WSB, 2017)

Age	Super group	Group	Formation	Approx. thickness (m)	Lithological description
Cretaceous to Recent	Kalahari Beds			200	■ Soil ■ Sand ■ Calcrete ■ Silcrete ■ Clay ■ Gravel
Cretaceous	Dolerite intrusions			N/A	Dolerite dyke and sill intrusive event
Upper Proterozoic	Damara	Ghanzi	Mamuno	1500	Red bed faces – siliclastic sandstone and mudstone and minor interclastic limestone, crossbedding, wave ripples. Quartzite and weakly metamorphosed mudstones
			Upper D’Kar	1500	Reddish, oxidized siliclastic metasediments consisting of interstratified sub-arkosic sandstones and siltstones
			Lower D’Kar		Interbedded siliclastic metasediments (grey-green mudstones, siltstones, sub-arkosic sandstones with subordinate limestone and rhythmites)
			Ngwako Pan	2000	Reddish-grey-purple, sub-arkosic to arkosic sandstone and siltstone undergone lower greenschist metamorphism. With pebble and granule-rich layers and mudstone interclasts.
			Kuke	500	Grey quartz arenite, red sandstone with conglomerate; crossbedding
		Kgwebe		2000	Bimodal volcanic suite: sub-arkosic to arkosic sediment interbedded with dacites and rhyolite lava flows that have undergone greenschist metamorphism
	Rooibok				Schists and gneiss

5.3.4.1 Kalahari group

Apart from around the Kgwebe Hills the whole area is covered by a sheet of Kalahari Beds of Late Cretaceous to Recent age. Kalahari Beds consist of variably consolidated fine to medium grained sand and silt, calcrete and silcrete, and lake and pan deposits. The thickness of the Kalahari Beds varies considerably. Close to areas of bedrock outcrop, the Kalahari Beds are thin and consist of weathered and re-deposited bedrock, but with increasing distance from outcrops the Kalahari Beds thicken to as much as 80m or more and up to 200m occur in the Kalahari Basin north and southeast, where palaeo-lake Makgadikgadi lacustrine deposits occur.

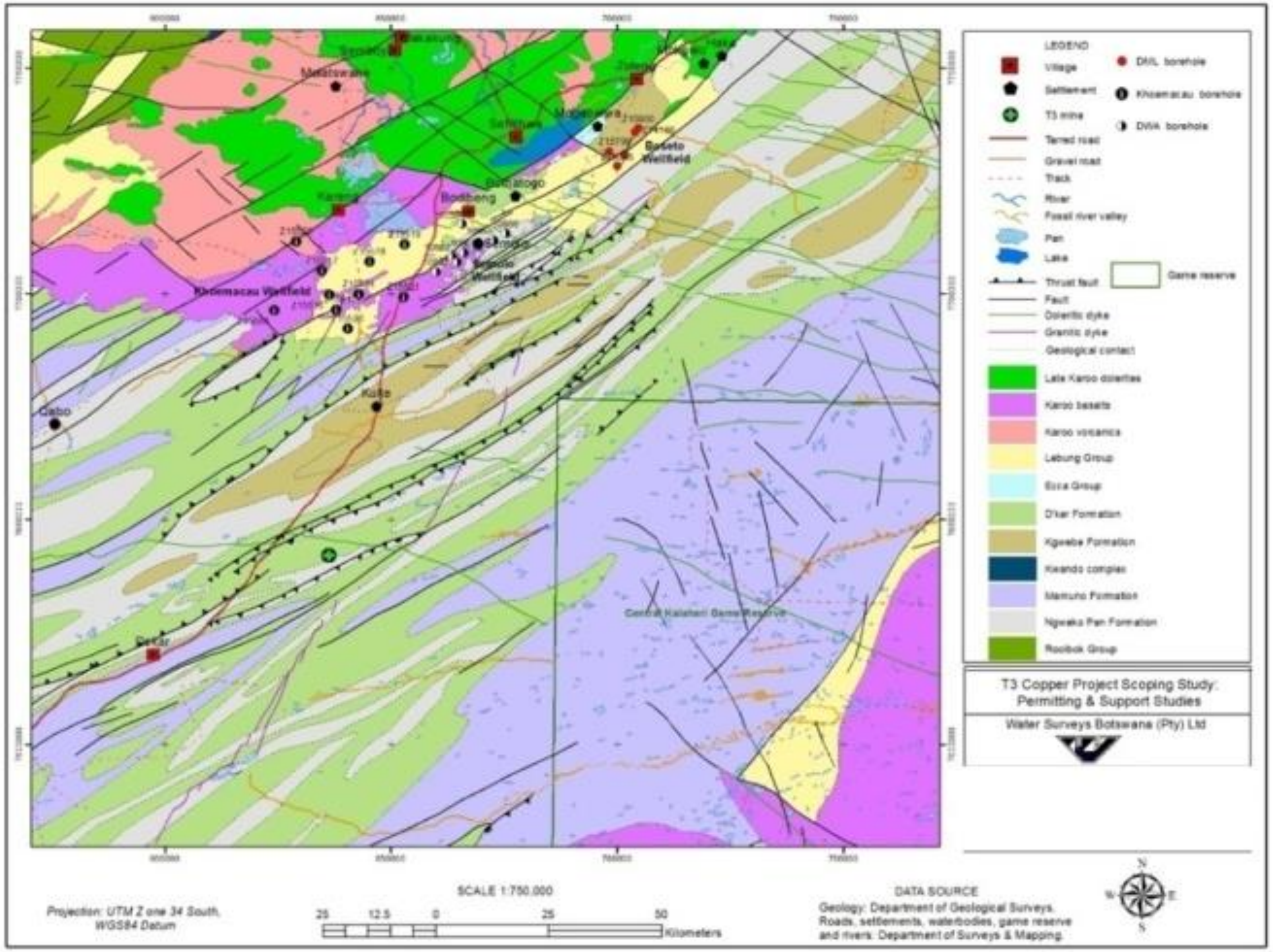


Figure 5.15: Geology map of the region of the study area (WSB, 2017)

5.3.4.2 Proterozoic basement rocks

The Proterozoic rocks are overlain by Kalahari Beds, which thicken markedly to the northwest and southeast respectively i.e. away from the Ghanzi Ridge.

Kgwebe Formation rocks are the oldest in the area. They are of Proterozoic age and outcrop in the Kgwebe Hills, where they occur in the core of isoclinal anticlines running generally south-west to north-east. They are unconformably overlain and surrounded by mid Proterozoic Ghanzi Group rocks. Kgwebe Formation rocks comprise a bimodal volcanic suite of massive dacite and rhyolite porphyries inter-bedded with tuffaceous sub-arkosic to arkosic sandstones and are around 2000m thick.

The exposed area of Ghanzi Group between Mamuno and Lake Ngami is popularly known as the Ghanzi Ridge.

Along the Ghanzi Ridge the Ghanzi Group varies from around 13,500m thick around Mamuno to 5000m south of Lake Ngami. The Ghanzi Group is subdivided into five formations of siliclastic metasediments (quartzites, arkose, quartzitic sandstones, shales and subordinate thin limestones) of which the Kuke Formation forms a basal conglomerate around 500m thick overlain by the Ngwako Pan Formation. The latter is composed of a reddish-grey-purple oxidised sandstone with a high mudstone-matrix, that was permeable enough to allow the upward percolation of mineral laden liquors that were precipitated in the basal 25m of the conformably overlying Lower D'kar Formation. Both the Lower and Upper D'kar Formations consist of siliclastic metasediments composed of laminated sandstones, siltstones and mudstones with subordinate limestones. The Upper D'kar is more coarsely grained than the Lower. Thicknesses of around 1500m are suggested for the D'kar Formation.

The Mamuno Formation is mainly comprised of red sandstone and mudstone and is the uppermost stratum of the Ghanzi Group.

5.3.4.3 Structure

The basement of the study area is late Proterozoic material accreted to the core of the Archean Kalahari Craton. The overlying Karoo rocks are locally preserved in graben structures. The bedrock is concealed by the overlying Kalahari Group sediments. The tectonic events in the area occurred in three episodes: Precambrian; Syn-Karoo and post-Karoo. The Precambrian tectonism was complex, starting with north-west-southeast rifting, calc-alkaline volcanism (Kgwebe Porphyry), and continental margin sedimentation of the Ghanzi Group. Deep seismic evidence indicates that the Ghanzi Group and basement were deformed by an early event in the Damara tectonism. Sedimentation continued in a more quiescent period and deposited the Nama Group, which was subsequently deformed by continuing Damara-age events, creating the Ghanzi-Chobe Fold Belt.

In the syn-Karoo tectonics the Karoo sedimentary basin was periodically uplifted, resulting in erosional unconformities at the base of the Tale Formation and the Ntane Sandstone Formations. Precambrian structures were probably reactivated and are reflected in the Karoo sedimentation patterns. The final stage of the Karoo tectonics is NE-SW extension resulting in widespread intrusion of dolerite sills and dykes and the widespread extrusion of the Stormberg flood basalts.

The post-Karoo event is perhaps the most important for groundwater exploration. NW-SE extension has resulted primarily in block faulting of the Karoo and older rocks. Ancient structures such as the Thamalakane and Kunyere faults and others formed in the Precambrian were reactivated.

The Okavango Delta lies within a north-easterly trending half graben, related to the East African Rift system. The major bounding structures are the Thamalakane and Kunyere faults with a downthrow to the north-west. The Gumare fault has a parallel strike to these major faults, but is antithetical, downthrowing to the southeast. The Okavango River has deposited sediment in the graben between these various faults in the form of a gently sloping cone with a gradient of 1:3300. Detailed lineament analysis revealed other prominent trends having a strike of 140°. Graben faulting along this trend has produced the Pan Handle. Other structural trends are 060° and 105°, the latter strike is parallel to the strike of the main Tuli Dyke Swarm, which underlie the Okavango region.

The crustal extension currently occurring in the Okavango region is predominantly east-west, the major north-easterly trending faults have arisen because of reactivation of structures in the underlying basement. The movement of the faults is oblique slip with a left lateral component of movement. The north-westerly lineaments represent a conjugate fault set.

5.3.5 Hydrology

Perennial river and/or surface water flow in the District is non-existent, with seasonal flow in the fossil river valley or channels very rare because nearly all rainfall is absorbed into the Kalahari sands. Though exploratory drilling for minerals and water over the years has contributed to the understanding of the sub-surface geology and hydrogeology of the district, the information obtained remains very sparse and did not give a comprehensive picture. The Ghanzi/Makunda groundwater survey represented the first major attempt to elucidate the sub-surface hydrology or hydrogeology of the aquifers within the District.

5.3.5.1 Elevation

The regional elevation model is present in Figure 5.16 and clearly shows the Ghanzi Ridge striking NE-SW roughly along the axis of the A3 highway. The T3 site lies towards the northern end of the ridge before it plunges below Kalahari Group lacustrine sediments. The lacustrine sediments (blue on Figure 5.16) represent the western extent of the Palaeo-Makgadikgadi Lake system into which the fossil drainage lines debauched. The drainage lines truncate abruptly at the fossil shoreline with only the Okwa and the modern Boteti River showing they breached the shoreline.

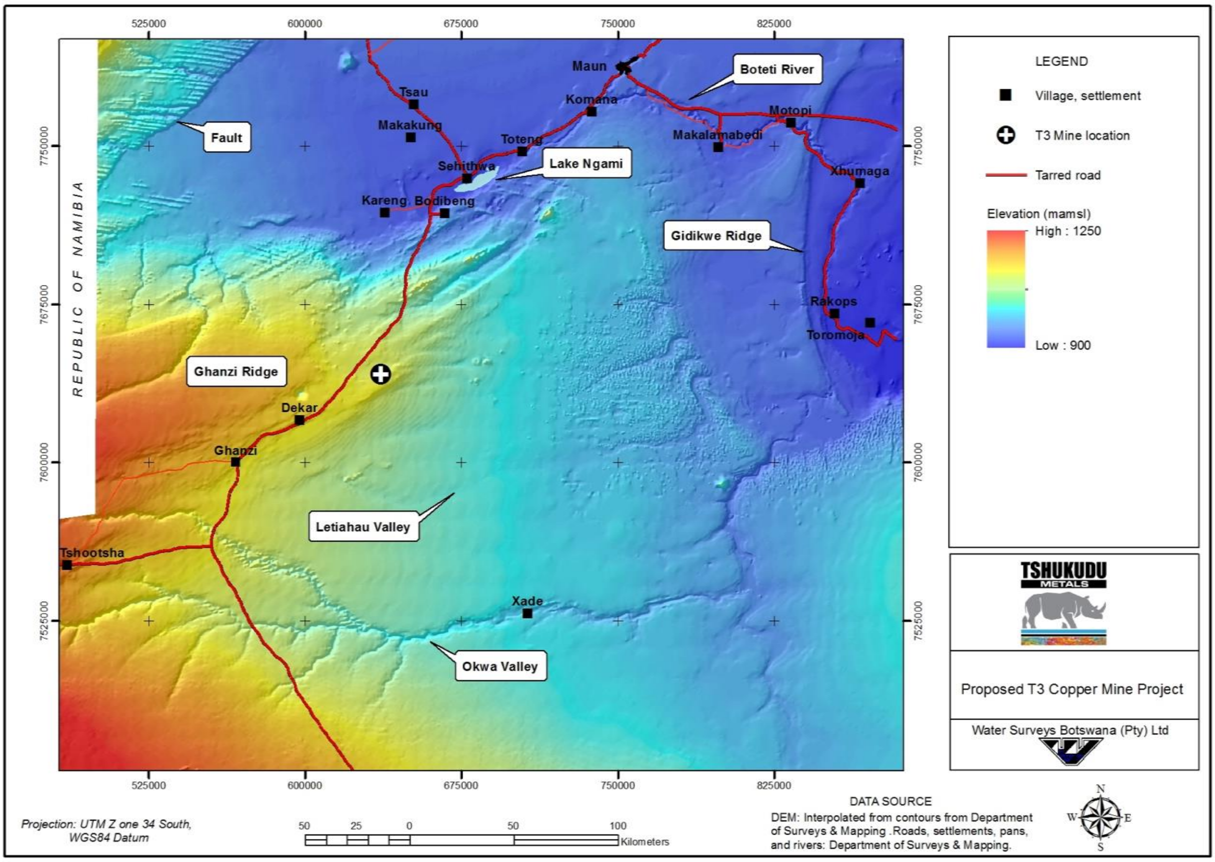


Figure 5.16: Regional digital terrain model

5.3.5.2 Drainage

There are no major surface drainage channels in the immediate area of the mine site. The elevation data (Figure 5.14 on page 119) shows the mine site (1115mamsl) to be close to the top of the Ghanzi Ridge, which peaks locally at 1125mamsl. Draining the ridge to the southeast are a series of roughly west – east trending palaeo-valleys, which drain internally to the CKGR-Okwa River system. The gradient at the mine site is to the northwest, but there are no discernible channels or valleys seen from the elevation contours. Sheet wash from rainfall would be initially to the northwest then eastwards. There is a surface water divide immediately southeast of the T3 site with run off waters draining eastwards. Further west (west of the A3 road) the lowlands form the loci of a series of pans, which are aligned roughly NE-SW. The pans hold water following periods of rainfall.

A drainage map has been generated from the digital elevation data (Figure 5.17) and the map clearly illustrates the water divide formed by the ridge. The map also shows that the area is relatively flat.

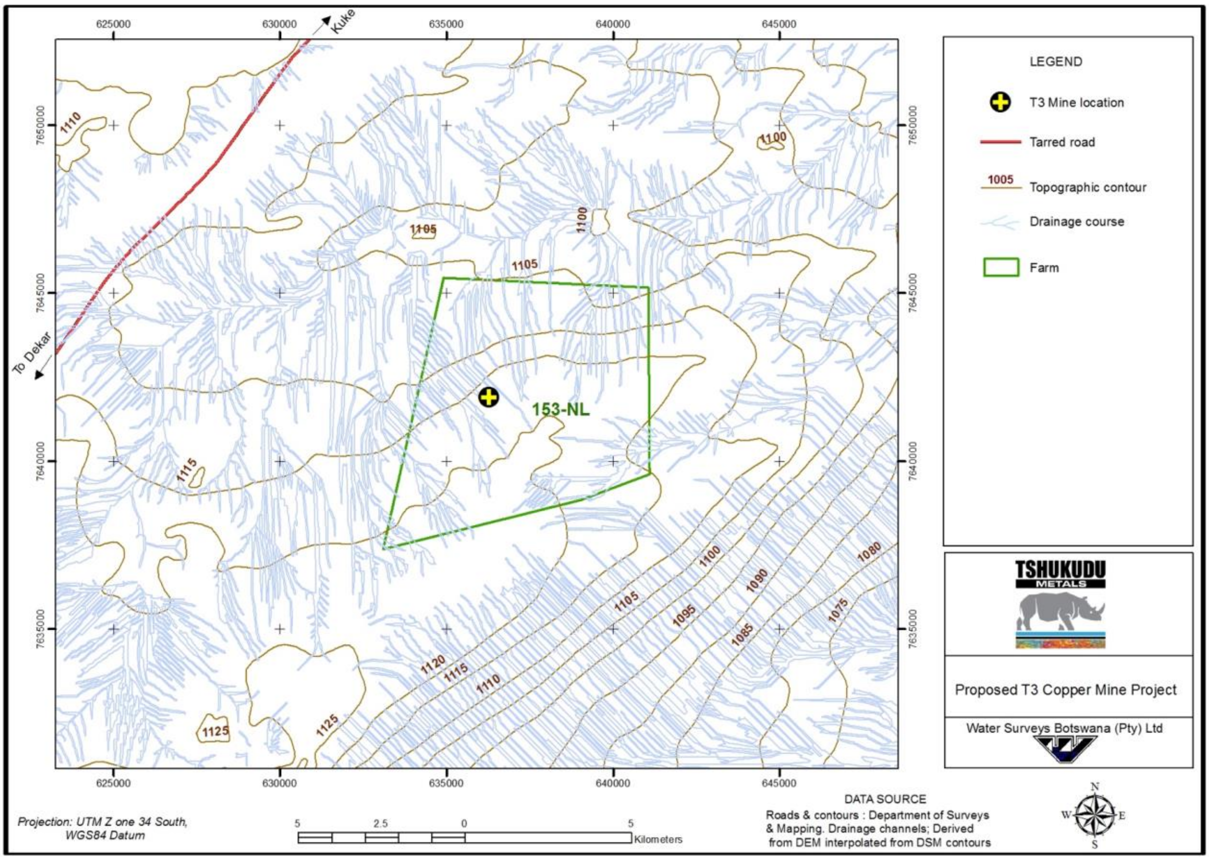


Figure 5.17: Drainage map derived from DTM data

5.3.6 Hydrogeology

A groundwater modelling specialist study was conducted for the Project by Water Surveys Botswana (WSB) in 2017. The objective of the study was to gain an understanding of the hydrogeology of the area to simulate the natural groundwater flow conditions at the mine site, as well as to predict the Project potential impacts, specifically regarding the following:

- Mine inflow (and dewatering) rates.
- Local changes in groundwater levels during mining and water abstraction.
- Local changes in groundwater contaminant transport during the life of mine.

The results of the study have been incorporated in this report. The hydrogeology of the region and the mine site is briefly discussed in the following subsections.

5.3.6.1 Existing groundwater users

Groundwater is a vital resource in the area and the proposed T3 Mine lies within an area of freehold farms and the private farmers are the only other users of groundwater area and are totally reliant upon it to water livestock, domestic supply and for irrigation. Abstraction volumes for livestock and domestic use are very small, whilst irrigation volumes are greater and dependent on the crop and the area under irrigation compared to the T3 water demand (333m^3/hr or 2,917Mm^3/a). The nearest settlements are Kuke and D'kar.

The locations of private boreholes around the T3 mine area, obtained from hydrocensuses undertaken as part of the ESIA study, are shown in Figure 5.18. Very little information exists on the depth and yield of the boreholes. However, the little information available shows depths are <60m and yields range from 18m^3/hr to 100m^3/hr.

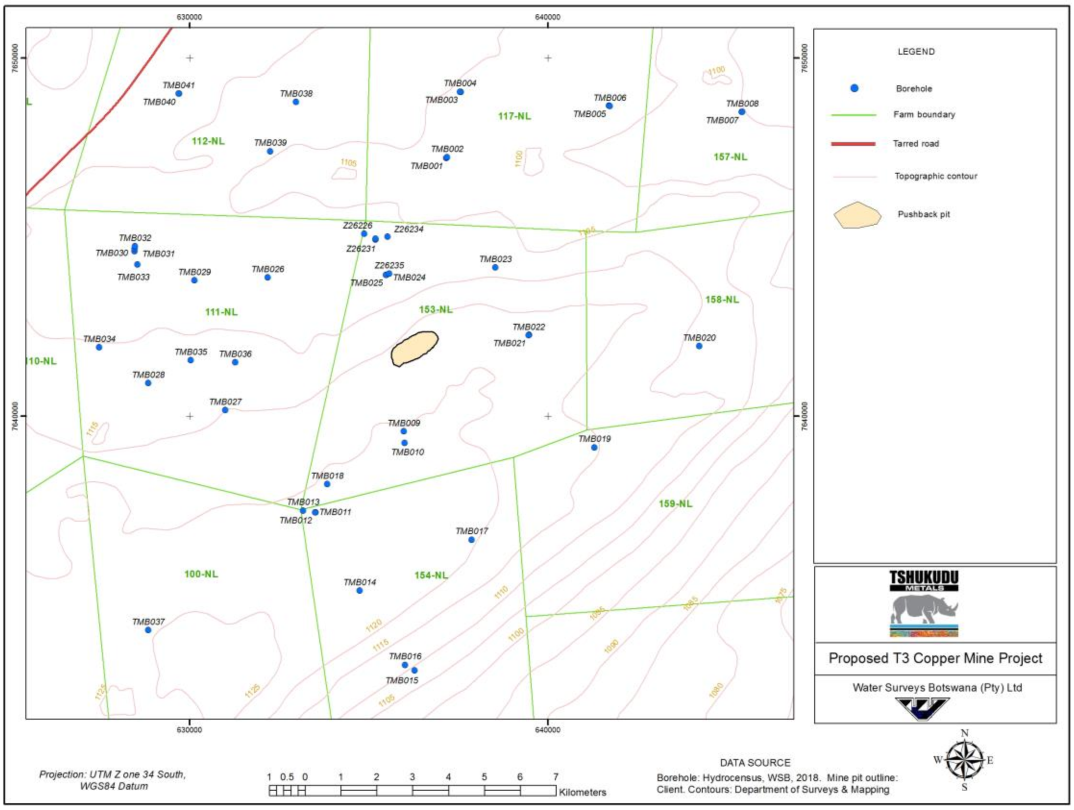


Figure 5.18: Private borehole location map

5.3.6.2 Regional hydrology

Within the regional study area, two different aquifer groups are recognized, being:

- Kalahari Aquifer
- Ghanzi Group Aquifer.

The Kalahari Group sediments near the Ghanzi ridge do not constitute an exploitable aquifer as the deposits are thin (<20m in thickness) and directly overlie the Proterozoic sediments. Northwards away from the main axis of the Ghanzi Ridge basal Kalahari group sands form an aquifer, however borehole yields are low (<5m^3/hour) and the water quality is invariably brackish to saline.

The Ghanzi Group metasediments form the main aquifer that is exploited by boreholes. The aquifer is highly fractured, but offers no primary porosity due to the recrystallised nature of the rocks, thus it is a secondary permeability aquifer. Groundwater is entirely stored within the fractures, the bulk of the storage probably being accommodated by intense small-scale fractures, whilst highly permeable zones coincide with the large regional faults or fracture zones.

Groundwater is generally encountered at shallow depths within the aquifer and first water strikes are often between 10 and 20m below ground level and static water levels average 10m below ground level along the Ghanzi ridge. In areas where the depth to water table is greater than about 30m (i.e. further off the main ridge), more saline waters are encountered; the salinity considered to be derived from the overlying Kalahari beds. The exposed met sediment outcrops provide active zones for recharge. zone, there is also a potential for high surface water contamination.

In general terms the regional aquifer is accepted as being semi-confined to confined. Most of the farmer boreholes abstract water from the upper parts of the Ghanzi Group fracture aquifers, as a result of being terminated soon after the first water strike. The borehole yields are generally low (1 – 10m^3/hour).

Aquifer properties of the Ghanzi Group are generally not adequately known as there is a paucity of good quality test pumping data. Tentative values for transmissivity were derived in 1987 (Molosiwa 1987). However, the tests were of a short duration and the boreholes under-pumped, thus the derived transmissivity values (100-200m^2/day) were considered unreliable and were re-interpreted during the NWMP (1992) study. This re-interpretation derived a median transmissivity of 38m^2/day and an estimated a storage coefficient of 0.01.

5.3.6.3 Site hydrogeology

The distribution of the Ghanzi Group rocks is readily identified from examination of the aeromagnetic data, which display a linear NE-SW trending succession of magnetic (red hue) and nonmagnetic bands (parallel green and blue colours) (shown in Appendix C1). A dolerite dyke crosses the northern part of the image with a WNW-ESE trend.

The lineaments interpreted from aeromagnetic data and from drilling are shown in Figure 5.17. It should be noted that water boreholes preferentially targeted northeast-southwest trending lineaments and where these lineaments were intersected by the conjugate northwest-southeast lineaments.

Around the T3 mine area, based on the mine geological model 11 (eleven) geological layers are recognised. Firstly, a thin veneer of Kalahari (<10m thick) comprising of sand, calcrete and silcrete overlying a weathered fractured mudstone. The underlying strata comprises of alternating fractured siltstones and sandstones. The beds dip north-westwards and south-eastwards away from the mine. Six major thrust zones have been identified (shown on Figure 5.19 structural lineament map) two of which (thrusts A and B) are important hydrogeologically.

A total of 16 vertical water boreholes have been drilled with yields ranging from 1m^3/hr to >100m^3/hr. Rest water levels are shallow being between 4mbgl and 8mbgl, being within the Kalahari beds. Water strikes are first recorded in the weathered fractured mudstone at depths of between 10m and 24m, thus the Kalahari is dry. These shallow water strikes show yields varying from a seepage to 10m^3/hr and were grouted off in the water supply boreholes.

Based on the recorded water strike information from water boreholes, core and reverse circulation mineral exploration boreholes, water strikes are shown to range in depth from 10m to 220m, with 70% of recorded water strikes occurring above 80mbgl and 90% above 140mbgl, illustrated in Figure 5.20. This is consistent with fractured rock aquifers, where the degree of fracturing and their openness to carry water decrease with depth.

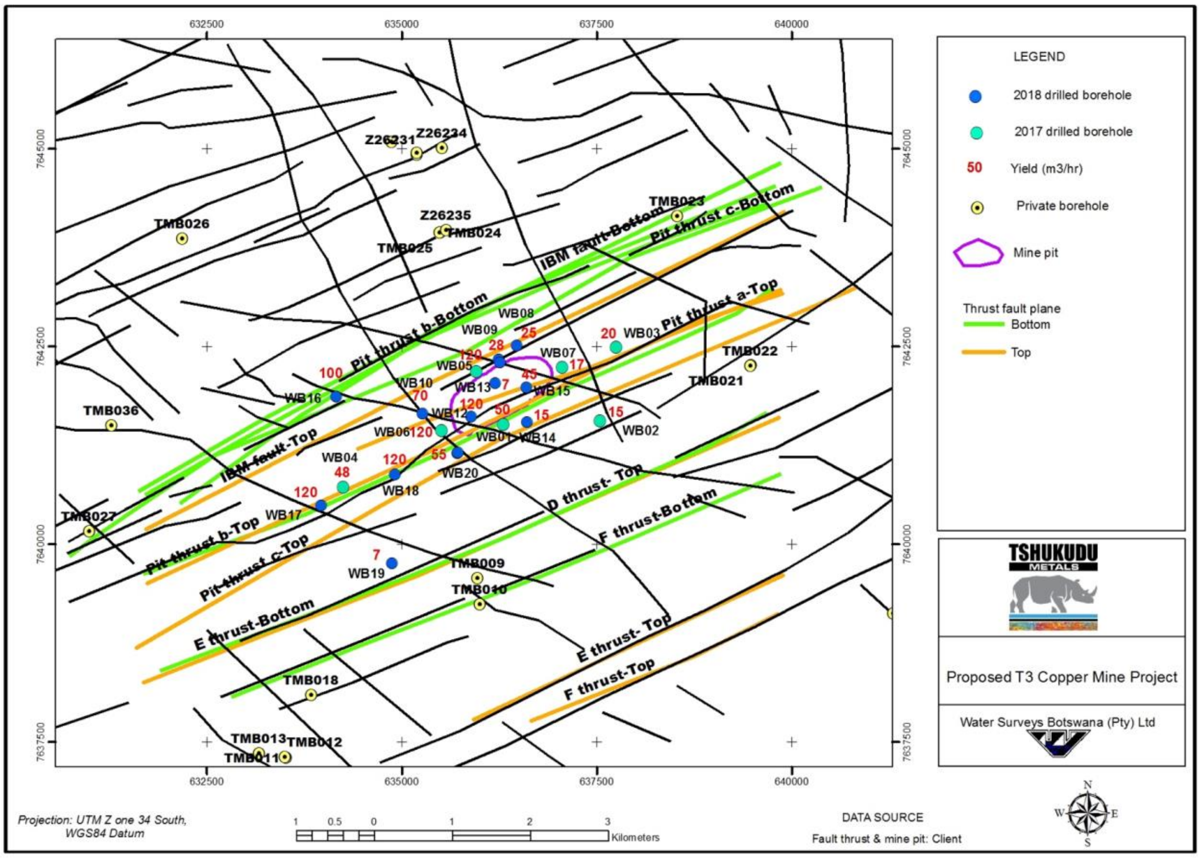


Figure 5.19: Derived aeromagnetic lineament map showing project & private boreholes

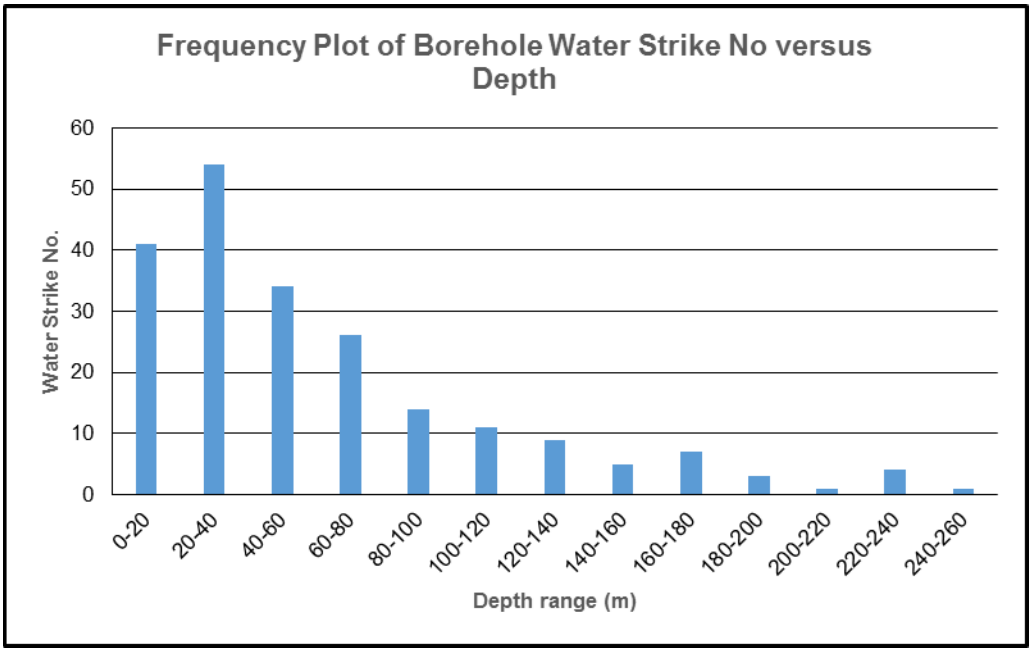


Figure 5.20: Frequency plot of water strike number versus depth

Aquifer transmissivity (T) and storativity (S) are important parameters that describe the aquifer's ability to transmit and store groundwater respectively. The calculated transmissivities and storage values derived from constant rate test analyses are presented in the specialist report in Appendix C1. The transmissivities show a range from 8m^2/day to 870m^2/day (mean 78m^2/day) derived from pumping well analysis, which are influenced by well losses and from 46m^2/day to 2600m^2/day (mean 565m^2/day) for observation wells. Calculated observation borehole storage values vary between 6.9x10^{-6} and 9x10^{-2} and reflect a confined storage. The rocks show no primary porosity, consequently groundwater is solely stored within fractures.

5.3.6.4 Ground water flow regime

Groundwater monitoring is undertaken monthly of T3 project boreholes. However, the current monitoring data is of a too short period to derive any conclusions, determine the natural aquifer recession or responses to rainfall, which would indicate recharge (determine the natural aquifer recession or responses to rainfall that would indicate recharge is occurring), being only 3 months during the 2018 dry season.

The piezometric contour map using the available water level data is shown in Figure 5.21. The map shows groundwater flow has a general northerly flow, following the northerly dip of the major fractures/faults.

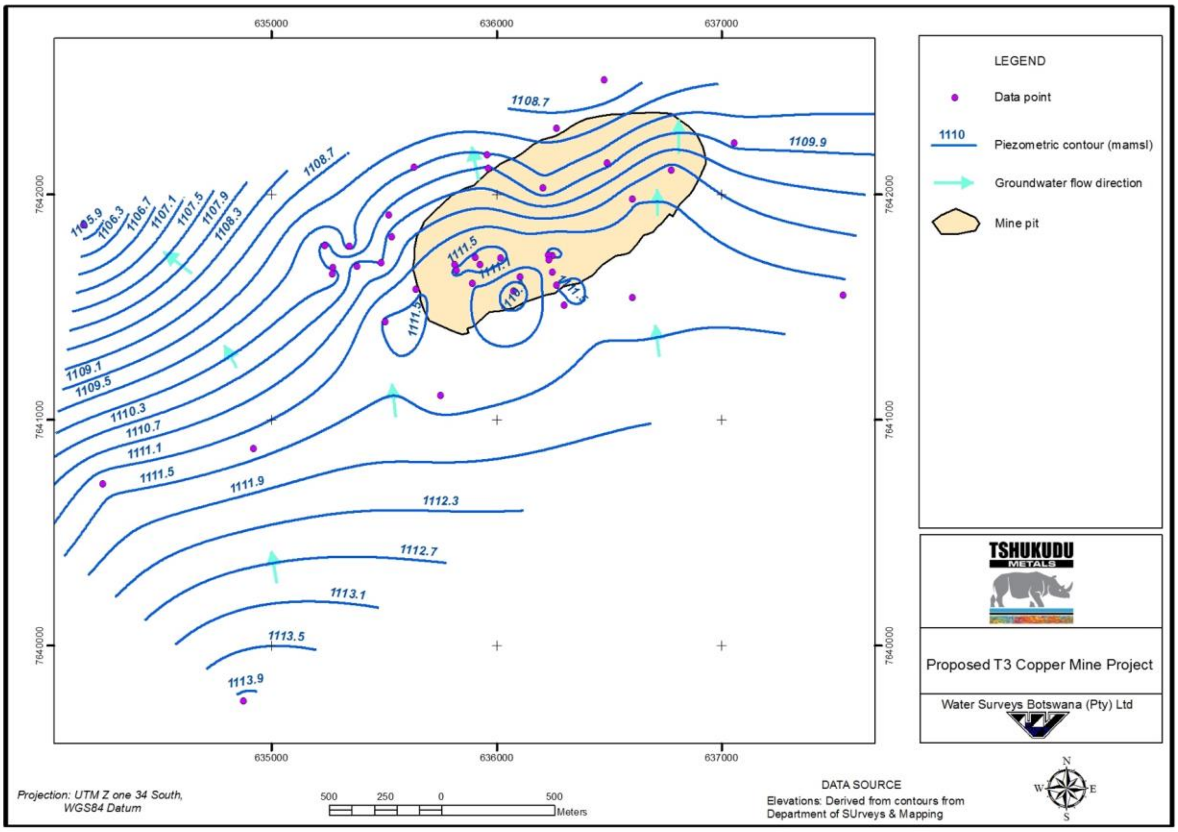


Figure 5.21: Piezometric surface map

5.3.7 Hydrochemistry

Water samples were collected at T3 project boreholes and private boreholes. Samples were analysed for major and minor ions to characterise the waters, compare the results with the BOS 32:2015 revised drinking water standard and BOS 93:2012, 2nd Edition waste water standard, and establish the groundwater baseline hydrochemistry prior to mining operations. The sample location points are shown in Figure 5.22, whilst the analysis results are presented in the specialist report in Appendix C1.

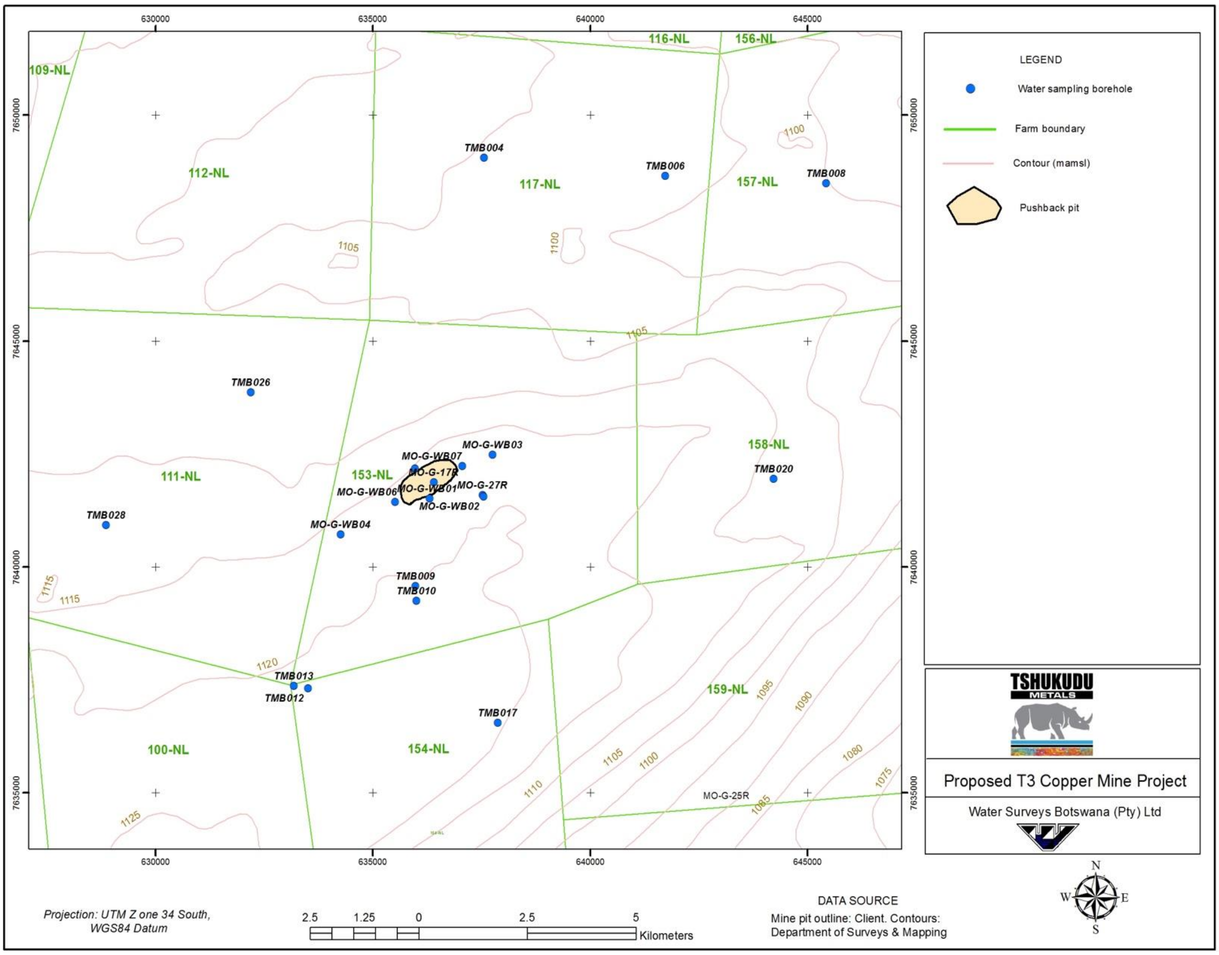


Figure 5.22: Hydrochemistry sample point locations

5.3.7.1 Water quality

General conclusions on the water quality are presented below:

T3 Project boreholes:

- All major ions analysed parameters are within BOS 32:2015 Class 1 Drinking Water Standard, except for the following, which are above the standard concentrations:
  - Iron concentrations in boreholes MO-G-WB02, MO-G-WB03, MO-G-WB04 and MO-G-WB018.
  - The manganese concentrations in MO-G-WB02, MO-G-WB12 and MO-G-WB13.
  - The nitrate concentration in MO-G-WB08 of 176mg/l is exceptionally high.

- The waters are slightly alkaline with pH values ranging from 7.25 to 8.02.
- TDS concentrations range from 468mg/l to 764mg/l. A TDS contour plot is presented in the specialist report in Appendix C1.
- Chloride and sulphate concentrations are low ranging between 19-48mg/l and 14-29mg/l respectively.
- Nitrate concentrations are generally below 25 mg/l except for MO-Go-WB08.
- Fluoride concentrations are low ranging from 0.1mg/l to 1.4mg/l.
- The waters are hard.
- Calcium and sodium are the dominant cations with concentrations ranging from 37mg/l to 104mg/l and 70mg/l to 123mg/l respectively.

Private Boreholes:

- The majority of the sampled private boreholes show them to be above BOS 32:2015 Class 1 Drinking Water Standard with respect to various ions, with only two boreholes (TMB012 & TMB020), having all the analysed parameters within the standard.
- The majority show very high calcium (>100mg/l) and nitrate concentrations (>50mg/l), the latter probably due to potential contamination from intensive cattle rearing.

5.3.7.2 Encrustation and corrosion

The total hardness of the T3 boreholes is between 150 and 300mg/l $CaCO_3$, whilst alkalinity is between 260mg/l and 400mg/l. The private boreholes show total hardness values between 170 and 490mg/l $CaCO_3$ and alkalinities between 3160 and 550mg/l $CaCO_3$. When the alkalinity is greater than total hardness, the hardness is entirely temporary and can be removed by boiling and when the alkalinity is less than the total hardness, the difference is equal to the permanent hardness (i.e. that which cannot be removed by boiling). For all the T3 project borehole analyses the temporary hardness exceeds permanent hardness, as is the case for all but three of the private boreholes which show permanent hardness.

The tendency for water to corrode or scale metal surfaces can be predicted using two indices, the Ryznar Stability Index (RSI) and Langelier Saturation Index (LSI). LSI estimates the tendency for calcium carbonate to precipitate or dissolve in water by considering the difference between water pH and the calcium carbonate saturation pH, (pHs). The RSI is used to determine the degree of the calcium carbonate precipitation based on a study using water of varying saturation indices for a more accurate prediction than LSI.

The calculated LSI values range from 0.1-0.4 indicating the waters are slightly scale forming and non-corrosive, whilst the RSI values range from 6.5-7 indicating the waters will have little scale but are slightly corrosive.

5.3.7.3 Water type

Hydrochemical water types are a reflection of the origin of the aquifer waters, the residence time in the aquifer, and the processes that occurred during the movement of the water. To elucidate the water types in the T3 area the data was plotted on Expanded Durov plots (see Appendix C1).

Three main water types are recognised in the area, with the waters evolving down the groundwater flow direction from Type I waters to Type III waters:

- Type I being $CaHCO_3$ waters (calcium ≥50%), representing recharge waters entering the groundwater flow system.
- Type II being a mixed cation Ca-(Na)-Mg-HCO_3 water, representing waters that are undergoing cation exchange of calcium by sodium and dissolution of magnesium.
- Type IIII $NaHCO_3$ waters, representing water that has undergone the cation exchange of calcium and magnesium by sodium.

A fourth sub-type, being a mixed anion calcium water (Ca-HCO_3-SO_4-Cl) representing either two water undergoing mixing or dissolution is occurring. Types I and II are found in the T3 mine project boreholes, whilst the private boreholes show all four types.

5.3.8 Groundwater vulnerability

To examine the potential for groundwater impact, it is important to firstly assess and understand the vulnerability of the setting. Groundwater vulnerability is a measure of how easy or how hard it is for pollutants or contamination at the surface to reach an aquifer. Vulnerability is considered to be high where natural factors offer little protection to the groundwater from contaminating activities at the land surface, and conversely it is considered to be low where the natural factors offer good protection so that there is little likelihood of contaminating activities resulting in groundwater degradation, that is, aquifer vulnerability is a function of the physical circumstances at a particular location and provides a measure of the ease with which unacceptable effects upon groundwater resources can occur.

In principle, there are two types of vulnerability:

- Intrinsic vulnerability, whereby an assessment of a location is undertaken whether or not pollutants are present and focuses on a description of the natural environment that depends on several factors including the soil type, presence of superficial deposits and characteristics of the bedrock.
- Specific vulnerability, whereby the assessment considers additional factors specific to the location. These include the nature of the activity under scrutiny and the characteristics of the pollutant posing the threat to groundwater including the behaviour of the soil and rock towards it.

The thickness and hydraulic properties of the geological formations above the aquifer, that is, the soil zone, the unsaturated zone and any confining layers are the key factors in determining the vulnerability of an aquifer system. These three are the principal natural controls determining the recharge rate and recharge time to the aquifer. Further the unsaturated zone provides groundwater protection by:

- Intercepting, adsorbing and eliminating pathogenic organisms.
- Attenuating and degrading pollutants

5.3.8.1 Project area vulnerability assessment

The vulnerability assessment method used for this study was that currently adopted in the UK (Foster & Skinner, 1995). The method classifies the predominant strata above the saturated aquifer, using lithology and thickness as the principal indicator of pollution vulnerability, as illustrated in Figure 5.21.

Based on the assessment the T3 mine area is defined as being “Vulnerable to most water pollutants with relatively rapid impact in many pollution scenarios”. Due to the groundwater being potentially exposed to surface pollution risks all potential pollution sources should have adequate protection measures constructed to minimise the risk of pollution. It must be noted (not considered in the classification) that the calcrete present in the area has the ability to neutralise the majority of contaminants.

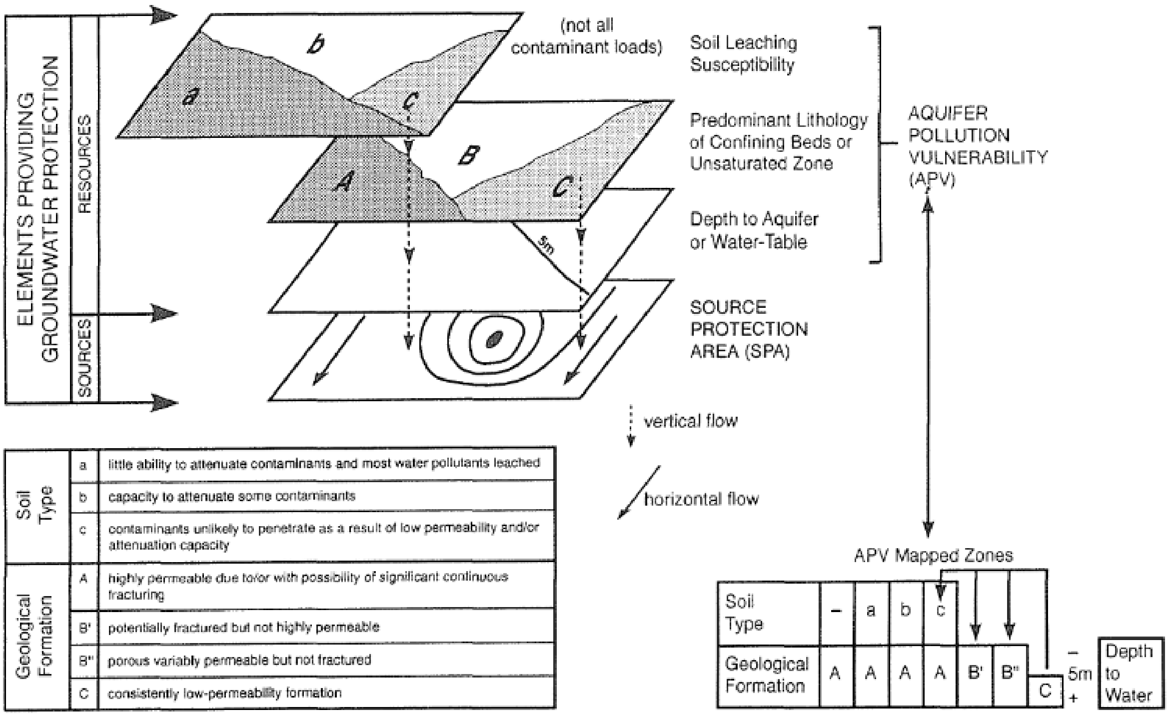


Figure 5.21: Elements of groundwater protection and scheme of aquifer vulnerability classification (derived from Adams & Foster, 1992)

5.3.9 Soils

The soils in the Ghanzi District are characterized by deep Kalahari sands which are classified as luvic or ferralic Aerosols, having formed from the light yellow and red Kalahari sands (GDDP 7). The soils are nutrient deficient deposits, which accumulated since the late Pliocene to recent times, also the soil is poor in natural fertility, low in organic status which translate to poor farming activities.

The sandy soils result in low water holding capacities. The soils are in general considered as having high parasites, and their ability to transmit water can in some places be hampered by high content of fine minerals. Sandy soils are not expected to cause any water logging problems. Dry conditions can cause sandy soils to become loose and fine, which should be considered due to the high frequency of haulage activities, however, many contractors have worked in these conditions in Botswana, and equipment is available to undertake construction in these soil conditions without progress delay.

The soils underlying the District are divided in three major groups following FAO soil taxonomy. These are:

- Eutric Regosols: These are found at the mine area representing very shallow to shallow, well to somewhat excessively drained, coarse sands to clayey loams.
- Eutric Leptosols: Found in the northeast part of the T3 farm and the farm to the north, being very shallow to shallow, well to somewhat excessively drained, fine to loamy fine sands.
- Ferralic Aerosols: Found on the farm to the east being very shallow to shallow, well to somewhat excessively drained, coarse sands to loamy fine sands.

All three soils have low organic carbon, are thin, have low attenuating properties thus they offer very limited protection against contamination from pollutants and will allow rapid access to the aquifer.

A general soil type map of the Ghanzi area is presented in Figure 5.24.

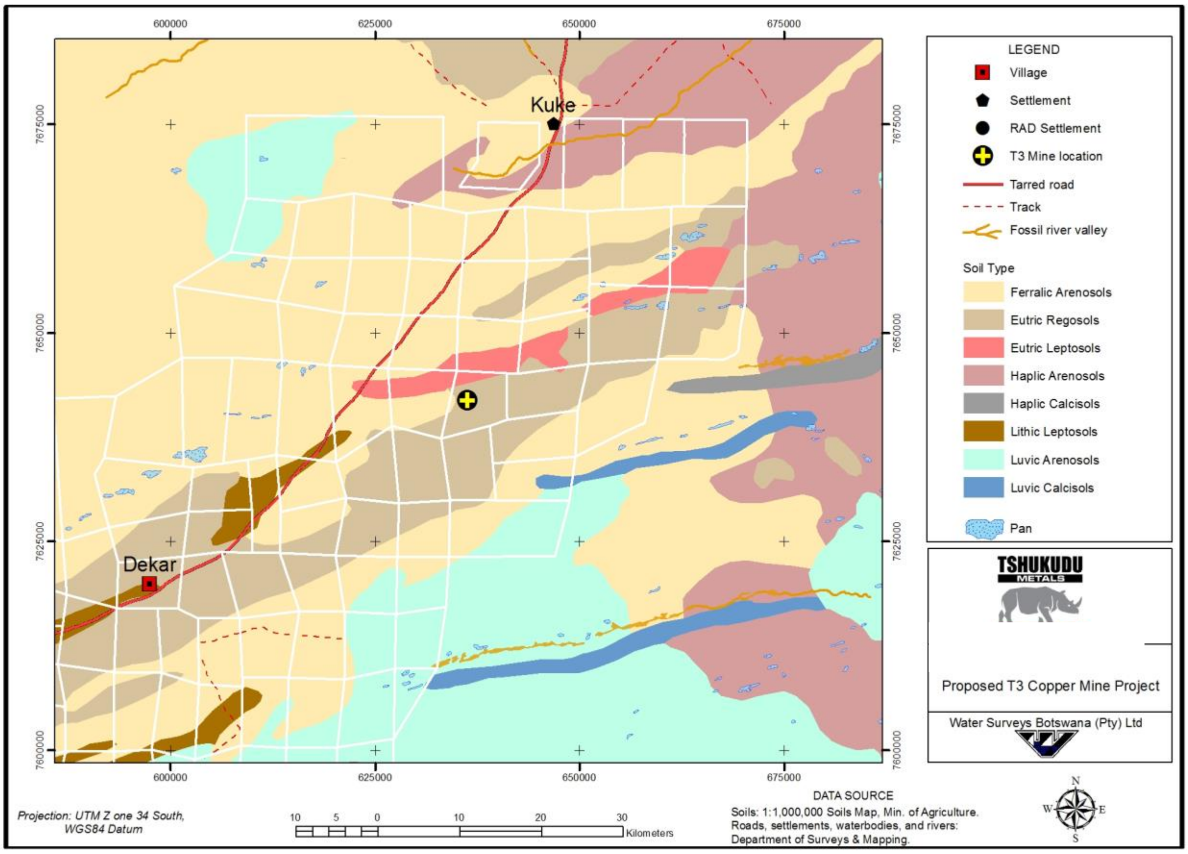


Figure 5.24: Soil types in the project area

The soil at the project site was samples and tested by soil specialist company TerraAfrica. Sixteen samples were collected on the study site using a hand-held soil auger. Both a topsoil sample (at 10cm depth) and a subsoil sample (at 50cm depth) were collected at 8 locations within the project area. Vegetation samples were collected at four additional points. The samples were sealed in clean plastic sampling bags and submitted to the laboratory for analyses. A full copy of the soil analysis report is provided in Appendix G. A summary of the key characteristics is provided below.

5.3.9.1 pH

All the samples except one (subsoil) had pH values between 4.5 and 5.3. These soils can be described as strongly acidic. Strongly acidic soils result in low availability of especially phosphorus (P) but also calcium (Ca), magnesium (Mg) and potassium (K). The subsoil at sampling point V4 had a pH level of 7.4 which is considered very alkaline. At this point, the sodium levels are much higher than for the other sampling points, resulting in a high sodium adsorption ratio (SAR).

5.3.9.2 Plant-available phosphorus (P)

The plant-available phosphorus levels measured were low in all the samples analysed. The levels ranged between 2.78 to 4.33 mg/kg. Such low levels are common for undisturbed soil profiles in the savannah of southern Africa and higher levels are usually found in crop fields where phosphorus is supplemented with fertilizer or in forested areas where much the higher soil organic matter content is linked with higher P levels. In addition to the low plant-available levels measured, plant availability of P is further impeded by the low pH levels measured in these soils.

5.3.9.3 Organic carbon (C)

The organic carbon content of both samples were very low The low levels are typical for bare or sparsely vegetated soil surfaces in warm, dry areas. The levels ranged from below detectable (the lowest measured as -0.24%) to 0.49%. The very low organic carbon content is not unusual for the dry sandy conditions of undisturbed natural areas of southern Africa. However, it is also an indication that lower growing vegetation species such as small shrubs and grass are very limited between the woody species. An increase in organic carbon content will improve the water-holding and nutrient retention capacity of the soil.

5.3.9.4 Exchangeable bases – essential plant growth elements (Ca, Mg, K)

Calcium levels range between 1705.1 and 15395.5 mg/kg. These Ca levels are very high and even the minimum value is considered more than sufficient for plant growth. Similarly, Mg levels range between 273,8 and 1704,6 mg/kg which is sufficient to excessively high. The high calcium and magnesium levels may originate from the geology. Potassium levels range between very low at 33,2 mg/kg to excessively high at 2981,9 mg/kg. The low potassium level would have been considered deficient should the soil have been used for crop production purposes.

5.3.9.5 Cation exchange capacity (CEC)

The cation exchange capacity of soil on site ranges between 0.93 to 5.63 cmol+/kg. The CEC of soil on site is directly linked to the clay content of the soil with the highest CEC level measured for V15 subsoil where the clay content is 5.3% as compared to the lowest CEC level where the clay content is 2.2%. The CEC value was also used to calculate the exchangeable sodium percentage of the samples (ESP).

5.3.9.6 Sodium (Na) and exchangeable sodium percentage (ESP)

The ESP of the topsoil is 33.36% and subsoil 46.28%. This indicates the soil there is solonetz that have structural problems. The results from one sample indicate that the soil profile in this area may have already formed a pan as a result of historical dissolution of clay particles. Especially the subsoil horizon in this area is unsuitable for crop production. It is anticipated that the natural vegetation in this area is very sparse.

The sodium levels of all the samples (except one sampling point) range between 8.0 and 146.3 mg/kg. This is within an acceptable range and not considered toxic levels.

5.3.9.7 Texture

Using the texture class triangle, the textural classes of all the samples (both topsoil and subsoil) have been determined as sand. Sandy soil has a very low water-holding capacity and show tendencies of hydrophobicity especially after prolonged periods of drought.

5.3.9.8 Maximum stockpile slope

Using the erodibility nomograph, the K- factors for the samples were determined as ranging between 0.56 and 0.62. It was established that maximum slope at which soil at the proposed Tshukudu Mine can be stockpiled is 3.2%. This maximum slope limits the potential of soil to be stockpiled at great heights and this should be considered during topsoil stockpile location planning for a great area will be required.

5.3.10 Geochemical analysis

Knight Piésold (KP) was engaged by Tshukudu Metals to conduct geochemical characterisation of the waste rock which will be produced from the development of the T3 Copper Project as part of the current Definitive Feasibility Study (DFS). As described in Chapter 4, a total of 67 rock samples were collected at T3 for analysis. The full results from the study are available in Appendix X, with a summary of the key findings in the sections below.

5.3.10.1 Acid base accounting

The results of the sulfur speciation results indicate that the total sulfur content of the samples varied from <0.01% to 2.48% at an average of 0.14% which is low. The sulfate contents were typically negligible, with only eleven samples recording a sulfate content above the limit of detection of 0.01%, up to a maximum of 0.07%. As such, the majority of sulfur in the samples is likely present as sulfide. The estimated sulfide contents varied from negligible to 2.41% at an average of 0.13% which is low.

The maximum potential acidity was calculated from the sulfide sulfur contents and varied from negligible to 74 kg H_2SO_4/t at an average of 4 kg H2SO4/t which is considered to be low.

The acid neutralising capacity (ANC) of the samples was determined along with the carbonate content. The two results can be used as a check against one another and to identify the contribution of ANC from carbonates and other non-carbonate minerals.

The ANC was measured from 23 to 640 kg H_2SO_4/t at an average of 93 kg H_2SO_4/t which is very high. The measured ANC results correlate very well with the estimated carbonate- ANC, indicating that the majority of ANC is likely available from carbonate minerals. However, the measured ANC values were typically slightly higher than the estimated carbonate ANC values, indicating that additional neutralising capacity is likely available from non-carbonate minerals, such as micas, feldspars and amphiboles. The neutralising capacity provided by non-carbonate minerals is typically released much more slowly than that provided by carbonates and may only be available under low pH conditions.

The ANC test method specified by Knight Piésold accounts for the possible presence of siderite ($FeCO_3$) by adding hydrogen peroxide (H_2O_2) to the digest solution to ensure that aqueous iron is oxidised and hydrolysed to re-release any acid consumed by siderite before completion of the back titration. This ensures that the ANC is not overestimated, as siderite does not provide any net neutralising benefit. This is because the acid consumed during dissolution of siderite is re-released upon oxidation of aqueous iron and precipitation of iron oxyhydroxides. The precipitation of iron oxyhydroxides causes the digest solution to become a distinct orange colour, as was noted during the ANC tests on almost 90% of samples. This indicates that a portion of the estimated carbonate ANC may include some siderite which has led to the values being overestimated.

However, given the high measured ANC in all samples (which accounts for siderite), the samples are still considered to have adequate available ANC.

The net acid producing potential (NAPP) of the samples was calculated from the MPA and the ANC, along with the ANC/MPA ratio. The NAPP values were negative for all samples, ranging from -635 to -22 kg H_2SO_4/t. This is due to consistently high ANC values compared to MPA. The average NAPP was negative at -89 kg H_2SO_4/t. The ANC/MPA ratios were typically high, with over 50% of samples recording ratios greater than 3. In addition, a ratio could not be determined for 46% of sample due to recording negligible MPA values. The lowest ANC/MPA ratio was 1.4, which still shows excess ANC compared to MPA (Knight Piésold, 2017).

The acid base accounting results for all samples are presented in Appendix C2 (Table 3.1).

5.3.10.2 Net acid generation

The net acid generation (NAG) test aids in the interpretation of acid formation potential classifications. It also identifies whether the sulfides and neutralising minerals contained in the samples are readily available to produce or consume acid respectively (Knight Piésold, 2017).

The results of the NAG test indicate that no samples produced measurable acid under extreme oxidising conditions, with the final pH varying from 7.1 to 11.7.

The NAG results for all samples are presented in Appendix C2 (Table 3.1).

5.3.10.3 Acid formation potential

The acid formation potential is calculated based on the acid base accounting results and the NAG test. The classification of the samples is summarised below and shown graphically in Appendix C2 (Figures 3.1 and 3.2):

- Thirteen samples (19%) classified as Acid Consuming.
- Fifty four samples (81%) classified as Non Acid Forming.

Based on the acid base accounting and NAG test results, the samples analysed have a high factor of safety against acid generation.

5.3.10.4 Element enrichments

The results of the multi-element analysis and comparison to average crustal abundance indicates that the samples have low to moderate levels of element enrichment. The most commonly enriched elements were silver, arsenic, bismuth, cadmium, copper, lead and zinc, as summarised in Appendix C2.

5.3.10.5 Soil quality screening

The results of the multi-element analysis have also been compared to a set of soil quality screening guidelines, which indicated that the majority of samples met the human health guidelines, although occasional exceedances for arsenic (three samples) and lead (five samples) were noted.

No samples met the ecological guidelines, with antimony, cadmium, chromium, copper, lead and zinc the most commonly elevated elements. The majority of samples failed to meet soil remediation guidelines, with arsenic, barium, copper, lead and zinc the most commonly exceeded guidelines.

Complete tabulated results compared to the assessment criteria are presented in Appendix C2.

5.3.10.6 Distilled water extract

Tabulated distilled water extract results compared to the reference water quality guidelines are presented in Appendix C2 and discussed in the following sections, with the implications for waste rock management provided in Chapter 7.

The TDS for all samples could not be measured due to very low EC results. As a result, the TDS values were estimated by multiplying the EC results by a constant. A low EC / TDS is generally indicative of a sample with low salinity and dissolved metal concentrations.

5.3.10.7 Comparison to surface water reference values

The distilled water extract results were compared to recommended effluent guidelines for rivers in Botswana and IFC / ANZECC guidelines which indicated the solutions to be of a reasonable quality. The majority of samples met the reference surface water quality values, although nine samples recorded pH values in excess of the upper bound Botswana and IFC pH guideline of 9. In addition, one sample exceeded the Botswana threshold for lead and nine samples exceeded the Botswana guideline for selenium of 0.01 mg/L, with two samples also exceeding the ANZECC value for selenium of 0.02 mg/L. It should be noted that the average sample concentrations met all surface water reference criteria adopted for this study.

5.3.10.8 Comparison to drinking water guidelines

The distilled water extract results were also compared to Botswana drinking water guidelines and WHO drinking water guidelines supplemented with Australian guidelines. Twenty one of the samples were found to exceed the Botswana and WHO drinking water limit for arsenic of 0.01 mg/L, with the average concentration from all samples calculated at almost 2.5 times the guideline value. There were also exceedances of aluminium (nineteen samples), lead (two samples) and selenium (one sample), although the average sample concentrations were below the drinking water guidelines. The pH in twenty samples exceeding the WHO upper bound pH threshold of 8.5, but all samples met the Botswana guideline of 9.5.

It should be noted that the EC guideline in the Botswana standards is 1500 µS/m. However, it is noted that the units are normally reported in µS/cm, which would provide a guideline value of 15 µS/cm, which is approaching the conductivity of distilled water.

5.3.11 Seismic activity

Botswana has tectonic activity in the northern and central parts of the country, with regional NE-SW trending normal faults with half-graben and graben development reflecting tensional stress conditions and incipient continental rifting related to the East African rifting system. The region is tectonically active as the East African Rift valley extends to the area through the Thamalakane fault. This fault has resulted in several tremors being experienced in the area. The Department of Geological Surveys has a seismic monitoring station near Toteng. This station is monitoring the Thamalakane Fault area. Currently there are plans to increase the number of seismic monitoring stations in the District due to the recent tremors which have been experienced in the District (Source: DGS, 2014).

5.3.12 Existing noise levels

The predominant land use within the project region is reserved for farming (freehold and leasehold) followed by Wildlife Management Areas and parastatal/residential zones within the south-western part of the Ghanzi district. The immediate area of influence in relation to noise includes the 153-NL freehold farm as well as the neighbouring farms bordering 153-NL. Villages and settlements within the project´s surroundings are Kuke Village (30 km North), D´kar (45 km South-West) and the administrative centre of the District, Ghanzi, located 85 km to the south-east. The project area can therefore be characterised as typically rural.

Average day-time and night-time (LA_{eq}) sound levels from all the monitoring locations adhered to the relevant BOBS 575:2013 residential standard of 50 dB(A) and 35 dB(A), respectively. The monitored levels are considered an accurate representation of ambient conditions, with limited impact from external sources. Noise sources identified during the day-time included the generator in the background, birds chirping, goat noises and vehicle car doors opening and closing. Night-time noise included roosters, goats, birds and donkey noises.

Ambient sound level monitoring results are presented in Table 5.3 and Table 5.4 and illustrated in Figure 5.25 and Figure 5.26. The field log sheets are presented in the Acoustic Assessment report (refer to Appendix E).

Table 5.3: Day-time noise monitoring results

Receptor ID	LA_{eq} (dBA)	LA_{max} (dBA)	LA_{min} (dBA)	BOBS Standard (dBA)	Compliant
Rec 01	43.4	62.4	37.4	50	Yes
Rec 02	47.6	62.0	39.5	50	Yes
Rec 03	47.9	62.9	32.4	50	Yes

Figure 5.25: Day-time environmental baseline noise monitoring results

Table 5.4: Night-time noise monitoring results

Night-time noise monitoring results Receptor ID	LA_{eq} (dBA)	LA_{max} (dBA)	LA_{min} (dBA)	BOBS Standard (dBA)	Compliant
Rec 01	30.0	63.0	16.0	35	Yes
Rec 02	29.6	45.9	18.0	35	Yes
Rec 03	33.3	49.1	20.6	35	Yes

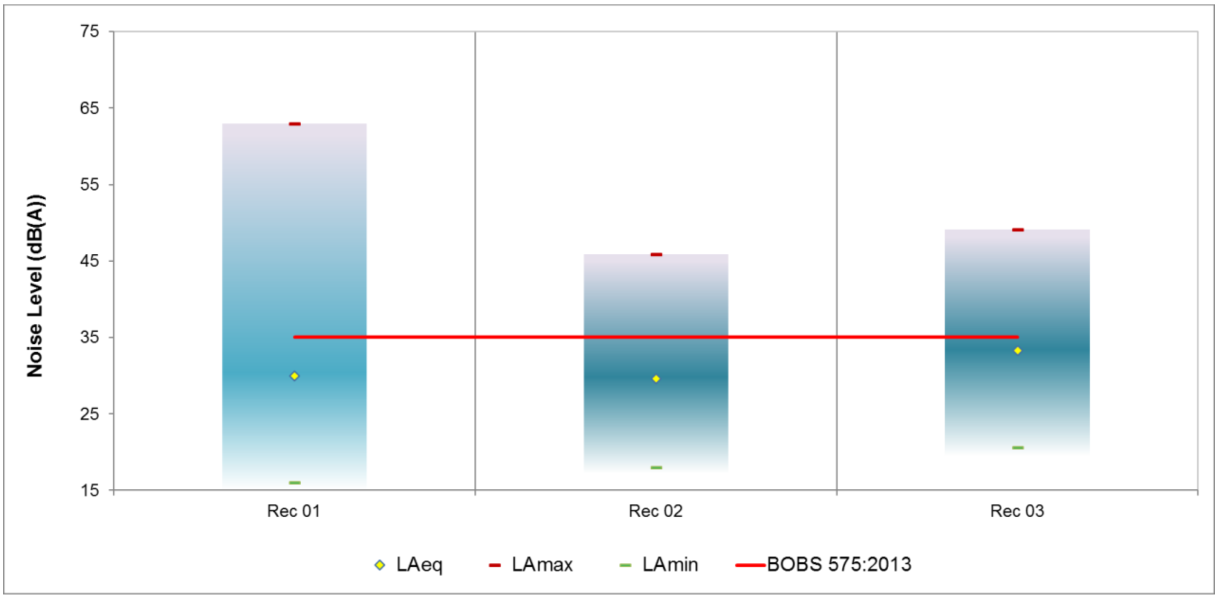


Figure 5.26: Night-time environmental baseline noise measurement results

5.3.13 Landscape character and visual amenity

In general terms, the local visual environment is rural and largely undeveloped, with very few residential receptors due to the expansive, sprawling agricultural farming areas and rangelands that make up the landscape within the region of the study area. Boseto Mine, located approximately 120km north east of the T3 project site, is the only existing mine within the region. Protected land uses in the greater area include Lake Ngami, the Kgwebe Hills, and the CKGR, each of which is considered a landscape of high value and sensitivity due to the tourism, historical, and/or ecological sensitivities attributed to each.

5.3.13.1 Existing primary landscape character

The topographical landscapes of the Ghanzi District can be described in general terms as a largely flat, desert and bushveld landscape. There is one topographical anomaly nearby, an isolated area of rocky hills, (Kgwebe Hills), which are situated in the north east portion of the study area, and contributes the only substantially diverse contours to the otherwise level landform of the region (GDDP 7).

In terms of vegetation, the region is generally classified as a transition zone and is largely defined by its situation within the sandveld environment of Botswana. On a more micro level, the study area is divided into the Northern Kgalagadi tree and bush savannah, and the Ghanzi bush savannah. Most of the CKGR can be broadly classified as semi-arid tree bush savannah, though it is comprised of a mosaic of several habitat units and veld types (GDDP 6). Generally, the vegetation may be characterised by an abundance of low growing shrubs and varying densities of good to poor quality grasses.

In specific terms, the primary landscape character type found in the study area can be classified as “Desert tree and shrub savannah landscape”. A belt of grassland can be found along the main Ghanzi-Maun road, and desert grasses are found throughout the study area as well.

The landscape character area type addressed within this report comprises the following elements:

- Altitude ranging between 900 to 1100m above sea level with very little change in gradient.
- Exposed sand and sandy soils throughout, often with isolated pans that fill and hold water during rainy seasons.
- Acacia mixed veld vegetation, some dense, low scrub and areas of grazed and cultivated land.
- Long expanses of straight twee-spoor (two-tyre) vehicle tracks exposing deep, loose sand. These typically follow the boundary lines of private farm properties.
- Narrow animal tracks used by livestock and herdsmen.
- Fenced agricultural farm boundaries.
- A built environment that includes Ghanzi Township, rural village settlements (e.g. D’kar and Kuke) comprising traditional thatched houses with external ablutions (latrines), or concrete block homes, mobile phone tower(s), unpaved roads, mainly pedestrian traffic, kraals, and small-scale plots of crops.
- A sense of remoteness and wildness devoid of obvious human impact on the environment such as heavy traffic, paved roads or commercial/industrial/infrastructural development.

Figure 5.27 illustrates the landscape character of the study area.

Figure 5.27: Examples of desert tree and shrub savannah landscape character area.

Secondary landscape character types in the local region include expanses of grassland, which have shown a high degree of veld disturbance exacerbated by a long history of grazing by domestic stock. These areas can be referred to in landscape terms as *managed grassland plains* (which is defined primarily by grazing activity as well as the government-managed road servitude between Ghanzi and Maun), and consist of primarily increaser and mostly pioneer and sub climax species of grass.

5.3.13.2 Existing visual amenity

In the same manner that the landscape character of the study area is considered part of the aesthetic environment, so is the Visual Amenity level of the region. This is relevant to the lines of sight and views that can be availed of by receptors (visitors to the area, residents, those employed in the area, etc.). The visual assessment was undertaken as part of the ESIA study to address impacts upon receptors and viewpoints within the visual catchment of the proposed mining activities and physical features, in terms of:

- Scenic character
- Landscape quality
- Light
- Sensitivity to change.

The existing visual amenity of the study area is arguably high in value as it offers uninterrupted long-range views of undeveloped bushveld landscapes. Local tourism opportunities offer “dark sky” tourism, where visitors to the area can travel to such a location specifically for star gazing experiences. A critical factor affecting astronomy observation is the remoteness and unspoilt character of an area, necessitating a lack of urban sky glow to avail of views to astronomical elements such as stars, planets, comets and constellations.

Although much of the land tenure around the proposed mine is designated for private farm use, the majority of this land remains undeveloped and is visually indicative of typical Kalahari savannah landscape. This results in long-range views being available to visual receptors, while the natural wildness of the local environs continues to contribute to the unspoilt visual amenity of the study area. This is considered a significant value in terms of the visual environment.

5.3.13.3 Light

The current state of visual amenity in the area is high due to the rural environment and naturally occurring vegetation and biodiversity being abundant in an undeveloped state. The study area is largely rural with almost no signs of industrial development to date. However, sensitive views are minimised by the density of the local vegetation and the relatively flat landform that limits a viewer's line of sight from extending past the local or intermediate zone. Additionally, landscapes of significant value are also minimal, as the study area is highly typical of the surrounding region and widely found across Botswana

A summarised table below (Table 5.5) shows a compilation of the light readings taken at various locations within the study area.

Table 5.5: Summary of light measurements

	Receptors	Light Intensity* Reading – Day (lux)	Light Intensity Reading – Night (lux)	Distance Category
1	Farm 153-NL's Main Homestead 21°18'4.21"S, 22°18'23.31"E	76,100	0.39	Long range (2.29km)
2	Homesteads to the West South West of Farm 153-NL 21°18'5.30"S, 22°18'17.67"E	74,800	0.41	Long range (2.34km)
3	Homesteads to the North East of Farm 153-NL 21°18'0.04"S, 22°18'28.66"E	75,700	0.33	Long range (2.34km)
4	Onsite Location 1 21°19'24.17"S, 22°17'49.81"E	74,300	0.42	Long range (2.07km)
5	Vorster homestead & staff housing 21°17'59.62"S, 22°14'18.77"E	76,300	0.41	Long range (8.38km)
6	A3 road- Access road junction 21°18'12.00"S, 22°11'34.00"E	74,300	0.41	Long range (~12.98km)
7	Onsite Location 2 (main camp) 21°19'11.00"S, 22°19'0.00"E	76,800	0.30	Short Range (0KM)
	AVERAGE	75,471.43	0.38	

*As reference only (dependent on weather conditions)

Full details of the light measurement points and methods are provided in the Landscape and Visual assessment report in Appendix H.

5.4 Biological environment

The biological environment describes the biotic or the living part of the study area and includes all flora and fauna and other microorganisms. A wet and dry season biodiversity baseline study, including camera trap surveys was undertaken for the T3 project site in 2017 and 2018. Therefore, information presented in this section includes the findings of the above-mentioned studies.

5.4.1 Vegetation

The Ghanzi District forms part of the Kalahari Acacia-Baikiaea savanna eco-region which is a variety of the vast savannah ecosystem covering much of Southern Africa. The Southern African Bushveld eco-region is well known for its abundance of large mammal species and rich birdlife but supports few endemic species.

5.4.1.1 Existing flora of the study area

A total of 63 plant species were identified within the region of the proposed works. This list consists of 28 woody (tree/shrub) species, 20 grasses and 15 forbs (refer to the Biodiversity report in Appendix D for vegetation communities' descriptions and breakdown in the proposed lease). None of the species encountered are of conservation concern (red data listed by IUCN) nor are any protected under Botswana law. It is important to note that the footprint of the proposed access road is within the boundaries of farms where livestock (cattle and goats) feed upon the under-canopy layers, and as such it is possible that the grass and forb layers could be under represented as they have been grazed back during the time of the site visits.

As mentioned above the biome of the greater region is *Terminalia Acacia* woodland/scrubland (Figure 5.28 (A & B)). The T3 site and the surrounding areas (including the footprint of the proposed access road) have greater abundances and densities of *Combretaceae* species, namely *Terminalia sericea, T. pruniodes, Combretum hereroense,* and *C. apiculatum* compared to the greater region. *Senegalia* and *Vachellia* species (*Senegalia mellifera*, *S. cinerea, Vachellia erioloba*, *V. tortilis* and *V. leuderitzii*) were also common throughout the site, though not as prevalent or dominant as in other areas near to the T3 site (for example T4 and T23 sites are dominated by *Senegalia/Vachellia* species). There are areas where the stands of *T. sericea, T. pruniodes* and *C. apiculatum* are so dense, creating mono-specific clusters, with very few other trees species growing amongst them, such is the dominance of the *Combretacea* in this region. There is a distinct paucity of larger tree species within this region, the largest trees (*C. imberbe* and *Ficus sycomorus*) were sporadically distributed and often located near depressions in the ground were ground water would be more easily accessible.

Below the *Combretacea/Mimosaceae* canopy layer there is a dense shrub layer that is primarily comprised of Grewia species (*G. flava, G. flavescens*, and *G. bicolour*) mixed with *Dichrostachys cinerea*, *Gymnosporia senegalensis* and *Rhigozum brevispinosum*. Some *Diospyros lycoides* and *Euclea divinornum* were also observed in the sub canopy layer, though they were not as common as the *Grewia* species (Figure 5.28(C)).

Interspersed amongst the thickets and tree stands, small patches of grasses were also observed. In these areas where the density of the woody species is reduced and the grass species (primarily *Stipagrostis uniplumis*, *Schmidtia kalahariensis*, *S. pappophoroidea*, and *Pogonarthria squarrosa*) have been able to proliferate and are thus more common. The forb diversity in these areas is relatively low when compared to the other floral groups. The most commonly observed forbs were *Vernonia glabra*, *Asparagus bechuanicus*, *Indigofera daleoides*, *Acrotome inflata*, and *Dicoma schinzii*.

Within the footprint of the proposed road, no exotic or invasive species were observed. However, with the exploration drilling sites within the T3 mine site, there were some clusters of *Verbecena enceloides* observed. This *V. enceloides* very common in disturbed areas and could easily spread to the proposed road footprint, as disturbance due to bush clearing could easily facilitate the establishment and proliferation of this weed. Therefore, it is imperative that the proposed site be monitored and if *V. enceloides* establishment occurs, then they can be removed before they gain any footholds within the area.

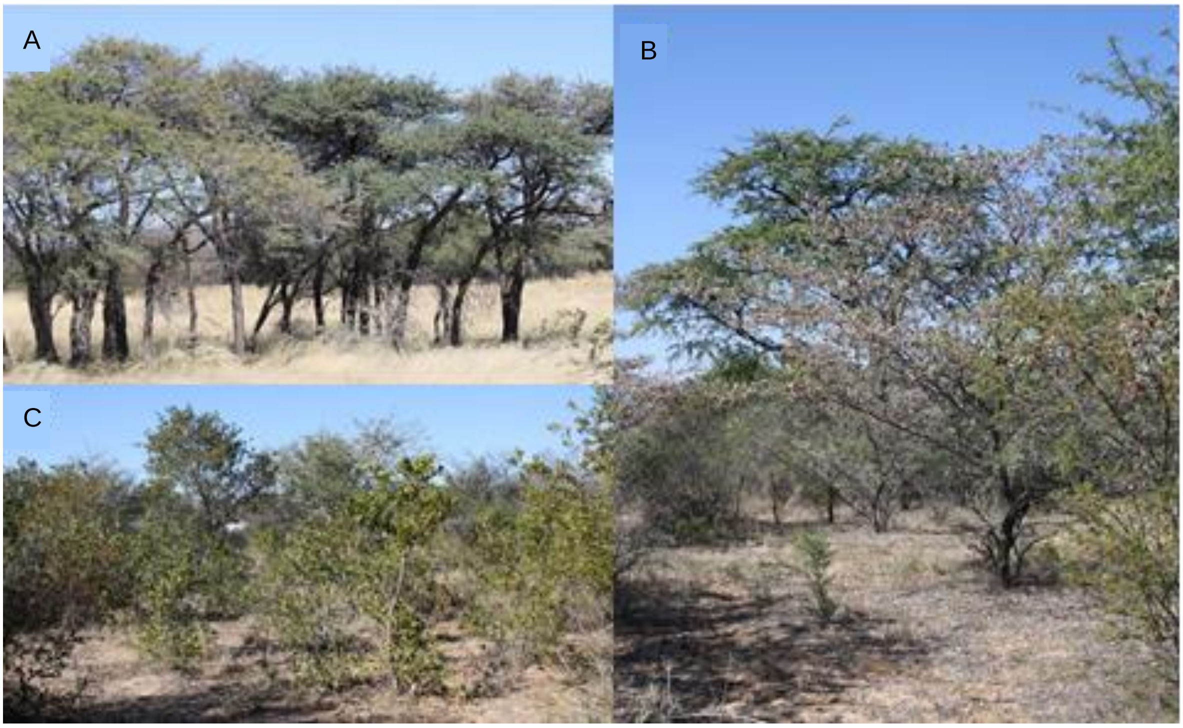


Figure 5.28: A) *Vachellia tortillis* B) Taller thicket stands C) Scrub thicket

5.4.1.2 Vegetation types

Following the classification of the three vegetation types, these were mapped within the N-153 farm boundary using remote telemetry. These are estimates of the vegetation types to determine how much of each vegetation type will be lost during the construction and operation of the T3 Copper Mine. Scrubland Savanna/ Thicket (SST) is the most common vegetation type covering 95.97% of the total farm area and 68.53% of the mine footprint. Grassland Savanna (GS) and Tree Savanna (TS) covered a significantly smaller area within the farm boundary (2.57% and 1.46% respectively) (Table 5.6). The boundaries between vegetation types are not always clear and thus this is an approximation of the area of each vegetation type. Within the farm boundary smaller areas of interest were then identified, these include the mine footprint, the areas of the mine pit and associated structures which is likely to be cleared of vegetation and any areas transformed by the current land use (including old fields and piosphere around the homestead).

As expected the SST was the most dominant vegetation type in all these areas. Of the 4,624 ha of SST, 49.63% is found within the mine footprint of which 13.58% falls within the area likely to be cleared during mine construction. Thus, depending on the extent of future vegetation clearance within the mine footprint, it is likely that between 13.58% and 49.63% of the total SST within the farm boundary will be cleared (Table 5.7). This equates to 47.62% of total vegetation on the farm. A further 12.89% of the total SST was found within transformed areas (Table 5.6). Here the vegetation has undergone some modification due to agricultural activity on the farm. These areas however, are unlikely to be impacted further by the current scope of mining activity that is proposed.

Grassland Savanna vegetation covered an estimated 124 ha within the farm boundary. This vegetation type was present in all these areas but at lower densities than SST. It was estimated that 55.32% of the total GS is located within the mine footprint of which 24.53% falls within the area that is likely to be cleared around the pit and mine infrastructure. Thus, depending on the extent of vegetation clearing within the mine footprint, it is likely that between 24.53% and 55.32% of the total GS within the farm boundary may be lost as a result of clearing (Table 5.6). This equated to 1.42% of total vegetation within the farm boundaries (Table 5.7). Several bands of GS are in close proximity to the mine footprint (the north eastern boundary) and it may be that larger areas of GS may be affected by mining activity outside the proposed footprint.

The Tree Savanna vegetation type was dominant around the homestead (transformed area) and only 3.5% of the total 70.4 ha occurred within the mine footprint (but within the buffer zone) (Table 5.6 and Table 5.7). Within the area likely to be cleared for the pit and other mine infrastructure this vegetation type was not present. Thus it is possible that there will be minimal or no loss of this vegetation types during mine construction and future vegetation clearance.

With 49.05% of the vegetation total vegetation on the farm falling within the overall T3 mine footprint it is likely that between 13.665% and 49.05% of the vegetation within the farm boundaries will be lost depending on the extent of vegetation clearing (Table 5.6).

Table 5.6: The areas and percentages of the three vegetation types identified within the 153-NL farm boundaries as well as within the T3 mine footprint and transformed areas

	Scrubland Savanna/ Thicket		Grassland Savanna		Tree Savanna		Total	
	Area (ha)	Percentage of total vegetation (%)	Area (ha)	Percentage of total vegetation (%)	Area (ha)	Percentage of total vegetation (%)	Total area (ha)	Total area of vegetation/ Total vegetation (%)
N-153 farm boundary (Total vegetation)	4624 ha	95.8 %	124 ha	2.6%	70 ha	1.5%	4818 ha	100
	Area (ha)	Area of SST/ Total Vegetation (%)	Area (ha)	Area of GS/ Total Vegetation (%)	Area (ha)	Area of TS/ Total Vegetation (%)	Total area (ha)	Total area of vegetation/ Total vegetation (%)
T3 mine footprint	2295 ha	47.6%	69 ha	1.4%	3 ha	0.1%	2367 ha	49.1
Mine pit and associated structures	628 ha	13.0%	30 ha	0.6%	0	0	658 ha	13.7
Transformed	621 ha	12.9%	25 ha	0.5%	66 ha	1.4%	712 ha	14.8

Table 5.7: The percentage of each vegetation type within the T3 mine footprint and transformed areas.

	SST within area/ Total SST (%)	GS within area/ Total SST (%)	TS within area/ Total SST (%)
T3 mine footprint	49.6%	55.3%	3.5%
Mine pit and associated structures	13.6%	24.5%	0
Transformed	13.6%	20.3%	93.8%

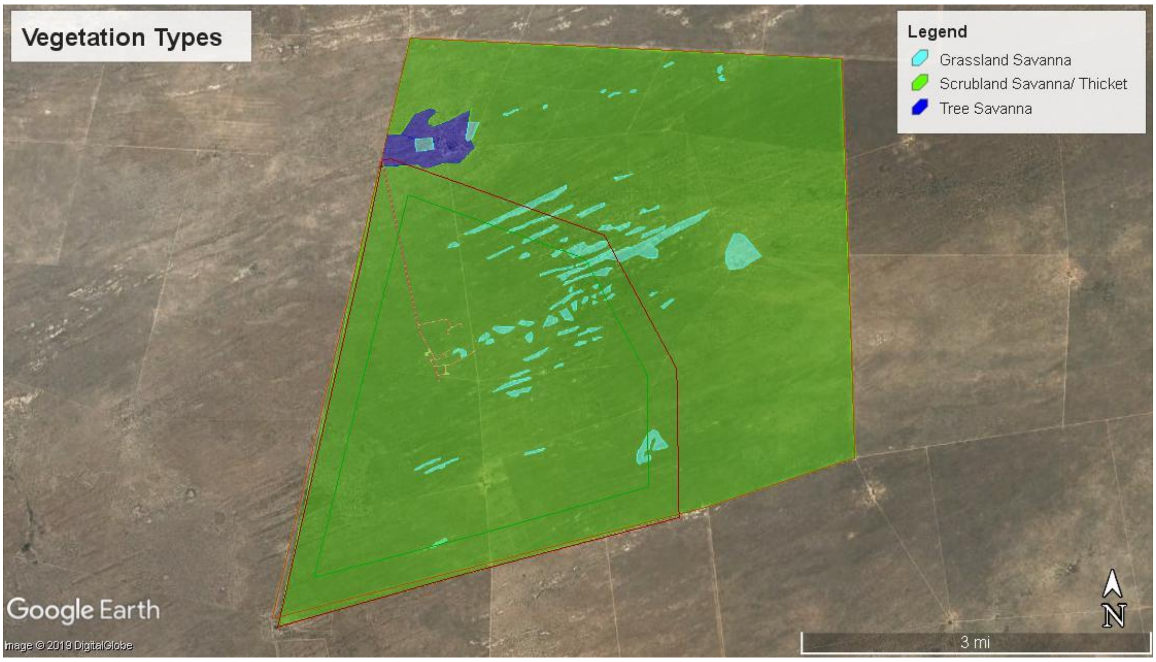


Figure 5.29: Three different vegetation types within the farm boundary and the mine footprint (outlined in red)

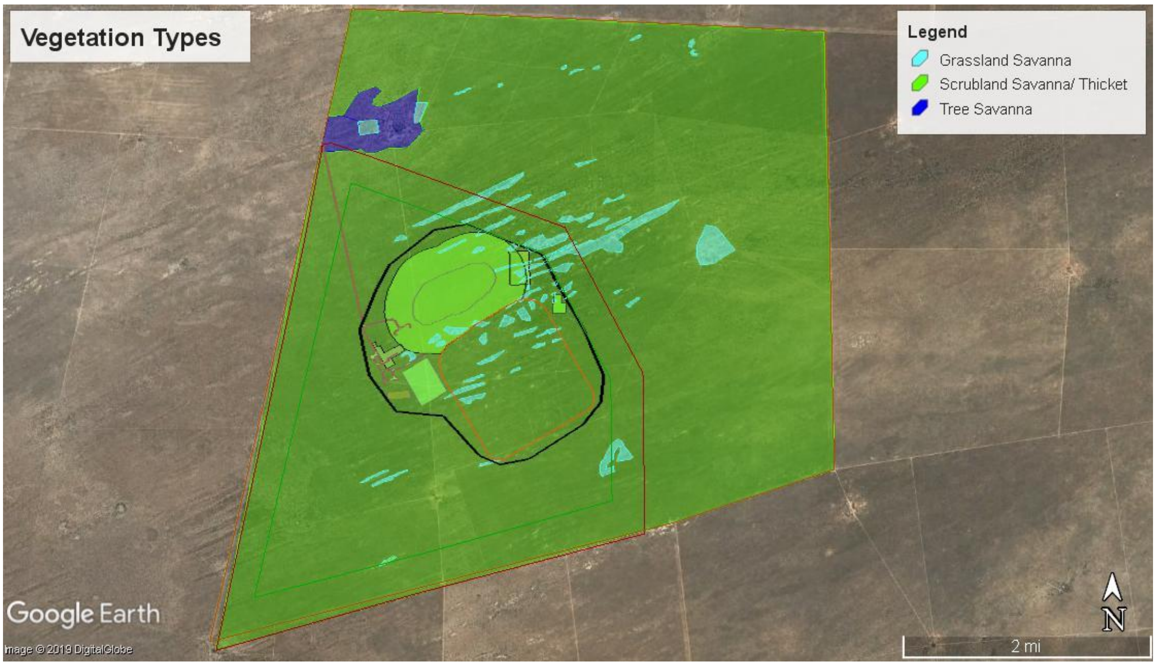


Figure 5.30: Three different vegetation types within the farm boundary, mine footprint (outlined in red) and the proposed site of the mine and associated infrastructure where vegetation will be cleared (outlined in black)

Figure 5.31: Three vegetation types within the farm boundary and within transformed area on the farm (outlined in black)

5.4.2 Fauna of the study area

Mammal species are under pressure throughout Africa due to loss of habitat and growing human populations. These factors have resulted in many mammals, especially larger species, being confined to protected areas. Botswana still has exceptionally high numbers of game but even here these animals are under increased pressure outside of conservation areas. The Ghanzi region supports a high diversity of mammalian species. The range distribution of as many as 76 mammal species fall within the Ghanzi area (see Appendix D). This is also partly due to the proximity of the Central Kalahari Game Reserve (CKGR) and movement of animals from and to the CKGR and surrounding areas. Animals moving into the neighbouring farmlands are often under threat, this is especially the case for large predators and animals that may be viewed as problematic. The most immediate threats posed to mammal species by the mining operation are conflict and persecution by project staff, and loss of habitat.

Through camera trapping observation during field surveys and consultations it has been confirmed that at least 30 species occur within the footprint of the proposed mine. With a further 46 species potentially occurring or frequenting the site. This includes 16 bat species. During the wet season camera trapping, 24 species were spotted and 24 species during the dry season, a total of 27 species were recorded (see Appendix D). The data analysis of the camera trapping is discussed in further detail in the Camera Trap Survey Reports from Cheetah Conservation Botswana (CCB). The presence of *Panthera leo* (Lion) and *Loxodonta africana* (African Elephant) was confirmed through consultations, although these animals very rarely frequent the area. One additional species, *Xerus inauris* (Ground Squirrel) was observed during a field survey.

5.4.2.1 Species of conservation concern

Most of these species (including species that could potentially occur or frequent the site) are rated as “Least Concern” (LC) or “Not Evaluated” (NE) by the IUCN nor are they protected in Botswana (refer to Appendix D for IUCN Status of each species). However, the following nine species are of conservation concern according to the IUCN red lists and are protected or partially protected under the Wildlife Conservation and National Parks Act of 1992 of Botswana:

- "Near Threatened" (NT) species - *Hyaena brunnea* (Brown Hyaena)
- "Vulnerable" (VU) species – *Smutsia temminckii* (Ground pangolin), *Panthera leo* (Lion), *Acinonyx jubatus* (Cheetah), *Panthera pardus* (Leopard), *Felis nigripes* (Small Spotted Cat), *Loxodonta africana* (African Elephant), *Giraffa camelopardalis* (Giraffe)
- "Endangered" (EN) species - *Lycaon pictus* (African Wild Dog).

In addition, the following seven species are protected or partially protected under the Wildlife Conservation and National Parks Act of 1992 of Botswana, but are rated as "Least Concern" according to IUCN data:

- Protected: *Galago moholi* (Southern Lesser Bushbaby), *Mellivora capensis* (Honey Badger), *Leptailurus serval* (Serval), *Proteles cristatus* (Aardwolf), *Orycteropus afer* (Aardvark), *Raphicerus campestris* (Steenbuck).
- Partially Protected: *Taurotragus oryx* (Eland).

It is imperative that all species that are of conservation concern be treated with care and that strict mitigation measure are put in place to assure their safety. Of concern are the carnivores that are prevalent in the region, within the project footprint 16 carnivorous species were observed with camera traps (Table 5.9) and the presence of one additional species (Lion) was confirmed via consultation. Occupancy of the protected carnivore species was very low according to the results from the camera trapping surveys. The high occurrence of large predators within the footprint could be due to the abundance of prey (antelope, other small mammals and often livestock). Predators are under pressure throughout Southern Africa with most of their populations showing a decreasing trend. Loss of habitat and human conflict are the biggest threats to these animals. Predators often move into farming land in search of prey which results in conflict with farmers, often leading to the extermination of the problem animal.

Some of the animals within the footprint of the project area which are of conservation concern are discussed below:

- **African wild dog:** These animals have wide ranging behaviour with home ranges as large as 300km^2. This makes them extremely sensitive to habitat fragmentation. These species are under threat from human encroachment on their territory, conflict with land owners, road accident and disease are the biggest threats to these species. They hunt medium sized antelope including Impala and Kudu, as well as smaller buck such as Duiker and Steenbok. Due to their large hunting ranges these animals often range outside the boundaries of protected areas (IUCN). Hunting packs from the CKGR have been known to occasionally move into the commercial farming areas west of the CKGR. This often leads to conflict between farmers and Wild Dogs (Fraser-Celin et.al, 2017). African Wild Dogs were recorded within the footprint once during the dry season survey. These animals are unlikely to frequent the site of the T3 access corridor or any of the mining operation sites but may move through the area.

  The disturbance and activity in the area is likely to deter these packs from returning to the T3 site. They are likely to venture elsewhere considering their hunting ranges are so large. The size of the site that will be fenced off and cleared is relatively small and thus the habitat alteration is unlikely to negatively affect these species. The biggest threat to these animals is conflict with project staff and road accidents due to increased traffic. As these species are not resident within the footprint the proposed operations will not have long term effects on their population if the correct mitigation measures are followed.

- **Brown Hyaena:** Brown Hyaenas are found in a wide variety of habitats, they are nocturnal and independent of water but do need vegetation cover. Primarily a scavenger, their impact on game and livestock populations is very small. They scavenge on other predator's kills and other carrion and rarely hunt larger prey but eat reptiles and fruit. They do well in non-protected areas suggesting they can tolerate land use change if food is still available. They often feed on leopard kills and are unfairly prosecuted by farmers as they very rarely hunt livestock but rather feed on remains. Human conflict is one of the biggest threats to Hyeana's as they are regarded as a problem animal (IUCN). In Western Botswana densities are higher on commercials farmlands used for livestock than for game ranching (Kent & Hill, 2013).

  These animals were recorded very often within the T3 footprint during the camera trap survey. Thus, there is a possibility that they may encounter workers or enter camps savaging for food when T3 is developed.

- **Cheetah:** Cheetahs occur in a wide range of habitats, they are wide ranging and have very low population's densities. This makes them vulnerable to habitat loss and fragmentation. Cheetahs can thrive in anthropologically altered landscapes if food is available hence they can be found outside of protected areas. These cheetahs are often threatened by farmers due to livestock theft. Cheetahs hunt medium sized prey including Impala, but also hunt ground dwelling birds and small mammals such as Hares. They have been known to hunt large antelope such as Eland and Kudu on rare occasions. Cheetahs were recorded a few times within the footprint, they probably move through this area in search of prey due to the high numbers of antelope. These animals are very shy and will likely avoid human interaction. With increased activity, they are likely to frequent the area less regularly or avoid the immediate area completely.

- **Leopard:** Leopards occur in a wide range of habitats but prefer to hunt in areas with cover. They generally prey on medium sized animals, but will hunt anything from birds, small mammals to antelope. They have also been known to prey on domestic animals and livestock. This often results in conflict with humans. Habitat fragmentation and conflict with land owners are the biggest threat to Leopards. These animals were recorded a few times within the project footprint, mainly during the dry season. The number of antelope and other possibly prey for Leopards are relatively high within the mining footprint. With increased activity they are likely to avoid the area as they are very reclusive animals.

- **Lion:** Lions occur in a wide range of habitats and will venture into farmlands to hunt but will not reside in these areas. They prefer to hunt medium to large antelope but will take down most prey ranging from mice to rhino and have been known to scavenge. Their populations are declining due to habitat loss and fragmentation and conflict with land owners. They were not recorded on the farm during the camera trap surveys, but it was established through consultation that they, very rarely, venture into the area to hunt. These animals are likely to avoid the area once the construction and operation of the mine starts.

A full list of mammal species that were observed within the footprint of the proposed project has been provided in Appendix D. The list is supplemented with species that could occur within the site, the likelihood of their occurrence is indicated. The family names are given in bold above the species names. The conservation status for each species is also indicated.

5.4.2.2 Reptile diversity

The distribution of 40 reptilian species fall within the development footprint (Appendix D), comprising of 22 snakes (*elapidae, viperdae, colubridae* and *boidae*), five lizards, five skinks, two chelonians, two geckos, one agama, one monitor lizard, one chameleon and one worm lizard species. None of the species that are potentially found in the area are protected under the Wildlife Conservation and National Parks Act of 1992 of Botswana. All reptile species are rated as either “LC” or “Not evaluated” (NE) by the IUCN red data lists.

Four reptile species were observed during field surveys, including the *Mabuya capensis* (Cape Skink), *Hemidactylus mabouia* (Tropical House Gecko), *Agama aculeate* (Ground Agama) and *Psammophylax tritaeniatus* (Striped Skaapsteker), as shown in Figure 5.32 below.

The proposed T3 access corridor is narrow strip of land, which has already been cleared to an extent due to the existing fence line and access track to T3 exploration and the farms. Thus, the habitat loss through activity in this area will not have a long-term impact on the reptile populations.

Figure 5.32: An *Agama aculeate* (Ground Agama) and *Psammophylax tritaenia* (Stripped Skaapsteker) observed during the field survey

5.4.2.3 Amphibian diversity

No amphibians were seen or heard during the field survey in the footprint of the T3 access corridor. However, the distribution of three frog species fall within the project footprint. None of the species that are potentially found in the area are protected under the Wildlife Conservation and National Parks Act of 1992 of Botswana. All reptile species are rated as either “LC” by the IUCN red data lists. The likelihood of encountering these species along the T3 access road during construction and operation is very low but will increase during the rainy season. These species will utilise the temporary water sources to breed. These water sources can include puddle or temporary pans. Care must be taken not to disturb these temporary water sources, and animals must not be harmed.

The likelihood of frog species occurring within the mining site is higher. There will be clean open water sources (during operation phase and possibly after closure) that will be utilised by these species. Frogs may also be attracted to the tailings dams as well, which is likely to kill any animals that enter, this however cannot be avoided. The frogs are likely to use clean water sources such as shallow pans to breed, thus the impact on their population would be marginal. Care must be taken to avoid contaminating any fresh water sources as this will have a significant negative impact on their populations.

5.4.2.4 Avifauna (vulture) diversity and occurrence within the T3 footprint

The preliminary baseline biodiversity survey conducted by Karunya Consultants determined that five species of vulture that are considered highly sensitive are likely to occur within the region of the proposed T3 site.

There are six species of vultures that are likely to occur within the region of the T3 site. However, five of these species are of high conservation concern, with two listed as "Endangered" and three listed as "Critically Endangered" according to the IUCN red data lists, these species are also protected in Botswana. A summary of each species is detailed in the following sections.

The species are listed as follows:

- White-backed Vulture (*Gyps africanus*) - Status: Critically Endangered (CR)
- Cape Vulture (*Gyps coprotheres*) - Status: Endangered (EN).
- Hooded Vulture (*Necrosyrtes monachus*) - Status: Critically Endangered (CR)
- White-headed Vulture (*Trigonoceps occipitalis*) - Status: Critically Endangered (CR)
- Lappet-faced Vulture (*Torgos tracheliotos*) - Status: Endangered (EN).

Current threats to these species are as follows:

- Unintentional poisoning: the use of poison baits targeted at mammalian carnivores which pose threats to livestock. Vultures are killed by feeding on the poison baits themselves or on the dead carnivores that ingested the bait first.
- Sentinel poisoning: the deliberate poisoning of carcasses of large mammals by poachers to reduce vulture activity in the area, to hide their areas of activity.
- Belief-based use: The vultures are sometimes used in traditional medicine (muthi) trade. They are caught and killed for their body-parts to be used as ingredients.
- Habitat loss and degradation: loss of suitable habitat (i.e. large trees of the correct species) for the vultures to roost in and raise chicks.
- Declining wild ungulate populations: declines in wild ungulates have caused shortages of available food for the vultures which eventually results in starvation.
- Electrocution and collisions with power infrastructure: Vultures have been known to collide with power infrastructure and be injured or killed by either through electrocution or from the collision itself. They can also be electrocuted if they attempt to land on power pylons.
- Nest harvesting or disturbance by humans: anthropogenic disturbance to nesting areas and the harvesting of chicks and eggs.
- Bush encroachment: proliferation of woody species causes reduced foraging ability in areas of a vultures range. The vulture's abilities to locate food may become impeded.
- Climate change: Increased climatic patterns can potentially cause range constrictions for more certain species e.g. some species of vulture breed at higher altitudes in cooler climates, raising temperatures may render certain breeding areas no longer viable.
- Bushmeat trade: In certain areas these vultures are killed and eaten by human (this particularly common in Western and Central Africa).

Figure 5.33 illustrates the movement of collared White-Backed Vultures throughout the study area, as provided by Raptors Botswana, a locally based NGO operating within the Ghanzi District (Karunya, 2017). As illustrated, vultures are quite active within the area and inhabit basically the whole Ghanzi Farm Block and its surroundings. Accordingly, the area presents a safe feeding ground and provides a strong population support for endangered species, not only for White Back Vultures.

An aerial survey was undertaken over the 153-NL farm footprint, and it was found that there are no vulture nests on the farm, which will be impacted by the mine footprint. The nearest vulture nest to the mine pit is located at approximately 7km distance. Details of the survey are available in Appendix D.

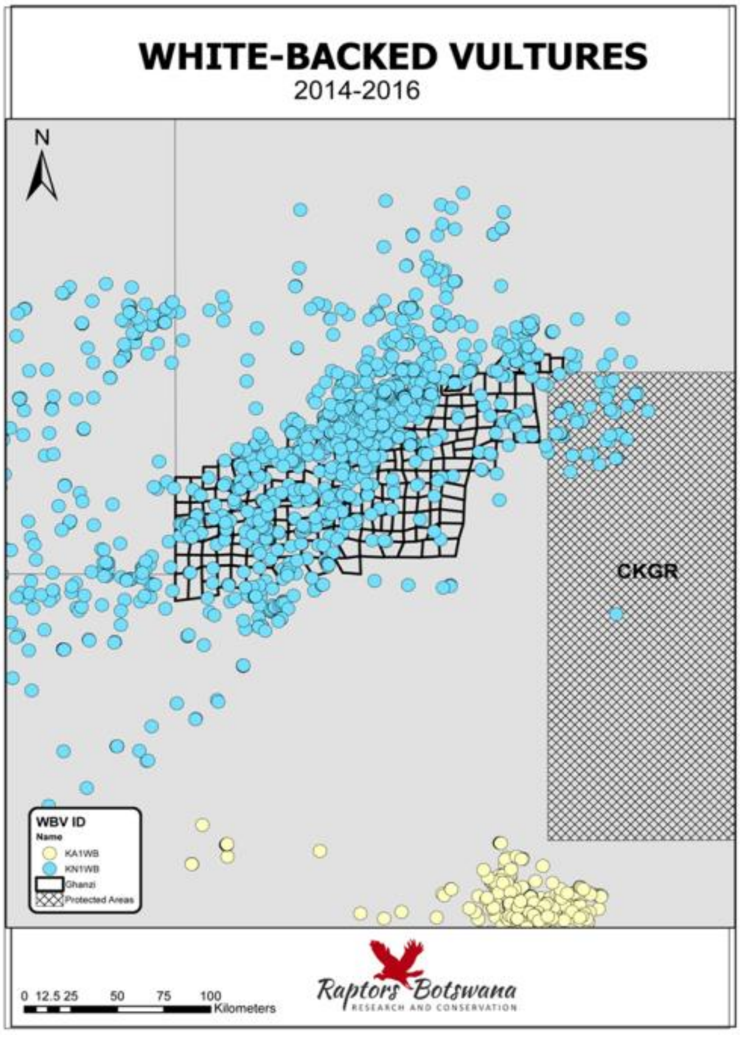


Figure 5.33: Representation of movement of two individual white-backed vultures in the area (Source: Karunya, 2017).

5.4.3 Areas of wildlife conservation importance

To avoid a loss of key wildlife areas and to develop wildlife in the rural economy of Botswana the Department of Wildlife and National Parks (DWNP) developed the concept of Wildlife Management Areas (WMAs) in the early 1980s. The areas of conservation importance proximate to the project site are discussed below. The footprint of the project is not within any of these areas.

5.4.3.1 Central Kalahari Game Reserve

The T3 project site is located approximately 45km from the western boundary of the CKGR. The game reserve is a vast wilderness, and the second largest game reserve in the world, covering 52,800 km². The reserve is bordered to the north by the Kuke veterinary cordon fence and to the south by the Khutse Game Reserve. The game reserve was established in 1971 to protect its series of pans, dry river valleys and game and was declared a UNESCO World Heritage Site in 2010. The CKGR is presently inhabited by traditional hunter gatherers belonging to the Basarwa (San) and Bakgalakgadi tribes, but there are no permanent human inhabitants in Khutse.

The CKGR is classified with a 1b IUCN Management Category (1), which acknowledges it as a large unmodified or slightly modified area that retains its natural character and influence, without permanent or significant human habitation. The management is geared to preserve the natural condition. This is the second highest classification and is equivalent to national park status. The CKGR is recognised as a Key Biodiversity Area (KBA) based on the IUCN guidelines.

The CKGR is home to vast wildlife populations, with important populations of giraffe, spotted hyena, brown hyena, honey badger, meerkat, yellow mongoose, warthog, cheetah, caracal, African wild dog, black-backed jackal, bat-eared fox, cape fox, leopard, lion, blue wildebeest, zebra, eland, gemsbok, springbok, steenbok, greater kudu, red hartebeest, aardvark, cape ground squirrel, cape hare and cape porcupine. The CKGR is recognised by Birdlife International as an Important Bird and Biodiversity Area (IBA code BW006). This IBA is recognised as it supports a substantial bird community typical of the Kalahari–Highveld biome. In addition, the reserves support on a seasonal basis, good numbers of visiting Lesser Kestrel (*Falco naumanni*), Pallid Harrier (*Circus macrourus*), Montagu's Harrier (*Circus pygargus*) and Black-winged Pratincole (*Glareola nordmanni*), as well as resident grassland species such as Ostrich (*Struthio camelus*) and Kori Bustard (*Ardeotis kori*) and regionally threatened or near-threatened birds of prey. Large numbers of Lesser Grey Shrike (*Lanius minor*) over-winter in this site.

The CKGR would qualify as a critical habitat under both the management category and the KBA status. IBAs are recognised as protected areas within the IFC Performance Standard 6, and support both the KBA classification critical habitat status.

5.4.3.2 Other gazetted protected areas

The Okavango Delta has been declared a World Heritage Site by UNESCO, and was the 1000th site to be awarded this status (located approximately 140 km from the T3 project site). The inscribed World Heritage property encompasses an area of 2,023,590 ha with a buffer zone in excess of 2,200,000ha. The Delta is one of very few large inland delta systems without an outlet to the sea, known as an endorheic delta, its waters drain instead into the desert sands of the Kalahari Basin. It is Africa’s third largest alluvial fan and the continent’s largest endorheic delta. Furthermore, it is in a near pristine state, being a largely untransformed wetland system. The ecological diversity has uniquely adapted their growth and reproductive behaviour, particularly the flooded grassland biota, to be timed with the arrival of floodwater in the dry, winter season of Botswana. Free roaming wildlife still moves between the Okavango Delta System and the Ghanzi Farm Block (GFB), and possibly into the CKGR, although several wildlife species are not common to both, such as elephant, zebra and sable antelope.

5.5 Socio-economic environment

Ghanzi District is characterised by a range of ethnic and cultural groups, which include the Bakgalagadi (comprising the Bashaga, Bangaloga, Bakgwatheng, and Babolaongwe), Batawana, Nama, Herero, Barolong, Afrikaners and English, among others.

The most diverse population group in Ghanzi District is the San, the most sizeable group of which is the Naro, followed by the Tsaokhoe and the X'ao-'aen (sometimes referred to as the Makaukau). The Naro tend to live in the north of the District including the freehold farms, and just south of the freehold farms (GDDP 7). The Tsaokhoe are also found on the farms, and in southern and central Ghanzi District. Gana and Gwi reside on some of the northern Ghanzi freehold farms and are also found in Kuke, Rooibrak, and New Xade.

In this section, a description of the baseline socio-economic environment in the broader affected area is provided, covering the Ghanzi District more broadly, and the Ghanzi township area, Kuke and D'kar villages more specifically.

5.5.1 Demography

Ghanzi District had a population of 43,095 during the 2011 census, of which 22,269 were males and 20,826 enumerated were females (Statistics Botswana, 2011). This indicates an increase of 1.49% compared to 2010 population estimates of 35,678. The District is sparsely settled, with the town of Ghanzi, as the only urban settlement in the District. Ghanzi township had a population of 14,809 persons during the 2011 census, while 1,159 persons lived in "localities with no affiliation", reflecting a dispersed population living on commercial freehold farms. The 2011 census also recorded 260 residents for Central Kalahari Game Reserve and its associated localities, comprised of 193 males and 67 females.

The population of the District is provided in Table 5.8 below, in comparison with the national population and other districts within the country.

Table 5.8: Population of Botswana by district and selected sub-districts (SB, 2011)

District	Males	Females	Total Population
National	989,128	1,035,776	2,024,904
Ghanzi	22,269	20,826	43,095
North West	73,593	78,691	124,712
Chobe	12,023	11,324	23,347
Barolong	26,683	28,148	54,831
Central Bobonong	34,251	37,685	71,936
Central Boteti	28,142	29,234	57,376
Central Mahalapye	57,543	61,332	118,875
Central Tutume	70,330	77,047	147,377
Kgalagadi North	10,352	10,124	20,476
Kgalagadi South	15,117	14,899	30,016
Kgatleng	44,580	47,080	91,660
Kweneng East	125,191	131,561	256,752
Kweneng West	24,407	23,390	47,797
North East	28,588	31,676	60,264
Ngwaketse	62,278	66,969	129,247
Ngwaketse West	6,873	6,816	13,689
Francistown City	48,124	50,837	98,961

District	Males	Females	Total Population
Gaborone City	113,580	118,012	231,592
Orapa Town	4,736	4,795	9,531
Selebi Phikwe	24,749	24,662	49,411
Serowe and Palapye	88,894	91,606	180,500
Sown Town	1,961	1,637	3,598
Lobatse Town	14,145	14,862	29,007
Jwaneng Town	9,831	8,177	18,008

The population in each of the Project affected areas is provided in the table below.

Table 5.9: Population of Project affected areas (SB, 2011)

Affected village	Population	Females	Males
Kuke	807	397	410
D'Kar	1,668	826	842
Ghanzi Township	14,809	7,247	7,562
Farms	5,114	2,109	3,005
CKGR and associated localities	260	67	193

5.5.2 Governance and administrative settings

The Republic of Botswana gained its independence in 1966 after eight decades as a British Protectorate. Rights are enshrined in a written Constitution, adopted at independence that has guided the nation for the past five decades. The first national election was held in 1965 with the advent of self-governance, and elections have been held every five years.

The Ministry of Local Government and Rural Development mobilises resources and transfers them to the local authorities. The mandate of the Ministry is to provide basic social services to both rural and urban areas. The Ministry serves as the central government's arm for local government matters and is the focal point for policy and operational matters at the local level. Its objective is to be a competitive, customer-focused centre of excellence in social service delivery, development coordination, community mobilisation and capacity building. At the local level, there are 16 Local Authorities. They are all under management of the Council Chief Executive Officer or Council Secretary/Town Clerk. The District Administration office, whose head is the District Commissioner, acts as the head of Central Government departments at the local level. The Ministry of Local Government implements other Ministries' policies and programmes through the District Commissioner. Another area well represented in districts is Tribal Administration, whose primary role is to enforce local order and customary law (see Ministry of Finance and Development Planning, 2009).

The administrative setting for Ghanzi District is similar to other District in Botswana (GDDP 7). It is managed by four local institutions, namely:

- District Council
- Tribal Administration
- Land Board
- Office of the District Commissioner.

These local institutions are all located in Ghanzi Township area and are described in the following sub-sections.

5.5.2.1 Ghanzi District Council

The District Council comprises elected representatives who have formal authority to make programmatic decision at the district level. The council has the power and the discretion to allocate resources in the district, though there is control from the Ministry of Local Government and Rural Development in the form of budget ceilings and funding of approved projects. There are government departments in the Districts that work with the Council on developmental issues. The policy decisions made by these departments are essentially at the ministerial level as they represent their respective ministries in the Districts. The Council carries out their statutory duties through a system of various standing committees. These include education, health, works, trade and licensing, and physical planning.

The Community Development Section of the Department of Social Welfare and Community Services focuses on working with Government institutions, specifically Village Development Committees (VDCs), but also with voluntary bodies such as Parent Teacher Associations, Village Extension Committees to mention but a few. VDCs co-ordinate village development activities.

5.5.2.2 Ghanzi Tribal Administration

The Department of Tribal Administration oversees Tribal Administration Services, Customary Courts Administration, and oversees recognised chiefs, sub-chiefs and headmen. Tribal Administration, and those falling under Tribal Administration, provides critical links between communities and government authorities. One of the core functions is to administer justice through the customary law system and to provide forum for public consultation for purposes of development.

5.5.2.3 Ghanzi Main Land Board

Land management is vested with the District Land Board. The main responsibility of the Land Board is to lease and allocate tribal land including open wells and boreholes. Some of the functions of the Land Board are:

- To allocate customary land right: This includes granting and cancelling rights of use, hearing appeals from Subordinate Land Boards, and placing restrictions or conditions on the use of tribal land. The Land Board also determines grazing areas in consultation with the District Council.
- To set aside land for common use in consultation with the District Council.
- To lease land: This includes granting and cancelling leases and granting permission for transfer of rights or change of use.
- To grant land in consultation with the District Council for stated purposes.
- The functions of the Sub Land Boards are to help the main Land Boards complete their functions. Specific duties comprise:
    - To allocate customary land. This includes, granting rights of use, hearing and approving applications for land for building residences or extensions to residences, ploughing lands, grazing areas and communal village land uses.

- To recommend cancellation of customary land rights and applications for boreholes and common law grants to the main Land Board.
- To hear and decide disputes regarding customary land rights in their areas.

5.5.2.4 Office of the District Commissioner Ghanzi

The objectives of the Office of the District Commissioner (ODC) are as follows:

- To provide co-leadership in district development planning and policy co-ordination and linkage between national and local level planning and development.
- To provide central government representation at the district and local levels and co-ordinate and monitor locally based central government departments and extension services.
- To undertake all relevant ceremonial and statutory responsibilities.
- To respond effectively to food relief needs as dictated by natural disasters and other circumstances.
- To ensure that District administration authorities are provided with adequate resources and administrative support services.

At the District level the ODC is headed by the District Commissioner (DC) who is charged with the responsibility of coordinating and supervising functions of sectoral ministries. The DC directly supervises officers whose departments and divisions are seconded to the DA, such as Lands, Social Benefits, Civil Registration, Accountant General (Revenue), Independent Electoral Commission, AIDS Coordinating Unit, and indirectly, Crop Production and Forestry, Immigration and Citizenship, National Registration, Library Services etc.

The main structure involved in strategic development issues within North West and Ghanzi Districts are the District Development Committees, chaired by the District Commissioner and membership covering central government officers in the districts, tribal administration, land boards, council chief executives, non-governmental organisations, and the private sector.

5.5.3 Settlement

Ghanzi District is situated in the western part of Botswana. It measures 117,910km^2. The District is bordered by North West District to the north, Central District in the east and Kgalagadi and Kweneng Districts to the south. To the west, it is bordered by Namibia. Charleshill measures only 9,600km^2 and it is the only sub–district (GDDP 6, 2009).

Tribal Land accounts for 40.49% (47,744km^2) of the total area, state land for 50.63% (59,686km^2) and freehold land for 8.88% (10,480km^2). The Central Kalahari Game Reserve comprises 44.36% (52,313km^2) of the total area. Together with the Khutse Game Reserve, it forms the largest Game Reserve complex in Botswana and the third largest in the world.

The most striking topographical feature in the district is the Ghanzi Ridge. The ridge crosses the district from the north (Kuke) to the west (Mamuno), over approximately 300 kilometres. The ridge contains the most productive land in the District, due to its high water potential and moderate quality soils. The bulk of the land along the ridge is freehold land. Many commercial farming enterprises (ranches) are found along the ridge. Most of the population of the district is located along the ridge, with major population centres being the Ghanzi Township and the villages of Charles Hill, Karakubis, Kalkfontein, and D'kar.

Approximately 45% of the District's population is composed of Remote Area Dwellers (RADs). In the absence of economically viable arable and industrial potential the majority of the RADs live on marginal benefits from a combination of activities: subsistence hunting and gathering, government handouts, casual labour, craft production, and small stock production (GDDP 6, 2009).

5.5.3.1 Settlement patterns

Ghanzi Township is the district centre and administrative capital. The township is a primary centre with all basic services and businesses of a higher order. Because of the high level of services and employment offered, the township experiences an influx of young people seeking employment and educational opportunities. The demand for plots and services in Ghanzi Township is very high. The lack of plots combined with an increase in population is leading to an increase in self- allocation (squatting) and in the number of people per plot.

Three villages (Charleshill, Kalkfontein, and Ncojane) rank second, as sub-centres, with smaller settlements in their catchment area (Karakubis, Makunda, Kole, Metsimantle, and Metsimantsho). All three villages, but especially Kalkfontein and Charles Hill, are expected to have an increase in investment (and development) as access has been improved with completion of the Trans Kalahari Road and the Maun-Ghanzi Road, linking the district with Namibia, Maun and the eastern part of the country, and once services like the telephone are fully connected.

The District has several RAD Settlements: Xade, Grootlaagte, Qabo, New Xanagas, West Hanahai, East Hanahai, Bere, Kacgae, and Chobokwane (GDDP 6, 2009).

5.5.4 Ethnic Background

The population of Botswana is characterised by several ethnic groups consisting of Tswana speaking people (79%), Kalanga people (11%), and Basarwa people (or Bushmen) (3%) (Nyati-Ramahobo, 2015). Other ethnic groups make up 7% of the national population and include Basubiya, Bayei and Hambukushu. Collectively all these ethnic groups are called 'Batswana' or people of Botswana.

Bangwato, Bakwena and Bangwaketse are regarded as the dominant ethnic gropus and take their names from Ngwato, Kwena and Ngwaketse, who are believed to be King Mogale's great-grandchildren (SIAPAC, 2014). Although friction and fighting were common among these groups, they always remained one people through language and culture and they always combined their forces against a common enemy. When they migrated north from Mogale's Kingdom, the Bangwato went further north to occupy what is now the Central District whose capital is Serowe. The Bangwaketse first settled south of present-day Mochudi before ultimately settling in Kanye, the current Administrative centre of the Southern District. The Bakwena remained at Dithejwane and later established their own capital at Molepolole. Other Tswana clans that migrated into Botswana much later or broke away from the Ngwato, Kwena and Ngwaketse clans include Bakgatla, Barolong, Batawana, Balete and Bahurutshe.

5.5.4.1 Ethnic inequalities

The United Nation Development Program notes that extreme inequalities weaken political legitimacy and corrode institutions (UNDP, 2010). Inequality in income and capabilities often reflect inequality in political power.

After independence, the goal of Botswana government was to assimilate all ethnic groups into the Tswana culture and create a mono-ethnic state, a model found in most British colonies (Nyathi-Ramahobo, 2013). In contrast to the above statement, the Tswana speaking people have dealt with the issue of non-Tswana ethnic identity by framing it in negative terms. This is evident in Setswana language in which the prefix ma-, is used to refer to non-Tswana tribes, and is derogatory (Nyathi-Ramahobo, 2013). Furthermore, the adopted Botswana's language policy provides another mechanism for reinforcing Tswana hegemony over other ethnic groups. Only English and Setswana are country's official languages, and none of the other 26 languages are used in official communications such as in schools, state media to mention but a few. In addition, there are instances where Tswana-speaking public officers such as nurses, teachers and the police officers are deployed to non-Tswana speaking villages. These officers often use Setswana to communicate with host communities and often apply Tswana customs in the deliverance of their services.

When analysing representation to Botswana Parliament throughout the post-independence period, Selolwane (2004) states that the Parliament is consistent with many other areas of Botswana's structure of power where the minority ethnic groups were initially represented by the dominant ethnic Tswana groups, under whose jurisdiction they had been subjected during colonial times. Minority ethnic groups only began having representation in the Parliament after an increase in number of members. The ethnic group with the biggest share of parliamentary seats has always been the Ngwato (Seolwane, 2004).

According to a newspaper article (www.mmegionline.bw), ethnic inequality is evident in ownership of land in urban areas, access to better education, as well as employment status in formal sectors. In Botswana, main hospitals, senior secondary schools and government departments are concentrated in the Southern part of the country within a 50km radius of the capital, Gaborone (Nyathi-Ramahobo, 2013). Other parts of the country, including minority dominated areas often lack critical services. For instance, there is only one hospital in the North West District which has a population of 124,712 residents (SB, 2011).

5.5.4.2 Indigenous groups

3.3% of the population identifies as belonging to indigenous groups, including the Basarwa who, in July 2015, numbered some 62,500. The Basarwa are not recognised in Botswana as indigenous groups, as all citizens are indigenous to Botswana, and therefore there are no specific laws on indigenous peoples' rights in the country nor is the concept of indigenous peoples included in the Botswana Constitution.

The Basarwa, due to the constitution, are therefore not seen or treated any differently from the other citizens of Botswana, however, they have limited political representation and leadership roles in both private and government sectors. While some communities have democratically-elected San headmen/ headwomen, numerous remote area settlements with San majorities lack San representational leaders (IWGIA, 2016).

The Basarwa are plagued with the social problems associated with many other indigenous groups found in other parts of the world, such as alcoholism, teenage pregnancies, and large families. Due to their nomadic nature, many Basarwa do not finish school and therefore literacy levels are low in this group. The Basarwa do not stay in employment for long periods due to their nomadic and free spirit nature (Karunya, 2016).

5.5.4.3 Cultural diversity and ethnicity of the study area

The most diverse population group in Ghanzi District is the San, the most sizeable group of which is the Naro, followed by the Tsaokhoe and the =X'ao-//'aen (sometimes referred to as the Makaukau). The Naro tend to live in the north of the District including the freehold farms, and just south of the freehold farms. The Tsaokhoe are also found on the farms, and in southern and central Ghanzi District. Gana and Gui reside on some of the northern Ghanzi freehold farms and are also found in Kuke, Rooibrak, and New Xade. In the CKGR, the San groups are as follows, including alternative naming conventions as applicable: Kua, Gui (Dcui), Gana (Dxana), Tsila, Tchua (Hua), Qaa, Ts'aokhoe, Golokhoe, Xoo, and Bakgalagadi (comprised of five main groups: Bakgwatheng, Babolaongwe, Bangologa, Baphaleng, and Bashaga).

5.5.5 Education

The District Council is mandated with provision and coordination of primary education with the Ministry of Education and Skills Development managing Community Junior Secondary Schools (CJSSs) and Senior Secondary Schools (GDDP 7, 2009). Ghanzi District has 15 pre-schools, 23 primary schools, four junior secondary schools, one senior secondary school and one private English-medium school. In 2014, there were a total of 3,547 pupils attending secondary education in Ghanzi District in 2014, of which 1,662 were males and 1,885 were females (SB, 2014). 142 students dropped out of secondary schools, of which 57 were boys and 75 were girls. According to the report, many young girls dropped out of school due to teenage pregnancy. 843 cases of teenage pregnancy were recorded nationwide in 2014, affecting most form five students.

The following subsections provide detailed information about the District educational facilities and enrolment.

5.5.5.1 Day care centres and pre-schools

There is a shortage of day care centres and pre-schools in Ghanzi. However, the government's initiative of establishing pre-schools in all primary schools as a way of promoting early childhood development and easy succession to primary education has improved the situation.

5.5.5.2 Primary schools

In 2014 Ghanzi District contained 22 primary schools and 232 classrooms with a total of 245 teachers teaching 5918 pupils. Pupil/teacher ratio was 25.8 compared to the national ratio of 25.1 (MoESD, 2017). While nationwide 1.2% of all primary school teachers were untrained; this was lower in Ghanzi District, at 0.7%. Kuke has one primary school with 337 pupils and 13 teachers, the pupil/teacher ratio was 26:1, which is above the national average of 25:1. Table 5.10 shows the primary school facilities within the District.

Table 5.10: Primary school facilities (Source: MoESD, 2017)

School	Enrolment	Number Teachers	No. of Classrooms	Teacher Pupil ratio	Classroom/pupil ratio
Ghanzi	757	24	22	1:34	1:34
Kabake	590	20	22	1:30	1:27
Kgaphamadi	390	14	12	1:30	1:33
Bere	78	7	7	1:11	1:11
Kacgae	137	8	7	1:19	1:19
East Hanahai	126	7	7	1:18	1:18

School	Enrolment	Number Teachers	No. of Classrooms	Teacher Pupil ratio	Classroom/pupil ratio
West Hanahai	99	7	7	1:14	1:14
New Xade	273	11	10	1:27	1:27
Dekar	533	16	9	1:35	1:59
Kuke	358	12	12	1:33	1:33
Choblkwane	96	8	8	1:12	1:12
Kalkfontein	269	11	14	1:24	1:19
Karakubis	196	8	9	1:26	1:22
Xanagas	329	12	10	1:27	1:32
New Xanagas	138	7	7	1:20	1:20
Boipelo	370	18	17	1:22	1:22
Makunda	191	8	8	1:27	1:24
Kole	167	8	8	1:24	1:24
Ncojane	365	15	14	1:26	1:24
Metsimantsho	129	9	8	1:16	1:16
Grootlaagte	177	8	7	1:25	1:25
Qabo	150	7	7	1:21	1:21
Totals	5918	245	232		

5.5.5.3 Secondary schools

There are four (4) secondary schools and a senior secondary school in the Ghanzi District. When compared with primary schools, community junior secondary schools have not experienced congestion as enrolments are still low in some schools. Table 5.11 shows secondary school facilities within the District. The senior secondary school by far is the only one that has reached its capacity as it admits children from other districts as well.

Table 5.11: Secondary school facilities (Source: MoESD, 2017)

School	Enrolment	Class rooms	No. of teachers	Teacher/ pupil ratio	Classroom/ pupil ratio
Itekeng CJSS	822	18	47	1:18	1:46
Tshimologo	199	8	19	1:10	1:24
Rethuseng	350	6	25	1:14	1:58
Marakanelo	260	8	19	1:13	1:32
Ghanzi senior	1 249	24	77	1:16	1:52

5.5.6 Health

The health sector continues to experience problem of manpower shortage in health officers. Most of the health facilities in the District were under-staffed and some run by Family Welfare Educators. This made it difficult to effectively implement policies and programmes. Attempts were made to fill vacant posts but without success because people declined transfers including new appointments to the District (probably because of its remoteness) as well as the low output from the training institutions.

The residents of the District are serviced by health posts, clinics and a primary hospital. The Ghanzi primary hospital was recently upgraded from a 50-bed to a 70-bed capacity with associated facilities and 26 houses.

Health facilities in Ghanzi District include:

- Ghanzi Primary hospital

- 3 major clinics in New Xade, Marama and Ghanzi
- 10 health posts
- 3 private general practitioners
- 2 dentistry's.

5.5.6.1 HIV and AIDS prevalence

HIV/AIDS is the biggest health challenge in the study area and indeed Botswana. The impact of HIV/AIDS in the country has been extensive, ranging from reduced life expectancy and reduced population growth to an increased number of child orphans.

The location of Ghanzi along the A3 highway is an added risk, the town being a stoppage point for long distance truck drivers, a group often associated with high risk sex behaviour and high rates of HIV and STIs. Gender inequalities and vulnerabilities increase women's risk for transmission. Young girls are particularly vulnerable, evidenced by the higher rates of HIV among females than males. The Project has the potential to exacerbate the HIV/AIDS and STI situation through influx of transient workforce (mostly men), increased disposable income, mobility and mixing of people: all with a risk of promoting higher risk sexual behaviour.

The Ghanzi District Annual Report for 2017 describes the HIV prevalence among pregnant women as decreasing from 17.4% in 2015 to 13.0% in 2016 then increasing to 15.7% in 2017. These figures are slightly below those reported with the rest of Botswana (see above). The same report mentions that partner testing (for pregnant women found to be HIV positive) remains low – at 16.3% (11% in 2015 and 17% in 2016). This low figure of partner testing could be considered a reflection of continued stigma in the community.

The Botswana Prevention of mother-to-child transmission (PMTCT) is perhaps one of the best in the world, with the Ghanzi report recording a mother-to-child transmission rate of 0.57% in 2017. There has been no recent formal HIV prevalence study done at Kuke and D'Kar however the HIV prevalence may be estimated from the numbers on antiretroviral (ART) treatment, as shown in Table 5.12.

Table 5.12: Population of D'kar and Kuke on antiretroviral treatment

	D'Kar	Kuke
Population	1668	870
No on ARV	250	270
Crude HIV prevalence	15%	31%

The above table refers to the total population of D'Kar and Kuke if age specific incidence rates were calculated the figures would be much higher amongst adults.

Antenatal statistics at Kuke Health Post also provide insight into HIV prevalence. Of the 81 antenatal clinic visits in 2017, 18 pregnant women were HIV positive (22%). Up until May 2018 there have been 28 new pregnant women of whom 3 tested positive for HIV (11%).

The District AIDS Coordinator Office in Ghanzi will be able to assist the Projects efforts in mitigating effects of HIV/AIDS related issues associated with project activities. The office has been set-up within the Office of the District Commissioner, mandated to plan, coordinate, and implement AIDS related activities for the District with assistance from District Multi-Sectoral AIDS Committee (DMSAC).

5.5.6.2 Challenges faced by organizations dealing with HIV and AIDS

Despite Botswana being one of the first countries in Sub-Saharan Africa to provide anti-retroviral drugs through the public health sector to its citizenry, the implementation of the ARV programme has not been without its setbacks. Some of the challenges in the North West and Ghanzi Districts are caused by a variety of factors ranging from the geographical location, socio-cultural issues and a whole array of other factors. The dominant factor posing a challenge for implementation of HIV and AIDS programmes in the districts emanates from their geographical location (NACA, 2013). The districts are located approximately 600km to 800km from Gaborone, which is the hub of economic activity and social development. This has greatly contributed to the slow progress in the devolution of development projects in that part of the country. The districts lack adequate resources to assist in dissemination of correct information into areas difficult to access and the information needs to be similar to that disseminated by hospitals and clinics. This requires more innovative education approaches for communities in remote areas of the districts and moving away from 'the one size fits all type of messages' like the common Abstain, Be faithful, Condoms (ABC).

Some cultural practices and religious belief systems could impair understanding of HIV and AIDS prevention messages like the common refusal of men to use condoms. Taking traditional medicine while one is on ARVs has also been known to destroy the efficacy of ART (NACA, 2016).

During the construction and operational activities of the proposed development, there is likelihood of in-migration to the study area by potential employees, which will promote sexual interaction of construction workers with local residents. This may result in transmission of sexual diseases and increased HIV prevalence rate at the study area.

The presence of the District AIDS Coordinator Office in Ghanzi Township may assist the project contractor's attempt in mitigating effects of HIV/AIDS related issues associated with the project activities. The office has been set-up within the Office of the District Commissioner, mandated to plan, coordinate, and implements AIDS related activities for each district with assistance from District Multi-Sectoral AIDS Committees (DMSAC). The office help plan and facilitate activities which educate, encourage and advocate for healthy living, HIV/AIDS, prevention, reducing stigma, and living with HIV.

5.5.6.3 Tuberculosis (TB) rates

In 2017 there were 175 new TB cases diagnosed in the Ghanzi District, 3 were multidrug resistant (MDR) and 2 pre-extensively drug resistant (XDR). The population of Ghanzi District is estimated to be 43 355 (2011 census) which gives a crude TB incidence rate for Ghanzi District of 415 per 100 000 population, this is above the Botswana incidence rate of 326 (252 – 410) per 100 000 reported in the WHO Global TB Report (2017).

Kuke Health Post currently has 13 clients on TB treatment (3 are MDR) and D'Kar has 18. TB treatment is usually for 6 months, so the crude incidence of TB at these 2 villagers could be as high as 1079 per 100 000 for D'Kar and 1641 per 100 000 for Kuke. To put this into perspective, there are currently 250 clients on ART treatment at the D'Kar Health Post and 270 at Kuke. As mentioned previously the risk of TB is markedly increased by HIV (up to 32 times) – this risk may be reduced through HIV treatment with ART (to about 4 times).

TB at Kuke and D'Kar is usually diagnosed by collecting sputa at the Health Post and referring this to Ghanzi Primary Hospital for Gene Xpert testing.

5.5.6.4 Malaria

During the last rainy season (October 2017 to May 2018) there were 60 cases of malaria reported in the Maun District and 25 in Ghanzi District. The Health Post at Kuke diagnosed 6 new cases in 2017 – all were from outside the Ghanzi District, most from Ngamiland. DKar Health Post did not see any malaria cases. The risk of malaria in Ghanzi and on the project site is extremely low but many staff will travel to work/home through Maun, so malaria remains an important health risk – especially for Botswana residents who live in areas of low malaria risk and expatriates from low/zero risk countries.

Figure 5.34 illustrates malaria hotspots in Botswana.

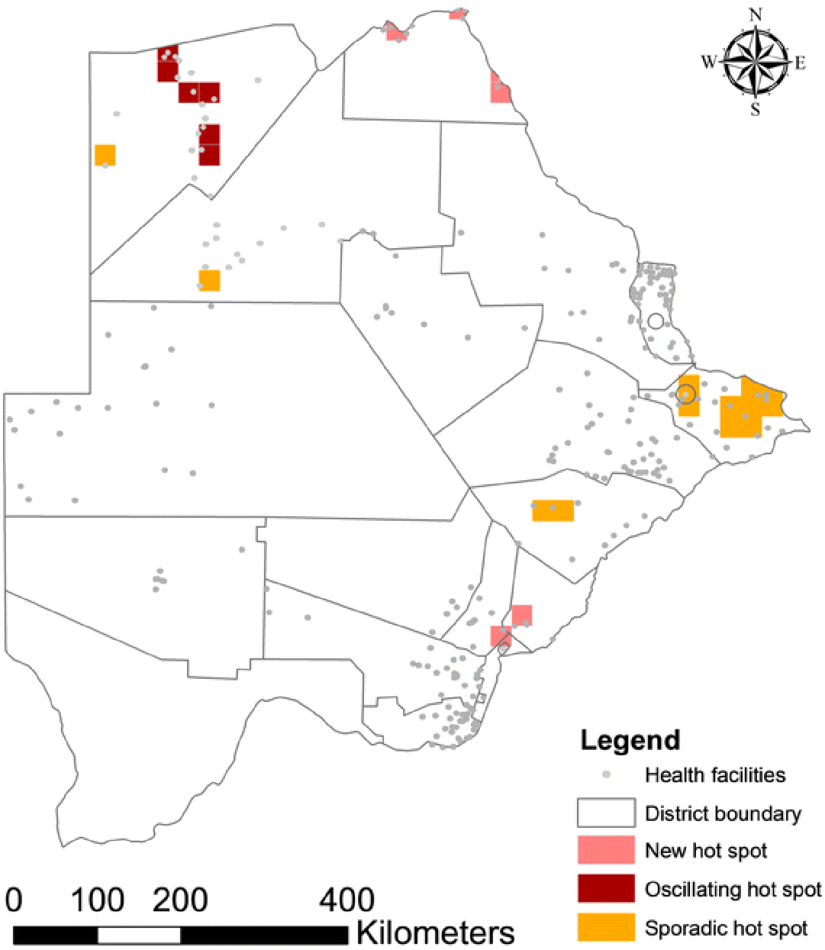


Figure 5.34: Malaria hot spots in Botswana (Source: biomedcentral.com, 2016).

Malaria rates are quite high in North West District, representing one-third of all outpatient diagnoses in 2009 in the District. Indeed, this was the most common diagnosis in the District, followed by diarrhoea and pneumonia. Overall, one-in-six cases of malaria in Botswana were found in North West District in 2009 (SB, 2012).

5.5.7 Economic activity

The livestock sector continues to be the main economic activity in the district. It provides the most important source of income for Ghanzi residents, ranging from profitable cattle sales to marginal casual labour. With the newly demarcated Matlhoaphuduhudu commercial ranches, this sector is expected to grow even bigger. The District cattle herd has grown over the last 40 years. In 1955 the herd accounted for 55,397, in 1965 it was 79,432, while in 1973 it was 145,000. The numbers continued to increase such that there were 136,336 and 165,000 cattle in 1985 and 1995 respectively. Most of these additions were in the communal area. Only a minority of the household's own cattle, but small stock ownership is more widespread. According to the Annual Agricultural Survey report (2014), the District recorded 77,380 cattle in 2014. Majority of the cattle are cross breed, making up 48,827 cattle followed by Tswana breed with a population of 24,645 and exotic breed at 3,908 cattle.

Although the district has deep to very deep sandy soils, which are excessively drained with a course surface texture and climatic conditions are very unfavourable for arable farming, farmers continue to plough and plant different crops like sorghum, maize, millet and cowpeas. Subsistence arable farming is not practiced as pastoral farming. Ploughing fields located in the area are seasonally cultivated and some are fallow. Ploughing fields in the area are seasonally ploughed because crop farmers rely on seasonal rains (rain-fed cultivation).

The commercial and industrial activity in the District is limited. The major problem is lack of raw materials and markets. The remoteness of the district and paucity of resources upon which industrial development can be based, leaves the district with a negligible industrial sector, especially in medium and large- scale projects. Small-scale industrial projects are limited to brick moulding, skin tanning, and leather production and dress making.

Except for some tourism activities in game farms and in the Central Kalahari Game Reserve, there is hardly any commercial tourism activity within the District. Some private operators do include the District in their tour itinerary, but no infrastructure exists for this purpose. The only places that attract tourists are establishments such as Kalahari Arms Hotel, Ghanzi Craft, Tautona Lodge, Thakadu Camp, Palm Afrique and the Ghanzi Grand Guest House. It is believed that the increase in the number of tourism attraction areas has been attributed to the completion of the Ghanzi-Sehithwa road and the Trans-Kalahari highway during DDP 5 (GDDP 6, 2009).

5.5.8 Poverty incidence and unemployment

According to the Botswana Core Welfare Indicators Survey report (2015) by Statistics Botswana, poverty incidence at Ghanzi District is estimated at 0.301%. Accordingly, females are more affected than their male counterparts as they have less access to employment opportunities, productive resources as well as education and training opportunities. The Drought Relief Program (Ipelegeng) plays an important role in the livelihoods of the local communities, particularly for women who are not participating in the formal employment sectors. The Village Development Committees (VDCs) are involved in the management of the program on behalf of the District Council.

Detailed information on poverty rates of the affected areas is included in the table that follows.

Table 5.13: Estimated poverty rates at the project affected areas

Village	Population	Poverty rate (%)	Number of poor	Proportion of poor in the village (%)
Ghanzi	12,999	0.222	2,886	0.008

Village	Population	Poverty rate (%)	Number of poor	Proportion of poor in the village (%)
D'Kar	1,456	0.593	863	0.002
Kuke	1.032	0.269	278	0.001

Unemployment is very high in Ghanzi District and this may be because there is only a limited amount of jobs available in the agricultural sector. During the survey, the highest unemployment rates were recorded among the male population in Kuke village, followed by D'kar village. It was also noted during the survey that majority of the locals lack skills, which has resulted in few of them securing formal employment. Majority of the residents are noted to be employed in the agricultural sector, farming operations, followed by formal employment in government offices and in retail sectors.

During the SIA survey, it was noted that out of the 278 households consulted, only 84 households noted that they have some construction-related experience. Majority of the skills noted included thatching, carpentry, driving, bricklaying, roofing and brick making. Of these 84 households, 36 noted that they have received training. A total of 74 households had a member who has worked in a mining sector before with common experience comprising driving, operating heavy machinery and mining. 33 households noted that they have received specific training in this regard. This highlights limited skills availability for both construction and mining operations among some households in the community, and requirement for skills development among others.

5.5.9 Economic vulnerability of women

According to the 2011 Household Income and Expenditure Survey, women in Botswana are often not employed in the formal sector, are over-represented in marginal employment sectors, and rely mostly on unpaid work (Statistics Botswana, 2014). Accordingly, this employment inequality leaves both women and female-headed households more at risk for poverty and economic marginalization than men and male headed-households. The survey states that 46% of female headed households compared with 27% of male ones were living in poverty. In a list of economic activities surveyed, male headed households were more likely to be engaged in a broader range of them than female headed ones. Males are also more likely to have higher levels of education than females in Botswana. More males than females finished secondary and university education. In summary, relative to men, women are less employed, less highly educated and less economically active.

Detailed information on the skills, experience, current employment status of the enumerated populations is provided in Appendix L.

5.5.10 District development strategy

As with other districts, Ghanzi District uses the growth centre strategy. The strategy advocates for an increased investment of social and economic infrastructure in the other centres of Ghanzi, Charleshill, Kalkfontein and Ncojane. The likely benefits to accrue from such investment concentration is expected to reach the smaller surrounding villages in terms of backward and forward linkages such as employment and market opportunities.

5.5.10.1 Ghanzi

Ghanzi town is the administrative centre of the District. It contains the highest order of services and caters for the entire district as well as the commercial farm areas. There is a primary hospital, medical clinics, an airport, commercial banks such as Barclays Bank, FNB Bank and Bank Gaborone, a number retail outlet (such as Spar, Choppies, JB Sports and Pep), primary, community junior school, a senior secondary school and a vocational training centre (Loci, 2012).

5.5.10.2 D'kar

D'kar is small village north of Ghanzi along the A3 road to Maun. It is home to a large community of Ncoakhoe San who operate an art gallery, cultural centre and wildlife ranch. The ranch is run under the auspices of the Kuru Family of Organisations (www.kuru.co.bw), an affiliated group of NGOs working towards the empowerment of the indigenous peoples of Southern Africa. It has a population of about 1,668 persons as per the 2011 population and housing census. A primary school has been built at D'kar for early education. This is a boarding school to allow for children from remote areas.

5.5.10.3 Kuke

Kuke has been established around a quarantine camp which controls the movement of animal diseases from the North West District into the Ghanzi District. The NWD is an area endowed with tourism while the Ghanzi District is an area endowed with large scale cattle farming. The government established this camp and as years went by people from neighbouring localities migrated to the area hence the population record of 833 during the 2011 national population and housing census (CSO, 2012). The residents of Kuke receive medical treatment through a health post which has been established within the camp. Serious cases are referred to the Ghanzi primary hospital.

5.5.11 Land management and land use

The Ghanzi Land Board is responsible for allocating land for various land uses. There are three types of land tenure in Ghanzi district. These are communal or tribal land tenure system, freehold and state land tenure systems. The total district covers an area of 117,010 km^2 of which communal land accounts for 20,034km^2 or (17%). Within the communal land tenure system, the wildlife management area accounts for 26,342km^2 or 22%, commercial area (leasehold farms) 17,720km^2 (15%), TGLP ranches 1,368km^2 (1%), CKGR covers 52,313km^2 (45%) and Ghanzi township 133km^2 (0.1%. The Ghanzi Freehold Farms situated in the northern part of the district consists of 172 farms with the average size of approximately 6,340 hectares (SIAPAC, 2013). However, land in the proposed project area is free hold land in which control of it is vested in the Minister of Lands through the assistance of the local land board office.

The T3 project is located within the freehold farm area of Ghanzi District whereas the housing facilities will be located within Ghanzi township area. Figure 5.35 shows the freehold farms within the greater study area. The Tshukudu Metals' prospecting licence is enclosed in orange.

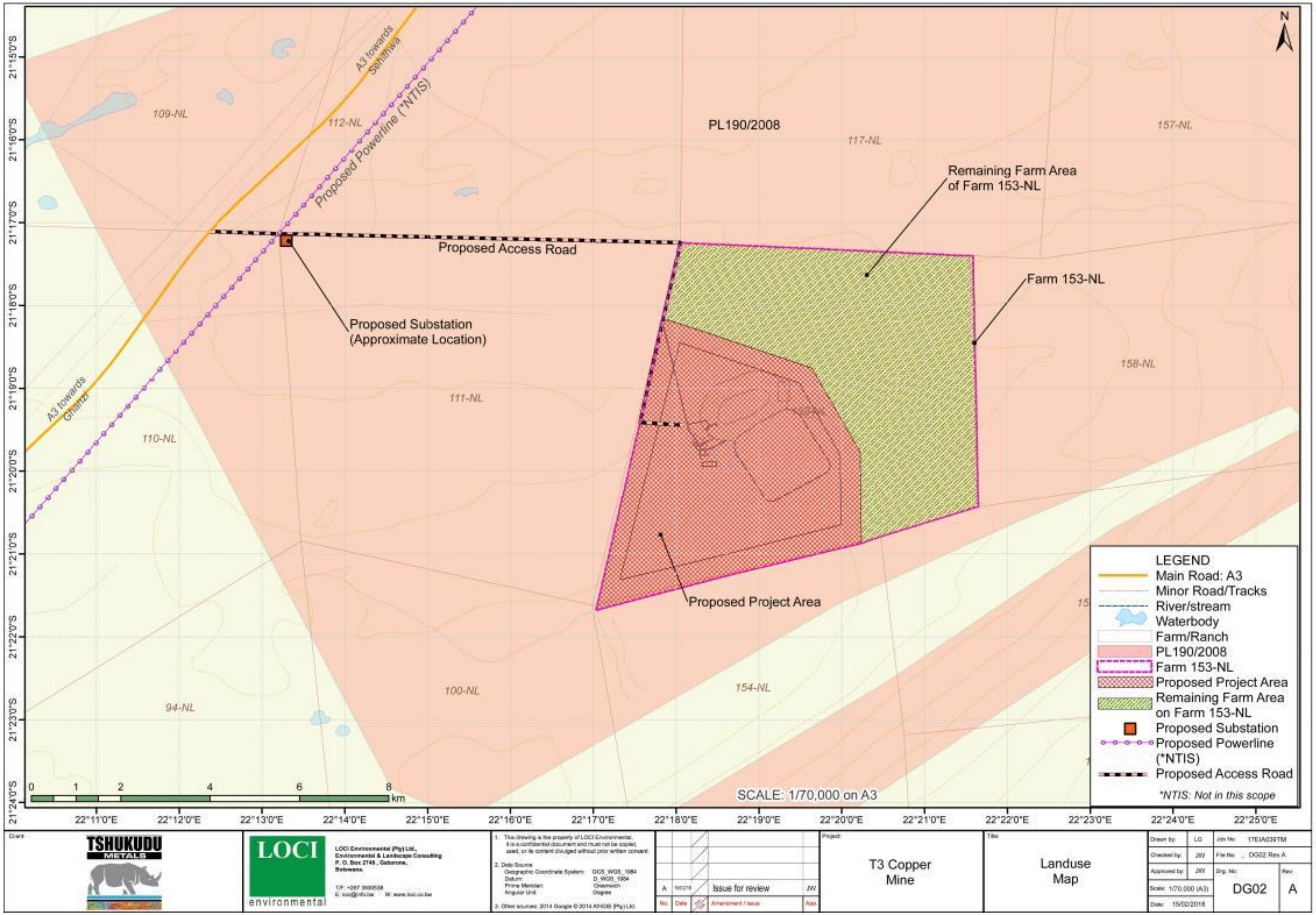


Figure 5.35: Land use map for the study area

Access agreements are in place with the farm owners affected neighbouring the mine site (acquired during exploration activities), and continued liaison between the Tshukudu Metals and the farmers is on-going. A summary of the access agreements is shown in Figure 5.36.

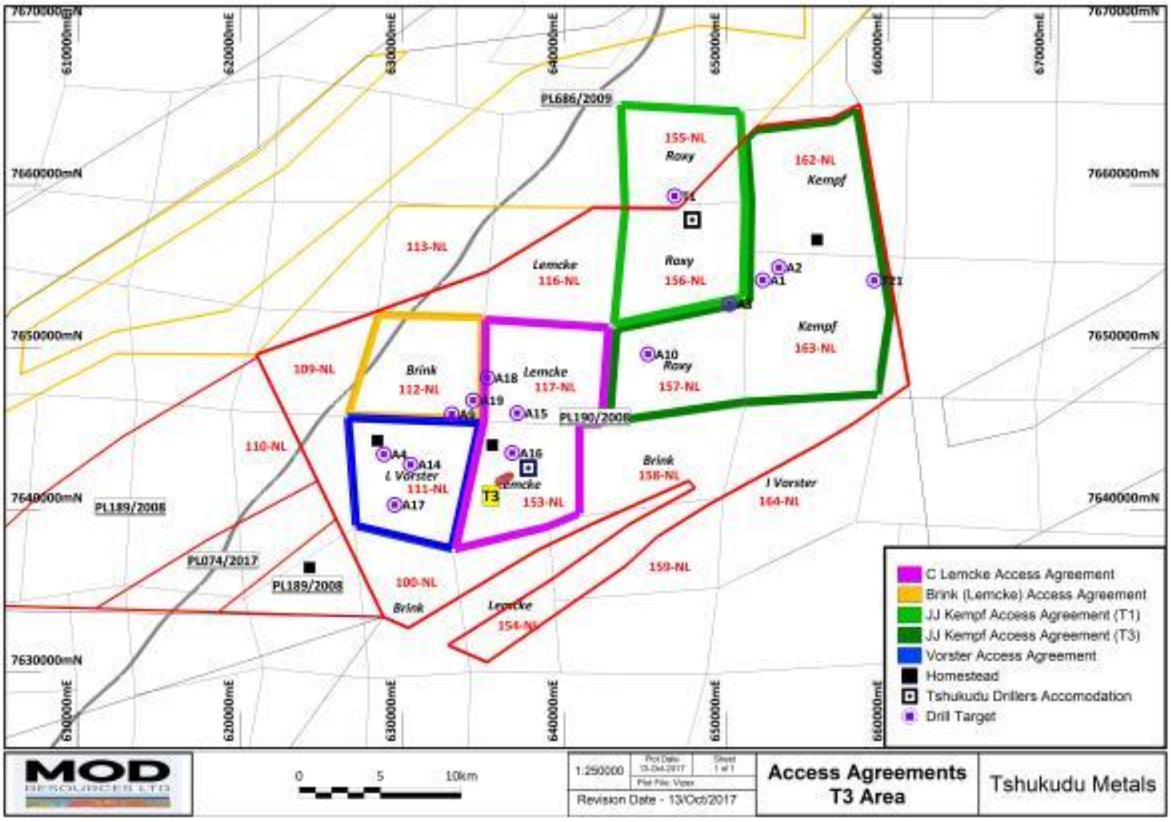


Figure 5.36: Access agreements with farm owners for exploration activities

5.5.12 District energy use and communication linkages

The District is linked to other districts through the A2 (Trans-Kalahari Highway). The road runs from east to west providing a linkage between the south eastern and western parts of the country, including the District. It also provides an international linkage between Botswana and Namibia to the west, Angola to the North West, as well as South Africa and Mozambique to the east. The road is therefore, an important medium for traffic movement and conveyance of goods locally, at regional and international levels. Accordingly, the A2 road has a volume of 700 vehicles per day (NMA, 2017). The Ghanzi-Maun A3 road links Ghanzi with the northern part of the country, including Francistown. Ghanzi-Mamuno road links Ghanzi with Namibia.

Regarding sources of fuel for cooking, the majority of the households (56.2%) in Ghanzi District used firewood, 29.9% use gas while 14.2% use electricity for cooking. 38.8% of energy for lighting is sourced from electricity grid, followed by paraffin and candle at 29.5% and 14.8% respectively (Statistics Botswana, 2011).

5.5.13 Sanitation and water supply

The study area villages have no water borne sewerage systems except for Ghanzi village. The existing sanitation facilities available include on-site disposal facilities such as pit-latrines and septic tanks in formal housing. Of 11,410 households in the District, 19.8% has access to flush toilets while 12.7% use pit latrines (Statistics Botswana, 2011). Ghanzi District depends entirely on underground aquifers for potable water supply, as there are no rivers or dams to augment the underground water sources. Unsustainable utilisation of water resources has been a problem in Ghanzi District, with the Ghanzi District Council reporting overuse primarily by livestock (Ghanzi District Development Plan, 2009).

5.5.14 Traffic

The A3 road runs about 270km north eastward from Ghanzi to Maun. The mine is located about 70km north east of Ghanzi, to the east of the A3 road. The area is also surrounded by a network of gravel roads that are used to access ploughing fields and farms around the area. Currently there is a network of dirt tracks traversing the location of the proposed development, running along farm field boundaries and providing access to the farm fields and homesteads around the proposed mine location, including Farm 153-NL.

5.5.14.1 Traffic controls at intersections

There are several intersections along the A3 road near the mine area. These are located along the A3 road where the road intersects with the dirt road network in the area. The intersections have bell mouth entrances from the dirt roads into A3 road. Traffic from the dirt roads is controlled by stop signs, while through traffic on the A3 road has a right of way.

Given the observed travel speeds, following distances and other traffic factors on A3 road near the mine location, it is clear that this section of the A3 road is operating at Level of Service A. According to the Highway Capacity manual, “Traffic flows at or above the posted speed limit and motorists have complete mobility between lanes. The average spacing between vehicles is about 550ft (167m) or 27 car lengths. Motorists have a high level of physical and psychological comfort. The effects of incidents or point breakdowns are easily absorbed. Service level type LOS A generally occurs late at night in urban areas and frequently in rural areas.”

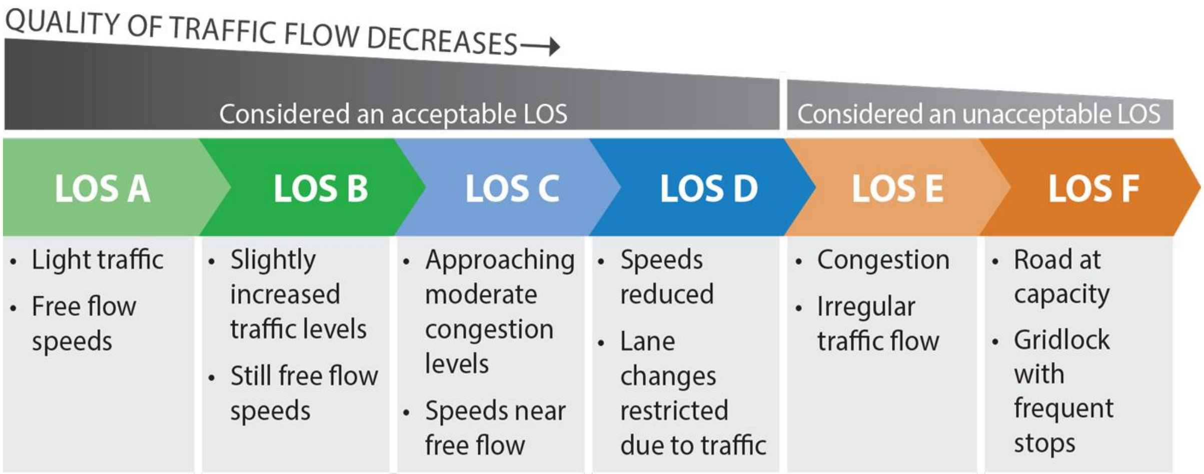


Figure 5.37: Highway level of service

Unofficial reports indicate that the A3 road has reached its life, however, the road has recently been resealed and it is currently in a good condition.

5.5.14.2 Area Intersections LoS (non-signalised intersections)

At intersections, Levels of Service are determined by the average intersection delays. The range of these Levels of Service is from A to F with average delay (Sec/Veh) ranging from 0 to 10 seconds per vehicle (Level of Service A) to more than 50 seconds for Level of Service F. At the intersections along the A3 road section near the mine location, there were no observed delays, indicating that the intersections are operating at Level of Service A (see Figure 5.38)

Level of Service Criteria for Unsignalized Intersections

Level of Service	Average Control Delay (sec/veh)
A	0 - 10
B	>10 - 15
C	>15 - 25
D	>25 - 35
E	>35 - 50
F	>50

Source: Highway Capacity Manual, 2000

Figure 5.38: Level of service at intersections

5.5.15 Waste management

Although both Ghanzi and Maun are provided with environmentally sound and well operated general waste disposal sites and HCRW treatment facilities (despite not being equipped with scrubbers), the only viable recycling activities in the area are taking place in Maun – which is quite a long distance from the project site. Long transport distances between waste generators in Kuke and D'Kar and the Ghanzi landfill, for instance, resulted in public waste transfer facilities currently operated in these settlements. Limited infrastructure and poor operating standards of the aforesaid transfer facilities makes them unsuitable for use by the mine and should there be any need for bulking (and possible compaction) of general waste generated by the mine for more cost-effective transport to the Ghanzi landfill, that should be done on the T3 mine's property.

On inspection, it was confirmed that the council landfill in Ghanzi is provided with a compliant lining system and is operated in accordance with Botswana's Guidelines for the Disposal of Waste by Landfill (First Edition, 1997). Effective access control, together with double weighbridges and data capturing hardware and software, ensures that the council has control over waste delivered to the landfill.

In addition to the general waste disposal area, the landfill is also equipped with a construction and demolition waste (building rubble) disposal area, a garden waste area as well as a used tyre storage area. Storage of used tyres immediately next to dry and unprocessed garden waste is however creating a risk that the material may be set alight, resulting in extensive air pollution from burning tyres.

The only hazardous waste facilities available at the Ghanzi landfill is a bulk used oil collection contained, see Figure 5.36 (from where it is reportedly transported to Gaborone for use a furnace fuel), as well as 2 x double chamber Health Care Risk Waste (HCRW) incinerators. The incinerators are not provided with air emission control systems like scrubbers.

Figure 5.39: Used oil storage container and incinerators at the Ghanzi landfill

Waste management service delivery in Ghanzi (waste collection and disposal) is currently at a reasonable standard, despite being under resourced in several areas like availability of waste collection vehicles. No waste minimisation and/or recycling initiatives are undertaken in Ghanzi, with the municipality unable to support such initiatives. Downtime on waste collection vehicles is problematic with the fleet being old and limited finances are available to upgrade the fleet. The Ghanzi landfill is however developed and operated to the required standards. Despite not being equipped with scrubbers for the control of air emissions, the Ghanzi municipal HCRW incinerators will have to be used for treatment and disposal of HCRW generated at the T3 Copper Mine's clinic.

5.6 Archaeology

Ghanzi District as a whole has a few registered sites in the site register, as listed in Table 5.14 below. From the BNMM registry, registered sites are from the Iron Age period with Ghanzi outcrop having been excavated and mapped extensively, for quarry purposes.

Table 5.14: Archaeological sites in Ghanzi District (Source: Leburu, 2017)

Site name	Map Code	Location	Type	Latitude	Longitude
Mabeleapodi Hills East	12-A2-1		Late Stone Age	21˚ 5	22˚ 25
Mabeleapodi Hills West	12-A2-2		Late Stone Age	21˚ 5	22˚ 23
Mabeleapodi Hills	12-A2-3		MSA/LSA	21˚ 55	22˚ 24
Kangumene	20-A1-1		Late Stone Age	20˚ 14	20˚ 01
Olifants kloof	20-A1-2		Late Stone Age	22˚ 11	20˚ 5
Mamuno Engravings	20-A1-3			22˚ 11	20˚ 5
Mamuno Rock Engravings	20-A1-4			22˚ 16' 42.0''	20˚ 01' 02.4''
Mamuno Engravings	20-A1-5			22˚ 17' 9.15''	20˚ 00' 56.4''
Hanahai East	21-B2-1	800/530	MSA/LSA	22˚ 07' 30''	21˚ 46' 55''
Hanahai West	21-B2-2	800/545	MSA/LSA	22˚ 06' 55''	21˚ 46' 30''
Okwa Valley South	21-B2-3	900/935	MSA	22˚ 41' 25''	21˚ 55'
Okwa Valley North	21-B2-4	225/945	MSA	21˚ 54' 55''	22˚ 40' 45''

An archaeological assessment was undertaken for the proposed T3 mine site and was further carried out for the service corridor. The field survey revealed that no archaeological findings or remains within and around the site (Leburu, 2017). Accordingly, the project site has deep Kalahari deep sand with thick bushes which makes it hard to locate or see archaeological artefacts. This means however, there is always a possibility of chance finds more especially during excavations (Leburu, 2017). These possible archaeological and historical finds are listed in Table 5.15 below.

Table 5.15: Possible chance finds at the T3 site

Artefacts	Period	Expected state
Charcoal, bones, pottery	Iron Age	Buried material
Historic material	Historic	Surface material

Although no archaeological sites were found, there were four observations of interest, as discussed below:

1. A small convex scraper belonging typologically to the Late Stone Age was noted at 21° 17' 09.0"S; 22° 12' 32.4"E (Figure 5.35). This was made on chalcedony.

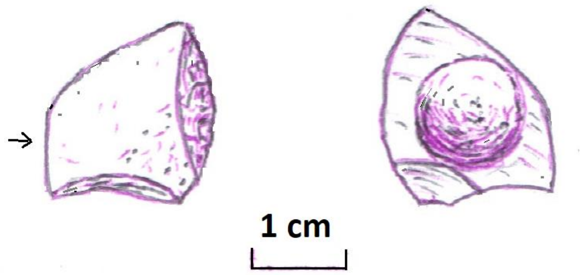


Figure 5.40: Scraper showing striking platform (arrow) and heat spall on ventral face

2. Lumps or chunks of chalcedony were noted near the road at roughly 21° 17' 09.2" S; 22° 12' 21.8" E (Figure 5.36). Chalcedony is an ideal raw material in the Stone Age as it is fine-grained but occurs naturally in small nodules. This is interesting in that it shows that suitable raw material is available in the area, but this occurrence has no heritage significance.

3. A probable ostrich crop stone was also noted (21° 17'09.1"S ; 22° 12' 59.6"E). It is a well-worn piece of calcrete, the right size for an ostrich crop stone. This has no heritage significance as far as the project goes.

Figure 5.41: Lumps of chalcedony (scale is 20cm)

4. A few pieces of wire suitable for the setting of snares were removed from near the main road (21° 17’ 09.3”S; 22° 12’ 35.6”E) . This has no heritage significance as far as the project goes.

One recently cleared area with two vertical support poles and pieces of modern iron could be a poacher’s camp or more likely a farm work station 21° 17’ 09.2”S; 22° 12’ 39.6”E. This has no heritage significance as far as the project goes.

The ecology team also found a stone flake outside the mine area at 21° 18’ 57.5”S; 22° 11’ 27.5”E. It is unclear if it is natural however. The photograph suggests that it is silcrete, the nearest known outcrop is the Nhabe River.

6 Public and Stakeholder Consultations

This Chapter presents the summary of the consultations undertaken with the public and key informants regarding the proposed development throughout the ESIA process. The consultations commenced during the scoping stage and were further undertaken during the detailed ESIA stage. The objective of the consultations was to seek the views and concerns of the consulted parties.

6.1 Regulations and requirements

Stakeholder engagement is an essential component of an Environmental and Social Impact Assessment process as it commits the client to an active and on-going communication process with all stakeholders from the project proposal stage to completion.

The stakeholder consultation process followed by the EIA consulting team was guided by relevant environmental and social assessment guiding documents such as:

- IFC Performance Standards of 2012
- Equator Principles of 2010
- Equator Principles of 2013
- EA Act no. 10 of 2010.

6.2 Stakeholder engagement plan

This Subsection presents the Stakeholder Engagement Plan (SEP) developed and followed for the project consultations. The SEP was designed to guide consultations with the project stakeholders. Therefore, this SEP (in accordance with IFC Performance Standards and Equator Principles) sets out the approach which the project will follow to consult with the stakeholders during the EIA phase.

For stakeholder engagement to be effective, it is essential to determine who the Project stakeholders are. A key element in this process included identification of individuals and groups who may find it more difficult to participate in the engagement exercise and those who may be extremely affected by the Project, due to their marginalised or vulnerable status (IFC, 2012). Although the SEP focuses primarily on consulting with external stakeholders, there are other “internal” stakeholders such as project contractors, staff etc, however, engagement with these stakeholders is not covered in this SEP.

6.2.1 Objectives and approach of the stakeholder engagement plan

The primary aims of stakeholder engagement are to:

- Promote the development of courteous and open relationships between Project stakeholders and the Client.
- Identify Project stakeholders and understand their interests, concerns and influence in relation to the Project activities.

- Provide stakeholders with timely information about the Project and the ESIA processes, as well as other relevant Project information. This is recommended by the Equator Principles (2013) to be undertaken in ways that are appropriate to stakeholders' interests and needs (considering factors such as location, language, culture and access to information), as well as appropriate to the level of expected adverse impact.
- Give stakeholders an opportunity (through consultation and other feedback mechanisms) to express their opinions and concerns in relation to the Project, and for these to be reflected in the ESIA report and decisions made about the Project activities, where possible.
- Record and resolve any grievances arising from Project related activities.

6.2.2 Stakeholder mapping and analysis

This Subsection describes how Project stakeholders were identified to date while Subsection 6.2.3 describes how the results of this analysis were used to identify tools and materials, as well develop consultation methodologies to consult with different stakeholders in ways appropriate to their needs.

It was also important to understand how each stakeholder may be affected, or view the Project, to design the engagement process to appropriately inform them, as well as understanding their views and concerns in a correct manner.

Table 6.1 provides a list of the identified stakeholders, including brief description of each. Detailed description of the stakeholders is provided in document attached in Appendix B.

Table 6.1: Stakeholder matrix table

Name of stakeholder organization, group or individual	Level of activity	Stakeholder description	Role in the project	Project related level of knowledge	Possible constraints to participation
Local communities, local community leaders					
Local chiefs of the communities residing near the Project site (Ghanzi, D'kar and Kuke *kgotla*	Local	These are leaders of the communities residing near the project site. The chiefs are responsible for taking care of their communities and facilitate meetings/discussions regarding the welfare of their communities. The residents of the affected communities will be affected by the Project activities. As detailed in Chapter 2 in this document, the project activities will result in both positive and negative impacts upon these communities.	As leaders of the affected communities, the input of these leaders in relation to the overall project planning and the ESIA study is important. The expectation is that positive impacts to be generated by the project implementation and operation must benefit them, to counter the project negative impacts they will be exposed to during its implementation. Dissatisfaction of these IAPs may have adverse impact on the Project implementation.	Consulted as part of the public meetings undertaken, refer to Section 6.3 and Appendix B for details.	None were identified to date. Socio-economic opportunities likely to be generated by the project encouraged the stakeholders to participate on the project stakeholder engagement process undertaken, as part of the overall scoping study.
Directly affected and neighbouring farms owners					
Affected farm owners: ▪ **Farm 153-NL (mining site)**	Local	This IAP will be directly affected by the Project as the mining activities will be undertaken within	The activities of these IAPs will be disturbed during the mining activities. Land	Consulted as part of the Ghanzi Beef Farmers Association during the scoping	None identified to date.

Name of stakeholder organization, group or individual	Level of activity	Stakeholder description	Role in the project	Project related level of knowledge	Possible constraints to participation
■ Farms 111-NL and 110-NL		a section of Farm 153-NL. The proposed access road corridor will also be developed within sections of Farms 110-NL and 111-NL.	acquisition process and The directly affected party will be paid for the area acquired for the mine development.	phase. One–on-one interviews were undertaken with the farmers during the detailed ESIA stage (as part of the SIA consultations.	
Neighbouring farm owners: ■ Proposed mine site (117-NL, 157-NL, 158-NL, 159-NL, 154-NL, 94-NL, 100-NL) ■ Proposed access road corridor (farm 112-NL) ■ Accommodation camp site (53-NK, 55-NK, 60-NK, 61-NK, 62-NK)	Local	These IAPs will be indirectly affected by the project activities due to their proximity to the proposed mining site, access road corridor and the accommodation camp site.	As neighbouring properties to the project development areas, adverse effects likely to be generated by the project activities may disturb activities practiced by these stakeholders. Issues raised by these stakeholders must be considered and relevant measures identified to mitigate such.	Consulted as part of the Ghanzi Beef Farmers Association during the scoping phase. One–on-one interviews were undertaken with the farmers during the detailed ESIA stage, as part of the SIA consultations.	None identified to date.
Botswana Defence Force (BDF)/Botswana Housing Corporation (BHC)	Local	The planned BDF camp near the accommodation camp is likely to contribute significantly to the social impacts to be experienced at the study area, hence consulted as	As a contributing factor towards social ills likely to be experienced at the study area (if the BDF camp is developed), cooperation between the mine and BDF will	Written correspondence	Non-disclosure of information regarding the BDF camp development due to security reasons. Bureaucracy prone to larger scale institution

Name of stakeholder organization, group or individual	Level of activity	Stakeholder description	Role in the project	Project related level of knowledge	Possible constraints to participation
		part of the SIA engagement exercise. The project will be developed by BDF and its implementation is overseen by BHC.	enable a better approach towards mitigation of social ills anticipated from both projects. Cooperation in terms of CSR between these organisations may also result in more benefits for the local communities.		delayed engagement.
Governmental institutions and Non- Governmental Organisations					
Department of Environmental Affairs	District/national	Government Department responsible for management of environmental issues, including authorisation of environmental reports.	Environmental authorisation for this scoping and ToR report will be obtained from this Department.	This Department has been informed about the project through the Project Brief submitted. Authorisation to implement the project will be granted to the Client by the Department.	As the competent authority, DEA has been informed about the project through the submitted Project Brief. The scoping and ToR report will be submitted to this stakeholder for review and approval, prior to the undertaking of the ESIA study.
Department of National Museums and Monuments	National	Government Department responsible for preservation of historical and cultural sites in Botswana.	Undertaking of the AIA survey for the Project and acquisition of AIA clearance prior to the Project development.	AIA report for the T3 project was submitted to this Department and was consulted as detailed in Section 6.3.	None were identified to date.

Name of stakeholder organization, group or individual	Level of activity	Stakeholder description	Role in the project	Project related level of knowledge	Possible constraints to participation
Water Utilities Corporation	National/District	An independent potable water provision and waste water management organisation.	Protection of any water infrastructure within the development areas (along the A3 road) likely to be damaged during the Project construction activities (particularly for the substation and service corridor components).	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	None were identified to date.
Department of Waste Management and Pollution Control	National	Government Department mandated to prevent and control pollution resulting from inappropriate and inadequate waste management practices.	Management of waste generated by the Project as per the Waste Management Act.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	None were identified to date.
Department of Tourism	National	Government Department responsible for development and implementation of policies, strategies and programmes aimed at ensuring sustainable tourism development.	The interest of these organisations is vested in sustainable development of the country through environmentally friendly community development initiatives.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	None were identified to date.
Department of Culture (Ministry of Youth, Sport and Culture)	National	Government Department mandated to preserve and celebrate historical events and cultural activities in Botswana.	Preservation of San/Basarwa culture and historical activities within the study area.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	None were identified to date.

Name of stakeholder organization, group or individual	Level of activity	Stakeholder description	Role in the project	Project related level of knowledge	Possible constraints to participation
Department of Occupational Health and Safety	National	The core business of the Division includes the perusal of factory building plans for suitability of designs; registration of factories; inspection of factories and other places of work such as building operations and works of engineering construction; registration and inspection of plant and machinery – e.g. passenger lifts, boilers, air receivers, cranes and lifting tackle etc. and legal action where there is contravention of the law.	The interest of these organisations is vested in sustainable development of the country through environmentally friendly community development initiatives.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	None were identified to date.
Department of Labour and Social Security		Government Department responsible for mediation and arbitration of trade disputes, monitoring training and localization of training programmes, processing of workers compensation claims, labour inspection, processing of workers permits and registration	Management of labour issues and acquisition of work permits for expatriates engaged by Tshukudu Metals.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	Delayed response

Name of stakeholder organization, group or individual	Level of activity	Stakeholder description	Role in the project	Project related level of knowledge	Possible constraints to participation
		of job seekers.			
Department of Water Affairs	National	DWA has the responsibility for policy, planning, assessment, development and protection of Botswana's scarce water resources.	Prevention of ground water pollution from mining activities. Acquisition of water rights for boreholes likely to be developed for the Project.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	None were identified to date.
Department of Mines	National	Government Department responsible for management of prospecting, related licences and mines.	Management of exploration activities. Acquisition of mining licence prior to mine development.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	None were identified to date.
Department of Wildlife and National Parks	District	Government Department responsible for conservation and protection of wildlife management of wildlife parks and game reserves.	The interest of this organisation is vested in sustainable development of the district through environmentally friendly community development initiatives.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	None were identified to date.
Department of Animal Production	District	Government Department responsible for promoting agricultural production through policy	The interest of these organisations is vested in sustainable development of the	Consulted as part of the stakeholder consultations undertaken, as	As noted above

Name of stakeholder organization, group or individual	Level of activity	Stakeholder description	Role in the project	Project related level of knowledge	Possible constraints to participation
		making.	country through environmentally friendly community development initiatives.	detailed in Section 6.3.	
Department of Forestry and Range Resources	District	Government authority tasked with the sustainable management and conservation of forests and developing its socio-economic benefits.	The interest of this organisation is vested in conservation of forests in Botswana and their management	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	Delayed response
Department of Veterinary Services	District	Government Department responsible for the control of animal disease and providing vaccinations of livestock in the District. They are also responsible for inserting Bolus into cattle for sale and processing the transfer of ownership of cattle during sales.	The interest of this organisation is vested in sustainable development of the district through environmentally friendly community development initiatives.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	Delayed response
District Health Management Team	District	The District Health Management Team is mandated to promote and provide comprehensive Preventative, Curative and Rehabilitative quality health services throughout Ghanzi	Management of HIV and AIDS issues likely to be generated by the Project implementation.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	Delayed response

Name of stakeholder organization, group or individual	Level of activity	Stakeholder description	Role in the project	Project related level of knowledge	Possible constraints to participation
		District. The increase of people on and off the farm for the project could increase the number health problems and issues. The DHMT could help prevent and cure any additional project related problems that may arise.			
Ghanzi Beef Producers Association	Local/district	The Ghanzi Beef Producers Association represents the cattle farmers in Ghanzi District (predominantly the commercial freehold farmers). The association is one of the most active and opinionated farmers' associations within Botswana.	The interest of this organisation is vested in sustainable development of the beef industry in Ghanzi.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3 and 6.4.	As noted above.
District Commissioner (Office of the District Commissioner)	District	District authority responsible for coordinating development and social programs in Ghanzi District.	Sustainable development of the District.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	Delayed response
Environmental Health Unit (Ghanzi District Council)	District	District Unit mandated to manage environmental issues throughout	Management of waste to be generated by the Project implementation	Consulted as part of the stakeholder consultations	Delayed response

Name of stakeholder organization, group or individual	Level of activity	Stakeholder description	Role in the project	Project related level of knowledge	Possible constraints to participation
		Ghanzi District.	and management of potential pollutants at the project site.	undertaken, as detailed in Section 6.3.	
District AIDS Coordinator (Office of the District Commissioner)	District	The AIDS coordinator is mandated to promote & provide comprehensive Preventative, Curative & Rehabilitative quality health services in relation to people living with HIV and AIDS throughout Ghanzi District. The HIV prevalence rate could be impacted by the project and therefore the project should work with the AIDS coordinator to help prevent further spread.	Provision of HIV and AIDS services and IEC materials at the study area.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	None identified to date.
Botswana Meat Commission	National	Botswana Meat Commission (BMC) was established in 1965, by an Act of Parliament to promote the development of the country's beef and related products globally. BMC is the sole exporter or beef from Botswana, apart from limited abattoir export permits	Preservation of the beef farming activities within the study area during the project development and operation.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	No input received to date, despite several attempts made to consult with the stakeholder.

Name of stakeholder organization, group or individual	Level of activity	Stakeholder description	Role in the project	Project related level of knowledge	Possible constraints to participation
		that have been issued in recent years.			
Botswana Tourism Organisation	National	A parastatal organisation mandated to develop and implement tourism marketing and promotion strategies for Botswana.	The facility will be assessed, registered and graded by the organisation prior to operation as required by the Tourism Act (2009).	Consulted as part of the stakeholder consultation interviews carried out.	None identified to date.
Botswana Chamber of Mines	National	NGO established to serve the interests of the mining and exploration industry incorporation with associated industries.	The purpose of the Botswana Chamber of Mines is influence policy decisions and strategic intents within the government, non-governmental organizations and related bodies.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	Delayed response
Kuru Family of Organisations	District	Lead organisation of the following trusts: ▪ Letloa Trust ▪ Bokomoso Trust ▪ Gantsi Crafts ▪ Komku Trust ▪ San Arts and Crafts ▪ Kuru D'Kar	Development of the Corporate Social Responsibility initiatives for the Project and capacity building for its members.	Consulted as part of the stakeholder consultations undertaken, as detailed in Section 6.3.	No input received to date.

Name of stakeholder organization, group or individual	Level of activity	Stakeholder description	Role in the project	Project related level of knowledge	Possible constraints to participation
		Trust. It provides strategic direction to its members to build capacity as well as provide technical, institutional and financial and management support.			
Raptors Botswana	District	Raptors Botswana is a non-profit organisation established by dedicated and passionate conservationists to ensure the survival of raptors in Botswana	Assist with identification of vultures in the project area, identify sensitivities and evaluate effective mitigation measures	Provided baseline information in relation to vulture movement in the District	None identified

It must be noted that during the SIA stage, additional stakeholders were identified and consulted. The consultation methodologies used for the Project are outlined in Section 6.2.3.

6.2.3 Consultation methodologies used

Several methods were used to consult with members of the public and stakeholders. These included methods discussed in the following subsections and summarised in Table 6.2.

6.2.3.1 Public meetings

Public meetings were conducted in villages and township located proximate to the proposed development areas, which included Ghanzi Township, Kuke and D'kar villages. The meetings were conducted in compliance with the requirement of the Section 7 (2a) of the EA Act, the IFC performance standards and the Equator Principles. The meetings were held during the scoping phase, as discussed in Subsection 6.3.1.

6.2.3.2 Stakeholder meetings

Stakeholder meetings were held with the Ghanzi Beef farmers Association and Ghanzi District Development Committee during the scoping and detailed ESIA stages respectively. The results of the stakeholders meetings are summarised in Subsections 6.3.2 and 6.4.6 to 6.4.8.

6.2.3.3 Focus group discussions

Focus group discussions were used to engage with smaller groups which represented a larger group. Focus group discussions were undertaken during the detailed ESIA stage as part of the qualitative survey. Summary of the discussions held with the project stakeholders is presented in Subsection 6.4.2.

6.2.3.4 One-on-one consultations

One-on-one consultations were undertaken with the following:

- Directly affected farm owners
- Neighbouring farm owners
- Key informants at local, district and national levels.

The consultations with the key informants commenced during the scoping phase and were further undertaken during the detailed ESIA phase. The consultations with the directly affected and neighbouring farm owners were undertaken during the detailed ESIA phase, in the form of a household survey carried-out for the project. A summary of these consultations is provided in Subsections 6.4.1 and 6.4.2.

The summary of the project consultations undertaken to date is listed in Table 6.2.

Table 6.2: Consultation methods, timelines and tools used during stakeholder engagement process

Type of stakeholder	Method of engagement	Tools used	ESIA Phase	Timelines
Interested and affected parties				
Affected communities	▪ Public meetings ▪ Public notices in the newspaper	PID, Phone calls, email and formal letters	Scoping	15th - 18th December 2017
Farm owners and local leaders	▪ Stakeholder meeting ▪ One-on-one interviews	PID, Phone calls, email and formal letters, semi-structured questionnaire	Scoping	15th - 19th December 2017
			Detailed ESIA	11th – 25th May 2018
Government authorities and NGOs				
Government Departments and NGOs at district and national levels	▪ One-on-one interviews ▪ Stakeholder meeting ▪ Written correspondence	PID, Phone calls, email and formal letters, semi-structured questionnaire	Scoping	15th - 19th December 2017 (District level) 8th - 30th January 2018 (National level)
			Detailed ESIA	25th May – 12th September 2018

As listed in Table 6.2 above, communicating with the public and stakeholders, regarding the Project, involved the use of:

- Telephones to reach the stakeholders and to be reached by interested parties/public
- Faxes to and from the stakeholders
- Newspaper advertisements to inform the public about the project and public meeting
- Notices to the public regarding the consultation meeting.

6.2.4 Disclosure of Project Information

In accordance with the IFC Performance Standard, a Project Information Document (PID) was developed for the Project. The Document was five pages long and contained mainly technical details about the Project, similar to what was presented during the public meetings. The Document was forwarded (both printed and electronically) to stakeholders who requested a copy.

After the update of the technical scope of the project, the document was also updated, to reflect such change.

6.3 Results of the stakeholder engagement process during the scoping stage

The primary results of consultation activities undertaken during the scoping phase are summarised below, whilst detailed information of consultations held are attached in Appendix B.

6.3.1 Summary of the public meetings

The consultations generally followed the same agenda, commencing with introduction of the meeting facilitators and the community leadership. Introductions would be followed by the welcome remarks from the chief. With the objective to ease communication barriers, the presentations were delivered in Setswana language.

The public participation meetings were facilitated by Johannes Westra and Victor Lelaka, with input from the Client's representatives Julian Hana, Gaba Chinyepi and Paya Boikobo. The meetings were conducted in the language of the local communities (Setswana and Naro[9]). During the comments and response sessions, appropriate answers were discussed between the project team.

Presentations were done by Loci Environmental (with support from the Client), including:

- A brief background on the ESIA process
- Project description
- Expected positive and negative impacts

[9] Translators were engaged in Kuke and D'kar

- Technical description of the Project
- Location of the Project
- Discussion and questions.

6.3.1.1 Public meetings schedule (venues and dates)

In preparation for the Project public consultation meetings, discussions were held with the respective *dikgosi* (tribal leaders) regarding dates and venues for the public meetings. The following public meetings schedule was followed:

- Ghanzi *kgotla* – 15th December at 0900 hours
- D'kar *kgotla* – 18th December at 0900 hours
- Kuke *kgotla* – 18th December at 1400 hours.

6.3.1.2 Meetings Advertisement

The public meetings were advertised 21 days prior to the public meeting dates, as required by the EA Act. The meetings were advertised in the Mmegi News newspaper on the 24th November 2017. A copy of the advertisement can be found in Appendix D.

In addition to the advertisements, the following methods were implemented to ensure the local public were aware of the meetings, and satisfactory attendance was achieved during the meetings:

- Hiring of a PA system (Ghanzi) announcing the meetings the evening prior
- Request for the local *dikgosi* to announce the meeting in meetings prior to this public meeting
- Faxes to local officials, MPs and land board officials to make them aware of upcoming meeting.

6.3.1.3 Consultation meeting attendance

The attendance at the public meetings was satisfactory as many of the local residents attended the meetings. The following is a list of the venues where public meetings were held, as well as the number of people who attended:

- 178 attendants at Ghanzi public meeting
- 81 attendants at D'kar public meeting
- 41 attendants at Kuke public meeting.

Attendance registers of each public meeting have been attached as Appendix B of this document.

Figure 6.1: Proceedings of the Ghanzi public meeting

6.3.1.4 Key issues raised

Summary of issues raised during the meetings included:

- Localisation of employment and entrepreneurship opportunities likely to be generated by the project.
- Employment process must be fair and transparent (recommended to be undertaken at *dikgotla*).
- Provision of training opportunities for the local communities to equip them with mining related skills.
- Corporate social responsibility initiatives to uplift the welfare or quality of life of the locals.
- Tshukudu was recommended to initiate an appropriate forum, which will enable the local communities to be constantly updated about the project activities.
- Kuke residents recommended that the mine residential camp should be located in Kuke, as the proximate village to the proposed mine area.
- Disturbance of farming activities.

- Lack of skilled manpower in the region may result in competition for skilled workers between the mine and the farmers (mechanics, electricians, plumbers etc.).
- Risks of depletion and pollution of groundwater resources due to the Project.

Full transcripts and meeting registers of the public meetings have been included in Appendix D.

6.3.2 Summary of the stakeholder meeting with Ghanzi Beef Producers Association

The mining site and the service corridor are located in proximity to freehold farms within Ghanzi farming block. The farms are mostly used for game and cattle farming (as detailed in Chapter 5). Because the freehold farmland is outside of the jurisdiction of local land boards, the environmental team has identified and consulted with the farmers' association during this scoping stage. The consultation was conducted on the 15th December 2017 at 1600 hours at Tautona Lodge in Ghanzi. According to the meeting register, 13 farmers attended the meeting. Key issues raised included:

- Presence of man-made water bodies within the region (after decommissioning of the mine pit) will attract wildlife into the study area (including elephants and buffalos), which may result in spread of foot and mouth disease. Accordingly, this may adversely affect the beef industry of the study area.
- Disturbance of farming activities due to mine development and operations.
- Competition for skilled workforce between the mine and farming operations, due to limited skilled manpower in the region (mechanics, welders, electricians, plumbers etc.).
- Improvement of livelihood of the affected communities from employment and entrepreneurship opportunities to be created by the Project.
- Improved infrastructure development which may benefit the farming activities within the area.

A copy of the meeting register and meeting transcript are included in Appendix B.

6.3.3 Summary of key informant consultations

Governmental (Botswana) departments (at local, district and national level) and Non-Governmental structures (VDCs) were interviewed to gather more insight into the issues and concerns in relation to the project. Furthermore, correspondences were written to other key stakeholders to gather more on insight on the issues and concerns likely to be generated by the Project on their mandate.

Table 6.3 provides the details of the key informants consulted at District level.

Table 6.3: Key informants consulted

Name	Organisation	Designation
Local key informants		
Tirelo Medupi	Ghanzi *kgotla*	Headman
Gosalamang Motshabanye	Ghanzi *kgotla*	Headman
Keolebetse Mosemele	Ghanzi *kgotla*	Headman

Kgosi April Montshusi	D'Kar *kgotla*	Chief
Kathemba Bimbo	D'Kar *kgotla*	Chief
Mmabontle Sedumago	D'Kar *kgotla*	Headman
Hon. Nana Mothusi	D'kar	Councillor
James Morris	D'Kar *kgotla*	VDC Member
Didimalang Sixpence	D'Kar *kgotla*	VDC Member
Tjamo Dibebe	Kuke *kgotla*	Chief
Sarah Tibi	Kuke *kgotla*	VDC Member
Lebogang Dithono	Kuke *kgotla*	VDC Member
Mary Xomae	Kuke *kgotla*	VDC Member
District and national key informants		
Ontlametse Ntebang	Department of National Museums and Monuments	Archaeologist
Charles Kenalemang	Department of Mines	Principal Mining Engineer
Rahul Bohra	Department of Mines	Acting Deputy Director (Inspectorate)
Silvester Mswela	Department of Animal Production, MOA	District Animal Production Officer
Chief Tsholofelo	Department of Wildlife and National Parks	Senior Wildlife Officer
Refilwe Chakalisa	Department of Tourism	Tourism Officer
Shane Kebadile	Ghanzi Beef Producers Association	Deputy Chairman
Stephen Ghanie	Botswana Meat Commission	Manager (Strategy, Projects and Innovations)
Gare Tisi	Kuru family Organisation	Secretary
Yaone Kabelo	Department of Waste Management and Pollution Control	Waste Management Officer 1
Onneile Nkepe	Regional Labour Office, Gaborone	Senior Labour Officer
Mpho Tsotetsi	Water Utilities Corporation, Ghanzi	Waterworks Engineer
Johannes Mosanawe	Department of Occupational Health and Safety	Principal Health and Safety Officer
Kedumetse Keetile	Department of Water Affairs	Principal Hydrogeologist

The key stakeholders consulted raised the issues discussed below:

- Water related concerns identified:
  - Potential lowering of the water table following substantial amount of water extracted by the mine for its process and dewatering activities.

  - Potential pollution of underground and surface water associated with the proposed processing and dewatering activities.

- Effects of the project on agricultural activities:
  - The project components were viewed to be developed within the existing beef farming and crop production area (at the study area), consequently resulting in loss of agricultural land and low food production.
  - Noise generation from the project activities are expected to disturb farming production.
  - Waste water from the mining may affect the soil of the study area (although the extent of the pollution effect could not be established), this is anticipated to affect the palatable grass species and other plants of the study area, consequently impacting the livestock feed intake (low nutrient intake).
  - Dust generation from haulage of materials and construction activities may be trapped on forage and plants leaves and end up being consumed by the livestock on the process.
  - Use of chemicals at the mine was viewed to have potential in polluting underground water, which is a key input in agricultural activities.
- Archaeological related impacts:
  - Sites of archaeological, historical and cultured significance maybe impacted by the Project. An AIA must be undertaken for all the Project development area prior to the construction phase.
  - When the construction activities commence, possibility of recovering human remains is expected, particularly in areas near and/or along kraals and old settlements at the study area.
- Mining related impacts:
  - Dust and gaseous emissions from mining and associated activities.
  - Noise related impacts due to utilisation of heavy machinery during mining and transportation activities.
  - Visual related impacts were noted by the Department of Mines, Wildlife and National Parks in relation to introduction of foreign objects at the study area.
  - It was emphasised that before Tshukudu Metals could be issued with a mining licence, a mine closure plan will be required for the proposed Project.
  - Depending on the buffer zones adopted for the mining area, blasting activities may put animals and proximate communities in danger of being hit by flying debris. Blasting activities will also result in low frequency sound waves affecting communities residing distant from the blasting area due to the geological characteristics of the area.
  - In relation to the above, the nearest structures to the blasting point, media of blasting and seismic shock must be considered when determining the distance of the buffer zone.
- Social and economic related impacts:

- Influx of people to the project site in search of employment and other opportunities.
- Employment and economic opportunities.
- Increased local electricity production and supply.
- National economic growth and mining activities diversification.

- The project operational activities may result in emissions of gases which may affect the health of the proximate communities.

Copies of the signed sheets and correspondences to and from the stakeholders are included in Appendix E.

6.4 Results of the stakeholder engagement process during the detailed ESIA phase

Additional consultations were undertaken during the detailed ESIA phase, as part of the SIA study. The results of the consultations are summarised in the subsections that follow.

6.4.1 One-on-one interviews with local stakeholders

Additional one-on-one interviews were carried out with knowledgeable local key informants to get a better understanding of complex issues raised by other consulted stakeholders. These interviews were conducted with the stakeholders identified and listed in Table 6.1.

The key informants consulted during the detailed ESIA phase are listed in Table 6.4 below.

Table 6.4: Key informants consulted

Name	Organisation	Designation
Local key informants		
Gosalamang Motshabanye	Ghanzi *kgotla*	Headman
Hon. Nana Mothusi	D'kar	Councillor
James Morris	D'Kar *kgotla*	VDC Member
Didimalang Sixpence	D'Kar *kgotla*	VDC Member
Tjamo Dibebe	Kuke *kgotla*	Chief
Lebogang Dithono	Kuke *kgotla*	VDC Member
Mary Xomae	Kuke *kgotla*	VDC Member
Leaname Boitshwarelo	Dkar Health Post	Nurse
Joseph Rahupe	Kuke Health Post	Nurse
Kopo Kate	D'kar/Kuke Social and Community Development	Social Worker
Badiredi Mokwena	Kuke Youth Committee	Chairperson

Kenny Kenneth	Dkar Primary School	Deputy School Head
Moagi Sandiwanga	Kuke Police	Sergeant
Tjemo Xukiri	Kuke Development Trust	Coordinator
Colonel O. Kamwi	Botswana defence Force	Colonel

A summary of the key comments and concerns raised during the meetings included:

- Localisation of employment opportunities for the local communities. It was advised that to ensure participation of the locals in the project employment activities, training must be provided to equip the local communities with skills to be required for the project activities.
- Opportunities for the local community to participate in the operation of the mine through service and equipment rentals.
- Development and implementation of the Corporate Social Responsibility initiatives by Tshukudu Metals to uplift the welfare of the local communities.
- Impacts on farming activities, in terms of air quality, groundwater quality, infrastructure development.
- Possibilities for smelting the copper within Botswana.
- Increased HIV and AIDS prevalence, crime and demand for social services due to influx of people at the study area.
- Proximity of the temporary accommodation camp to the BDF camp must be managed to avoid trespassing and unauthorised activities either parties.
- Operational incidents and accidents at the mine and contractors' camp may require emergency response from BDF personnel stationed BDF camp in Ghanzi.
- The operational activities of the camp development may benefit the BDF personnel. No major issues are expected from the project in relation to the BDF camp.

Copies of the signed sheets are included in Appendix B.

6.4.2 Summary of focus group meetings/discussions with local and district stakeholders.

Focus group meetings/discussions were undertaken with the following community groups at Ghanzi Township, D'kar and Kuke villages:

- Village Development Committees
- School heads
- Farmers Committee
- Home Based Care/Community volunteers
- Women group

- Men group
- Youth group
- Elderly people.
- Ghanzi District Council social workers
- Ghanzi Police Station
- Ghanzi Technical and Vocational Training Centre
- Botswana Council of Women (Ghanzi Branch).

A summary of the key comments and concerns raised during this meeting included:

- Local community employment and labour-related issue regarding contracted drilling company.
- Training opportunities for local youths to equip them with mining related skills for future employment by the Project.
- Housing alternatives for the mine workers to promote outsourcing of housing to locals.
- Impacts of the full scale mine operation on the groundwater and farming activities.
- Influx of people at the study area, which will increase:
  - Crime
  - Domestic violence
  - Teenage pregnancies and drop out of students from school due to unplanned pregnancies
  - Mushrooming of drinking shebeens and excessive use of alcohol.
- Rehabilitation and re-use of the site for income generation activities by the communities after decommissioning of the project.

6.4.3 Summary of the consultation with the directly affected freehold farms owners

One-on-one consultations were undertaken with the directly affected farmers. The list of farmers consulted is presented in Table 6.5.

Table 6.5: Affected farmers consulted

Name	Farm No.	Description
Directly affected farmers		
Callie Lemcke	Farm 153-NL	Proposed mining site within the site.
Johannes Van De Nest	Farm 110-NL	Northern section of the farm will be directly affected by the access road development.
Leon Vorster	Farm 111-NL	Northern section of the farm will be directly affected by the access road development.

Majority of the issues raised by the farmers were in relation to lack of consultations/feedback by Tshukudu Metals and the disturbances caused by the exploration activities.

Key issues raised included:

- Lack of consultations regarding the project activities:
  - Farm owners note their dissatisfaction regarding their engagement by the project proponent.
  - It was also mentioned that frequent updates should be provided to the farmers regarding the on-going ESIA studies and the project planning activities.
- According to the consulted farmers, the exploration activities have led to loss of vegetation, dust generation, littering and increased noise levels within the farm areas.
- There is likely to be competition for skilled labour between farming and mining activities, which may affect beef farming activities adversely. Accordingly, there is shortage of skilled labour within Ghanzi District.
- The overall mining development is perceived to be beneficial to the regional and national economies, however it is viewed to lead to significant environmental and social impacts which require appropriate measures.
- Negative impacts related to the project were noted to include
  - Pollution and drawdown of ground water due to mining activities.
  - Influx of people at the study area in search of jobs and business opportunities. This may lead to increased crime, increased health issues, increased violence and demand for social services at the study area.
  - The owner of Farm 153-NL stated that he was concerned over the impact that dust may have on his disabled son. Due to his health conditions he is likely to be more vulnerable to air quality impacts, which he believe may have occurred during the exploration phases.
- Accordingly, negotiations for land acquisition between the farmers have proceeded well, although some challenges were experienced during the process.
- The project will benefit the affected communities if its benefits are localised.
- The project will be beneficial to the economy of the country through employment and business opportunities creation, revenue generation (mine royalties) and increased foreign investment in the national economic activities.
- The project may also lead to improved infrastructure development of Ghanzi District.

Detailed information on issues raised by the consulted farmers is provided in the SIA report in Appendix L.

6.4.4 Summary of the consultations with the directly affected farms workers

One-on-one consultations were also carried out with the neighbouring farm owners. To date, ten households were consulted in Farms 153-NL and 111-NL respectively (five in each farm). Issues raised by the farm workers were related to localisation of employment opportunities, training opportunities and possible corporate social responsibility initiatives to be developed and implemented for the project.

The list of the consulted farm workers and detailed consultation results are included in Appendix B.

6.4.5 Summary of the consultation with the neighbouring farm owners

One-on-one consultations were also carried out with the farm owners neighbouring the mine site, access corridor and the accommodation camp development site. To date, thirteen farm owners (or managers in the absence of owners) were consulted, eight being farms neighbouring the mine and access road areas, as well as five farms neighbouring the accommodation camp site.

The main issues raised during the stakeholder consultations were as follows:

- Compensation for directly affected farm owners.
- Water usage conflicts between the mine and the farmers due to excessive use of water for mining activities.
- Relocation fears if the mine operations extend beyond Farm 153-NL.
- Localisation of employment and engagement/involvement of local community structures to assist in communicating job opportunities, and to assist in identifying the local labour pool
- Road safety concerns, particularly in relation to young children and cattle.
- Ill-treatment of the employees engaged by the sub-contracted exploration companies over wages and dismissal from work.
- Economic incentives for the local farmers and businesses in terms of buying local produce and services.
- Corporate Social Responsibility initiatives implementation.

6.4.6 Summary of the Ghanzi District Development Committee (GDDC) stakeholder meeting

A stakeholder meeting was carried out for the Ghanzi District Development Committee from relevant units such as social welfare, environmental management, physical planning and technical unit on the 11th June 2018 at 0900 at Ghanzi District Council boardroom. The meeting was officiated by Victor Lelaka with input from the Client representative, Ms Cecilia Suping (Tshukudu Metals Community Liaison Officer). The meeting started with a presentation on the proposed mine location, technical description of the operation of the mine as well as the discussion on another related facilities development. The attendants were notified of the preliminary impacts anticipated during the development and operation of the mine. After the presentation, all attendants were given an opportunity to raise comments and questions.

Most officials were supportive of the Project, considering the positive impacts the Project will have on the development of the District. Most were quick to note employment opportunities, revenue generation for the District development through services to be offered to the mine by the Council, infrastructure development and positive attempts in diversifying the District economic activities through operations of mine. In relation to negative impacts associated with this development, the officials were concerned about the spread of HIV/AIDS and other sexually transmitted diseases to be brought by the miners to local communities. It was also noted that crime might increase in the District, with housing service rentals likely to increase, as well as the potential for the District to experience an influx of people.

It was also noted that issues of land transaction should be mitigated well in advance, to avoid any cheap monetary acquisition of land from the locals. Also, there was concern over the potential relocation of Kuke and Dkar due to on-going exploration if the mine finds mineral deposits in that area, due to the on-going exploration near these villages. This is not relevant to the current ESIA scope for the mine but relevant to further exploration activities. Waste disposal and water usage issues were also raised by one official, requesting for a proper waste disposal by the mine during its facilities construction and operation. Other issues discussed were CSR initiatives expected to be spearheaded by the mine in partnership with the district council as well as further consultation between the Council and the project team about the Project.

Copies of the meeting registers and transcripts are attached in Appendix B.

6.4.7 Summary of the stakeholder meeting with the Ghanzi District Health Management Team (GDHMT)

A stakeholder meeting with the GDHMT was conducted on the 12th June 2018 at Ghanzi District Hospital. The meeting was officiated by Dave Barnes (HIA study specialist) and Victor Lelaka (SIA study consultant) with input from the Client representative, Mr Godfrey Boloka (Tshukudu Metals Health, Safety and Environment Officer). The meeting started with a presentation on the proposed mine location, technical description of the operation of the mine as well as the discussion on other related facilities development. The meeting attendants were notified of the preliminary health impacts anticipated during the development and operation of the mine.

A summary of the key comments and concerns raised during the meetings included:

- Influx of people to study area which may result in increased HIV and AIDS prevalence, high TB rates and increased demand for primary medical/health services.
- There is a possibility that teenage pregnancy could increase, given the prevailing high rates experienced at the study area. Accordingly, the Ghanzi District recorded 177 cases of teenage pregnancies in 2017. The proposed accommodation of contractors in close proximity to Ghanzi Township is likely to worsen this trend.
- It was recommended that a robust information, education and communication (IEC) programmes for HIV and AIDS, STIs and TB be implemented for the Project targeting vulnerable groups within the community. Development and implementation of these programmes should be in partnership with District Health Medical Team (DHMT) to ensure alignment with Ministry of Health programmes.
- Tshukudu Metals should consider supporting the local health institutions in extending voluntary counselling and testing (VCTs) services, treatment for TB as well as extension of key health facilities to counter influx as a CSR initiative.

6.5 Summary of the project and ESIA progress update meeting by the Client

As part of the project planning activities, the client organised and conducted a stakeholder meeting on the 23rd of August 2018 at Tautona Lodge in Ghanzi Township. The purpose of the meeting was to update key stakeholders about the project and ESIA activities. The meeting was facilitated by the client representatives Julian Hana, Gaba Chinyepi and Leutlwetse Tumelo, with input from the ESIA team leader Johannes Westra. The issues raised included:

- Pollution and drawdown of groundwater.
- Attraction of animals to the farming area due to introduction of man-made water bodies.
- Increased demand for water due to the implementation of the project.
- Influx of people to the study area in search of jobs and other opportunities.
- Negative social impacts related to the implementation of the project.
- Socio-economic benefits to be generated by the proposed development.

Minutes of the meeting are included in Appendix B.

6.6 Availability of minutes and recordings

The list of stakeholders consulted during the stakeholder consultation exercise is attached to this document as Appendix D. Detailed copies (audio files and full write-ups) of all the consultation are kept on record, and can be availed for audit purposes if required.

7 Identification and Assessment of Impacts

Different methodologies were used to identify and assess possible environmental impacts that may result from the proposed project (refer to Chapter 4). Each specialist study (e.g. ecology, archaeology, et al) required the undertaking of a baseline study and site investigation, to provide a description of environmental character of the area of the proposed Project and its surroundings. To this end a series of field investigations and desk-based studies were undertaken with the primary aim to enable an assessment of the environmental impacts that forecasted activities may have on each specialist area of the receiving environment. This provides the context for the assessment of impacts associated with the proposed development.

7.1 Introduction

This subsection details the impacts which may be generated by the implementation of the Project, based on the findings of the specialist studies. These impacts include:

- Loss of vegetation and disturbance of plant communities due to bush clearing
- Increased risk of invasive or encroacher flora species establishing due to bush clearing and soil disturbance
- Disturbance and alteration of faunal and avifauna habitats
- Conflict between construction crews and local fauna
- Increased erosion risk because of soil substrate disruption and reduced vegetation cover
- Risk of fauna fatalities due to collisions with moving equipment
- Decline in air quality (in the local area) from the production of dust from the use of heavy mining equipment, materials handling and use of unpaved haul roads
- Acoustic and visual amenity quality impacts
- Local change of groundwater levels (cone of depression) due to mine de-watering
- Risk of contamination of local groundwater
- Land pollution due to waste quantities generated
- Increased instances of HIV/AIDS and STI infections, increased occurrence of TB and malaria
- Increased number of road traffic accident
- Capacity challenges for medical emergency response, e.g. health facilities such as emergency room at Ghanzi Primary Hospital
- Population influx
- Creation of employment
- Increased local and regional economic activities due to multiplier-effects and improved markets for goods and services due to influx of people to the study area
- Regional economic development

- Skills transfer and development
- Community development induced by the Local Empowerment Drive (LED) and Corporate Social Responsibility initiatives (CSR)
- Loss of land for the directly affected freehold farmers (Farm 153-NL, 111-NL and 110-NL)
- Social disruption
- Conflict or competition between jobs/opportunity seekers and the locals
- Increased pressure on local services and infrastructure
- Establishment and growth of informal settlements
- Resistance to the mine development and operation due to perceived negative impacts
- Sustainability of communities beyond mining
- Loss of community cohesion and structures
- Impacts on archeological sites or artefacts

7.2 Biodiversity Impact Assessment

This section discusses the predicted ecological impacts in relation to the proposed T3 Copper Mine Project. The impacts are separated into categories of flora, fauna and avifauna. Most impacts occur during the construction phase of the project, and then continue into the operational phase. Therefore, the impacts have been combined in the sections below.

7.2.1 Construction and operation phase impacts on flora

The main impact on flora during the construction period will be loss of vegetation and establishment and possible proliferation of alien flora and encroacher species. Clearing of vegetation will be done to pave way for the proposed development (T3 mine and road corridor). The impacts associated with vegetation clearing include loss of (unmodified) habitat and alteration natural ecological processes. The vegetation will be lost by clearing activities at the proposed mining area, dumps and stockpiles and tailings storage facility areas, as well as in a linear corridor where the proposed road and powerline network is earmarked. The impacts are summarised as follows:

- Loss of vegetation and disturbance of plant communities due to bush clearing: Bush clearing (approx. 400ha) is required for the mine footprint and construction of the access corridor. Bush clearing will be required for the construction of the various infrastructure components within the T3 site and further areas will be cleared prior to mining activities. No species of conservation concern were identified, and none of these species are listed as protected. Furthermore, as the T3 site falls within a cattle farm there has been some modification of the vegetation (4% of farm), trees have been cleared to accommodate larger grasslands.

  Approximately 400ha will be permanently cleared of vegetation. The overall footprint acquired for the project is 2,500ha, which is less than half of farm 153-NL. It must also be noted that significant areas within the footprint (buffer areas) will not be cleared, and the fact that some clearance was already undertaken on the farm. In the context of the habitat in the Ghanzi farm block, the vegetation represented here is common and widespread. This is on 16% of the mine lease area and therefore only 8% of the entire 153NL farm. It must be noted that this is not all permanent habitat loss, as the only part that cannot be revegetated is the pit.

Regardless of this, the clearing can still be considered a significant impact as there will be extensive disturbance within the T3 site. The impact thus becomes **moderate, negative and permanent**.

- Loss of floristic diversity through invasion by alien taxa or encroachment by encroacher species: The disturbance to the soil layer sand changes of land use leaves the site vulnerable to the establishment of invasive or exotic species as well as native encroacher species. Only one exotic species was observed within the T3 site (*Verbecena enceloides*), along with three known encroacher species (*Dichrostachys cinerea, Vachellia tortilis* and *Senegalia cinerea*).

  Proliferation of these species can result in displacement of native vegetation, change in species composition, and a net loss of biodiversity. Hygiene procedures are required to minimise the risk, and regular monitoring will be required, and an alien invasive and eradication procedure would need to be implemented. Though the encroacher species that were observed are native and naturally found within the biome, they are capable of rapidly establishing on previously disturbed areas, creating dense mono-specific thickets. These areas will also require monitoring and should any of these species begin to encroach, actions to remove and control them should be implemented. This impact is **negative, moderate and long term.**

- Increased risk of bushfires (in surrounding areas) as a result of negligence (unchecked fires): Unattended fires can result in bush fires that that become destructive to the local environments posing a threat to flora, fauna and the local agricultural communities. Fires could be caused by welding, or smoking. The negative environmental impacts of the proposed project are expected to be **negative, slight to moderate (depending on the extent of fire) and long term.**

- Risk of water pollution impacting flora (hydrocarbons, chemicals): Spillages of fuel hydrocarbons or chemicals may occur in cases of improper storage and refuelling of construction machinery. Traffic incidents are also a risk if haul packs capsise and concentrate is lost to the environment en-route. These hydrocarbons and chemicals are harmful to both flora and fauna in biotic communities. The fuel will be used on machinery and trucks during construction and operation thus the impact is classified as **negative, slight and long-term**. The impact has been rated as slight because any accidental spillage will occur in operational areas of the mine, where flora has been cleared and most fauna species are kept out.

7.2.2 Construction and operation impacts on fauna

Bush clearing, construction and mining activity within the project footprint will alter or destroy local faunal habitats, impacting species that rely on those habitats.

7.2.2.1 Disturbance, alteration and destruction of faunal habitats

Animals that have home ranges which exceed the footprint of the works are likely to vacate the area. It is anticipated that many of these animals have already vacated the area due to the exploration drilling works and vegetation clearance for this. Small, less mobile animals or animals with burrows or nests in the area will be affected by the works. These animals may not be able to vacate the area and if encountered need to be relocated by qualified personnel. Due to the nature of the works this is predicted to be a long-term impact but is not likely to have significant negative impacts on the faunal pollutions as a whole, due to the relatively small size of the footprint and the current land use. Specific impacts on some of the sensitive species are highlighted below. No burrows or dens were found within the project footprint for any of the below species.

- **African wild dog:** These animals are unlikely to frequent the mining site or the T3 access corridor, but may move through the area. The disturbance and activity in the area is likely to deter these packs from returning to the T3 area. They are likely to venture elsewhere, considering that their hunting ranges are so large. The size of the site that will be fenced off and cleared is relatively small, and thus the habitat alteration is unlikely to negatively affect these species. The biggest threat to these animals is conflict with project staff and road accidents due to increased traffic. As these species are not resident within the footprint, the proposed operations will not have long term effects on their population if the correct mitigation measures are followed.

- **Brown hyaena:** These animals were recorded very often within the T3 footprint during the camera trap survey. Thus, there is a possibility that they may encounter workers or enter site (especially catering and waste facilities) searching for food when T3 is developed. When these animals are spotted they must not be harmed, and a Wildlife Officer must be informed. It is imperative to store waste products and food from camps in secure areas and dispose of these materials in a timely fashion, as this may attract scavengers. Correct measure should be followed to avoid conflict between hyenas and workers at all costs. Many of these animals are not likely to reside in the area at times of increased activity, but as mentioned may frequent it for food. However, there are no predicted long-term impacts on their populations if the correct mitigation measures are followed.

- **Cheetah:** These animals are very shy and will likely avoid human interaction. With increased activity, they are likely to frequent the area less regularly or avoid the immediate area completely. The biggest threat to these species during the mining site and access corridor construction and operation is conflict with workers. If any Cheetahs are spotted they should be avoided, and a Wildlife Official must be informed, however, it is likely they will leave the area. There are no predicted long-term impacts on the populations of this species by mining operation if the correct mitigation measures are followed (IUCN).

- **Leopard:** The number of antelope and other possible prey for Leopards are relatively high within the mining footprint. With increased activity they are likely to avoid the area as they are very reclusive animals. In times of drought or when there is an increased pressure for prey, they may stray into the farm area to hunt. The biggest threat that the proposed project poses to these animals is conflict with staff. If any Leopards are seen, they must be avoided as they can be especially aggressive when they feel threatened. If the correct mitigation measures are followed there are no foreseeable negative impacts on the populations of these predators (IUCN).

- **Lion:** Lions were not recorded on the farm during the camera trap surveys, but it was established through consultation that they, very rarely, venture into the area to hunt. These animals are likely to avoid the area once the construction and operation of the mine starts. If, however, they are seen they must be avoided at all costs as they are very dangerous. Conflict between these animals and project staff must be avoided at all cost. As these animals very rarely frequent the farm, there are no foreseeable impacts on their populations (IUCN).

- **Reptiles:** Many of these species are likely to move away from the areas of construction and operation. A threat posed to reptiles is conflict with workers and run over by vehicles. There is a negative stigma attached to snakes and they are often killed on site when encountered. There is a high risk of workers at the site encountering snakes, including venomous species. No snakes encountered at the construction sites must be handled or harmed by workers.

The management of the temporary camps is of great importance particularly in view of food waste disposal. If this is done poorly it will attract rodent scavengers which will invariably attract snakes, some of which are venomous. Drivers along main and access roads must be informed of the dangers they pose to reptiles on the road. Care must be taken to avoid hitting these animals.

The impact is rated as **negative, moderate and medium term.**

7.2.2.2 Conflict between construction and mine workers and fauna

The possibility of conflict between local fauna and project workers is considered low during the construction and operation phases, with the largest risk during the initial site clearance and establishment. Many of the faunal species occurring in the area will avoid any locales with increased human activity, however the dangerous game species found within the region are far ranging and nomadic therefore there is a possibility they may traverse the proposed site. Relocation of species found within the site footprint must be carried out by appropriate appointed personnel or a Department of Wildlife official. Strict procedures must be followed to avoid human/wildlife interactions at all costs for the safety of both workers and animals alike. This impact is **negative, slight and medium term**.

This impact is also expected to be applicable to the decommissioning phase of the project, where the mining activity has ceased and there is a possibility some animals will come back into the area, while rehabilitation works are still ongoing.

7.2.2.3 Excavations posing a threat to fauna

There is a risk of animals falling into excavated areas and being injured, trapped or killed. During the construction the excavations include trenches for services and foundations for various project components. During the operational phase of the project the excavations that pose a risk is mainly the open mine pit. Should any animals get trapped or be harmed in anyway, the relevant personnel must be informed. If these stipulations are followed the impact on animals can be mitigated. Considering that the mine site is within a functional cattle farm it is imperative that these excavations are managed correctly due to the high cattle densities. This impact is **negative, slight and medium term.**

7.2.2.4 Blasting negatively impacting fauna and potentially increasing mortality

Blasting will take place during the construction and operation of the project to break up rock material in the open pit. Fauna can be displaced by the disturbance caused by blast over pressure and vibration, and the possibility that fly-rock and debris can increase mortality of species. Furthermore, certain species reproductive success can be impaired by blasting events. However, blasting will be mostly contained within the pit, which limits the impact on fauna species. The impact of blasting on fauna is **negative, sight and medium term,** as occurrences of blasting are expected throughout the project construction operation.

7.2.2.5 Vehicle collision with fauna and livestock, and incidents of road kill

During construction and operation of the mine, trucks and vehicles will use existing roads and existing tracks to access the site. These roads may be utilised and frequented by game, livestock and small vertebrates. The risk of vehicle collisions poses a threat to both drivers, passengers, bystanders and animals. Drivers therefore, should be informed of the dangers, and strict regulations such as speed limits should be implemented and adhered to. If drivers adhere to regulations and remain cautious and aware the risk of collisions can be significantly reduced. This impact is classified as **negative, slight and medium term.**

7.2.2.6 Poaching

During construction phase workers may be tempted to catch and slaughter local wildlife species due to the availability of game in the area. This however should be strictly prohibited. No animals are to be poached or caught for re-sale or consumption purposes. It is highly unlikely that this impact will be severe due to the fact that fauna is expected to move out of the area due to the activities, but some opportunities for poaching will remain. An additional risk is the fact that the new access corridor also improves access for poachers into the area. The poaching impact is **negative, moderate and medium term.**

7.2.2.7 Increased ambient noise levels

Noise pollution from the use of heavy machinery will disturb local fauna, both during the construction and operational phases of the project. Animals that are affected by the increased noise levels are likely to vacate the area, but some may not be able to. This impact is classified as **negative, moderate and medium term.**

7.2.2.8 Lighting resulting in the disorientation of fauna

Artificial lighting can, disorientate terrestrial fauna, and attract migrating birds and invertebrates. This can negatively affect faunal behavioural patterns and result in collisions with infrastructure. Strategic lighting placement can severely reduce the significance of these impacts on the local fauna. Thus, the impact is considered to be **negative, moderate and medium term.**

7.2.2.9 Displacement of territorial species as a result of mine fencing

It is possible that the security fencing around the mine site will cause displacement, entrapment or confinement of species which inhabit or frequent the mine site. However, the significance of this impact is low as the regions surrounding the mine site have already been extensively fenced to demarcate the different farm boundaries as well as the various camps within the farm. Based on the camera trapping surveys, the species most commonly associated with the greater region are non-territorial and will vacate the area following increased anthropogenic disturbance at the onset of construction activities. This impact is **negative, slight and medium term.**

7.2.2.10 Potential impact of elephants migrating south through the veterinary fences

The ground water below the proposed T3 site is shallow (refer to hydrogeological specialist study in Appendix C1), and it is believed that the aquifer is very large. For the copper mining to take place, dewatering of the local water surrounding the pit will be undertaken. It has been proposed that water will be pumped into holding tanks for use as processing water. This has caused concern amongst the land holders within the region, as they are worried that the large volumes of water will attract elephants (*Loxodonta Africana*) from north of the veterinary fence. It must be noted that the project scope does not include any large water ponds (except for the TSF). Should an influx of Elephants from the north occur, it is likely that they will damage the fence and thus risk other species to venture south across the veterinary fence carrying foot and mouth disease (*Aphthae epizooticae*).

Considering that elephants have an affinity towards water, it is expected that any elephants within the local region of the T3 site will be drawn towards any sources of water. Based on the biodiversity fieldwork, it was found that elephants do rarely frequent the farms within the T3 region. Therefore, it stands to reason that, should the proposed water dams be constructed as part of the mine development, the Elephants venturing into the region may frequent the area. However, this does not necessarily mean that the T3 TSF will cause an exodus of elephants from the north of Botswana to the Ghanzi region. The impact of construction and operation will be **negative, moderate and long term**.

7.2.3 Construction and operational impacts on avifauna

The predicted impacts that the proposed development may have on the vultures within the region were also considered. As in other impact sections, this impact is considered for the various phases of the proposed project. These impacts are directed at all vulture species found within the area, however they are particularly relevant to White-backed vultures and Lappet-faced vultures as these are the species which have been confirmed to be nesting within the greater region.

- Loss of foraging area: The clearing, construction and operation of the T3 mine will cause a slight loss of foraging area in which vultures may search of food. However, considering the current land use and the relatively small size of the project footprint (compared to the area that vultures use for foraging), the significance of this impact is low. The impact is **slight, negative and medium term.** This is because the ranges of these birds are huge in comparison to the size of the proposed footprint and such the loss of foraging area will not severely impact the local vulture populations.

  Considering the relatively small size of the proposed project and the large home ranges of vultures it is unlikely the project will have any significant effects on the local vulture populations. However, it may be necessary to assess the occurrence of vultures nesting within the surrounding farms (within a 10 km radius) as the most significant impact of the proposed mine will most likely be disturbance as a result of blasting, causing panic to parent vultures. This may result in vultures abandoning nests which in-turn can increase the likelihood of egg and chick mortality.

- Poaching: Vultures are susceptible to human poaching, harvesting and exploitation. Although there were no vultures found in the T3 footprint, nests were identified in surrounding areas (the nearest nest to the project site was at approximately 7km). This must be treated in the same manner as poaching and exploitation of other fauna and must be strictly prohibited to personnel associated with the T3 project. The impact however is **slight, negative and medium term**.

- Decline in air quality: Construction activities, mining activities, haulage of goods and blasting will result in dust production which will cause a reduction in the quality of the air in the local area. This can potentially affect nesting and roosting vultures in the areas surrounding the T3 project site (not were found within the site), however the dust control mitigations recommended in this document reduce the significance of this impact on the vultures. The impact is classified as **slight, negative and medium term.**

- Noise disturbance (non-blasting related): Excessive noise can cause disturbance to vultures in the area particularly those nesting or roosting Overall this impact is not considered severe as the nearest nesting sites were found to be approximately 7km from the proposed T3 site, and noise models show that noise levels and noise contours (refer to Appendix E) do not reach this far. Furthermore, vultures forage during the day and will not remain in close proximity to areas of noise disturbance, as most noise generating activities will be carried out during the day initially during the construction phase, it stands to reason that this impact will not be significant. Thus, the impact anticipated will be **slight, negative and medium term.**

- Blasting related disturbance: Blasting can potentially cause disturbance to nesting vultures, whereby high blast overpressure can cause adult birds to and to abandon nests, resulting in failed breeding. However, there are no current nesting sites within the proposed mining area, and distance to the nearest nests (7km) is considered significant (as mentioned in the previous section). The impact is therefore considered to be **negative, slight and medium term.**

- Vehicle collisions along haul roads: As vultures feed on carrion it is likely that they will be attracted to any road kill, which will then put them at risk of collisions with vehicles, which would result in vulture mortalities. The impact is said to be **moderate, negative and medium term**.

- Risk of electrocution vultures: vultures are larger bird species and are often electrocuted when a bird bridges the gap between two phase lines or a phase and earth line. The risk is a high on smaller power lines such as the 33kV and 66kV lines. These bird species are often found roosting and nesting on power lines pylons or use the lines as vantage points. The powerlines are expected to remain in place after the mine closes. The impact is therefore categorised as **moderate, negative and long term**.
- Vulture collisions with power lines: vultures are at risk of collision with power lines. They may struggle to manoeuvre to avoid power lines and may collide with the lines resulting in injury and death. The impact is categorised as **moderate, negative and long term**.

7.2.4 Cumulative impacts associated with the T3 copper mine

7.2.4.1 Flora climate change resilience

Climate change can broadly be described as phenomena whereby significant changes of global climatic patterns result in alteration and changes to temperature, precipitation and relative humidity within large areas. Climate change can cause significant changes to abiotic conditions of habitats and environments. Considering that most species are highly adapted to their environments, changes to their environmental conditions would then often result in distribution shifts as species attempt to relocate to areas more suited to their environmental presences. It can be surmised that though there may be some changes to the vegetation community and composition within the T3 region as a result of the cumulative effects of the mining activities and climate change none of the species found within the region will be threatened with extinction.

7.2.4.2 Cumulative impacts to ecology

The impact of the various activities associated with the proposed project, combined with the current land uses (cattle farming), will affect the flora and fauna and will certainly result in a large cumulative impact. Within the T3 site the vegetation diversity and composition will be affected even after rehabilitation, this in turn will directly affect the fauna that will frequent the area. The cumulative impact of the proposed project, though severe to the localised vegetation communities, will not threaten the existence of any of these plant populations.

7.3 Air quality impact assessment

The purpose of the Air Quality Impact assessment was to identify the potential impacts and associated risks posed by the proposed T3 Copper Mine Project on the air quality of the area. The outcomes of the impact assessment have provided a basis to identify the key risk drivers and make informed decisions on the way forward to ensure that these risks do not result in unacceptable social or environmental risk. The impacts identified were for construction, operation and decommissioning phases.

The mitigated dust concentration results at specified sensitive receptors (refer to Chapter 5) are presented in tabular format, while concentration isopleths are presented graphically to indicate the dispersion of pollutants.

It must be noted that a post mitigation model will be developed during project implementation based on the implemented measures and dust monitoring results. Using the proposed mitigation measures, it is anticipated that dust will be reduced by 50% - 80% (WSP, 2018)

7.3.1 PM_{10} concentrations

Predicted PM_{10} concentrations associated with operations at the proposed T3 Copper Mine at the site boundary and at each sensitive receptor are presented in Table 7.1. Exceedances of the respective guidelines/standards are shown in red.

The maximum predicted concentration P100 (the 100th percentile) value was predicted and presented in the assessment for comparison with the WHO/IFC guidelines as an environmentally conservative approach. The 100th percentile does not eliminate outliers in the model, predicting more conservative results. The SA standards allow for four exceedances of the daily standard per annum. This allows for the fourth highest concentration P99 (99th percentile) to be presented and compared against the daily average SA standard.

Table 7.1: 24-hour, monthly and annual average PM_{10} concentrations predicted at each sensitive receptor and at the site boundary

Rec No.	Sensitive Receptor	WHO 24-Hour Av PM_{10} Guideline ($\mu g/m^3$)	P100 24-Hour Average ($\mu g/m^3$)	SA 24-Hour Av PM_{10} Standard ($\mu g/m^3$)	P99 24-Hour Average ($\mu g/m^3$)	BOS Monthly Av PM_{10} Standard ($\mu g/m^3$)	P100 Monthly Average ($\mu g/m^3$)	WHO Annual Av PM10 Guideline ($\mu g/m^3$)	SA Annual Av PM_{10} Standard	BOS Annual Av PM_{10} Standard ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)
Rec 01	Vorster homestead		53.20		19.02		6.14				1.94
Rec 02	Farm 153-NL		133.67		41.83		9.06				3.65
Rec 03	Workers homes north-east of Farm 153-NL	50	114.29	75	45.51	200	7.77	20	40	100	3.18
Maximum Fenceline			449.80		165.75		51.66				21.28

Annual average concentration at the site boundary exceeds the WHO guideline only

Figure 7.1 shows the plume isopleths for the monthly average PM_{10} concentrations for the proposed T3 Copper Mine. The 24-hour and annual average were also modelled and are shown in the specialist report in Appendix F.

Predicted P100 24-hour average PM_{10} concentrations exceed the WHO 24-hour average guideline of 50 $\mu g/m^3$ at the site boundary and at all surrounding sensitive receptors. However, predicted P99 24-hour average PM_{10} concentrations are expected to be below the WHO 24-hour average guideline of 50 $\mu g/m^3$ at all surrounding sensitive receptors. Predicted 24-hour average PM_{10} concentrations exceed the SA 24-hour average standard of 75 $\mu g/m^3$ at the site boundary although concentrations are compliant at all sensitive receptors.

Monthly average PM_{10} concentrations are predicted to be compliant with the Botswana monthly average PM_{10} standard of 200 $\mu g/m^3$ at the site boundary and all sensitive receptors.

Annual average PM_{10} concentrations exceed the WHO annual average guideline of 20$\mu g/m^3$ at the site boundary although concentrations are compliant at all surrounding sensitive receptors. Annual average PM_{10} concentrations are predicted to be compliant with both the SA PM_{10} annual average standard of 40$\mu g/m^3$ and the Botswana annual average standard of 100$\mu g/m^3$ at the site boundary and at all sensitive receptors.

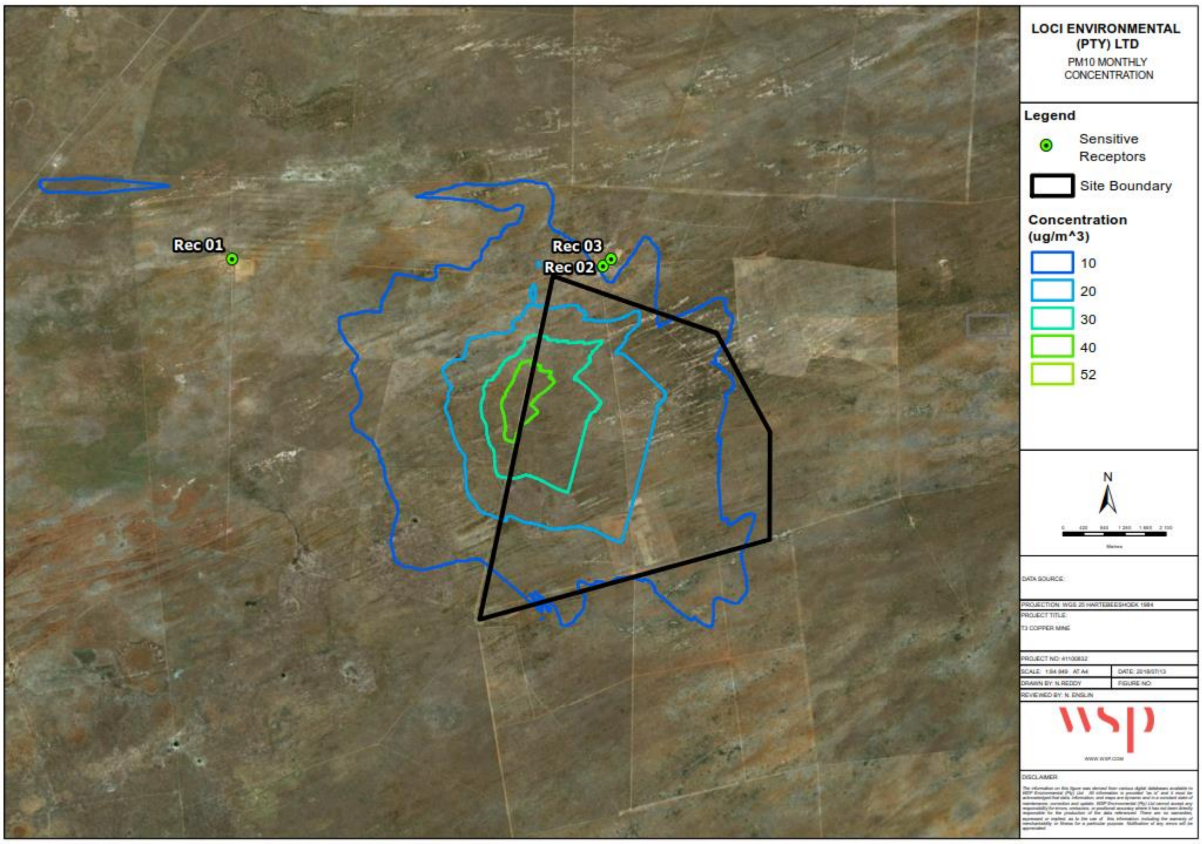


Figure 7.1: **Monthly average PM_{10} concentrations for the proposed T3 Copper Mine**

7.3.2 $PM_{2.5}$ concentrations

Predicted $PM_{2.5}$ concentrations associated with operations at the proposed T3 Copper Mine at the site boundary and at each sensitive receptor are presented in Table 7.2. Exceedances of the respective guidelines/standards are shown in red. Figure 7.2 shows the plume isopleths for annual and 24-hour average $PM_{2.5}$ concentrations for the proposed T3 Copper Mine. The 24-hour average was also modelled and is provided in the specialist report (Appendix F).

Table 7.2: 24-hour and annual average $PM_{2.5}$ concentrations predicted at each sensitive receptor and at the site boundary

Rec No.	Sensitive Receptor	WHO 24-Hour Av $PM_{2.5}$ Guideline (ug/m³)	P100 24-Hour Average (ug/m³)	SA 24-Hour Av $PM_{2.5}$ Standard (ug/m³)	P99 24-Hour Average (ug/m³)	WHO Annual Av $PM_{2.5}$ Guideline (ug/m³)	SA Annual Av $PM_{2.5}$ Standard (ug/m³)	Annual Average (ug/m³)
Rec 01	Vorster homestead	25	8.17	40	2.85	10	20	0.27
Rec 02	Farm 153-NL		18.06		7.00			0.51
Rec 03	Workers homes north-east of Farm 153-NL		15.60		6.42			0.46
Maximum fenceline			60.56		28.61			3.25

It must be noted that there are no Botswana standards for $PM_{2.5}$ and as such, $PM_{2.5}$ concentrations have been compared to the WHO guidelines and South African standards only.

The predicted P100 24-hour average $PM_{2.5}$ concentrations exceed the WHO guideline of 25 µg/m^3 at the site boundary although concentrations are compliant at all surrounding sensitive receptors. However, predicted P99 24-hour average PM10 concentrations are expected to be below the WHO 24-hour average guideline of 25 µg/m3 at all surrounding sensitive receptors. Predicted P99 24-hour average $PM_{2.5}$ concentrations fall below the SA $PM_{2.5}$ 24-hour average standard of 40 µg/m^3 at the site boundary and at all sensitive receptors.

Annual average $PM_{2.5}$ concentrations are compliant with both the WHO $PM_{2.5}$ guideline of 10 µg/m^3 and the SA 24-hour average standard of 20 µg/m^3 at the site boundary and at all sensitive receptors.

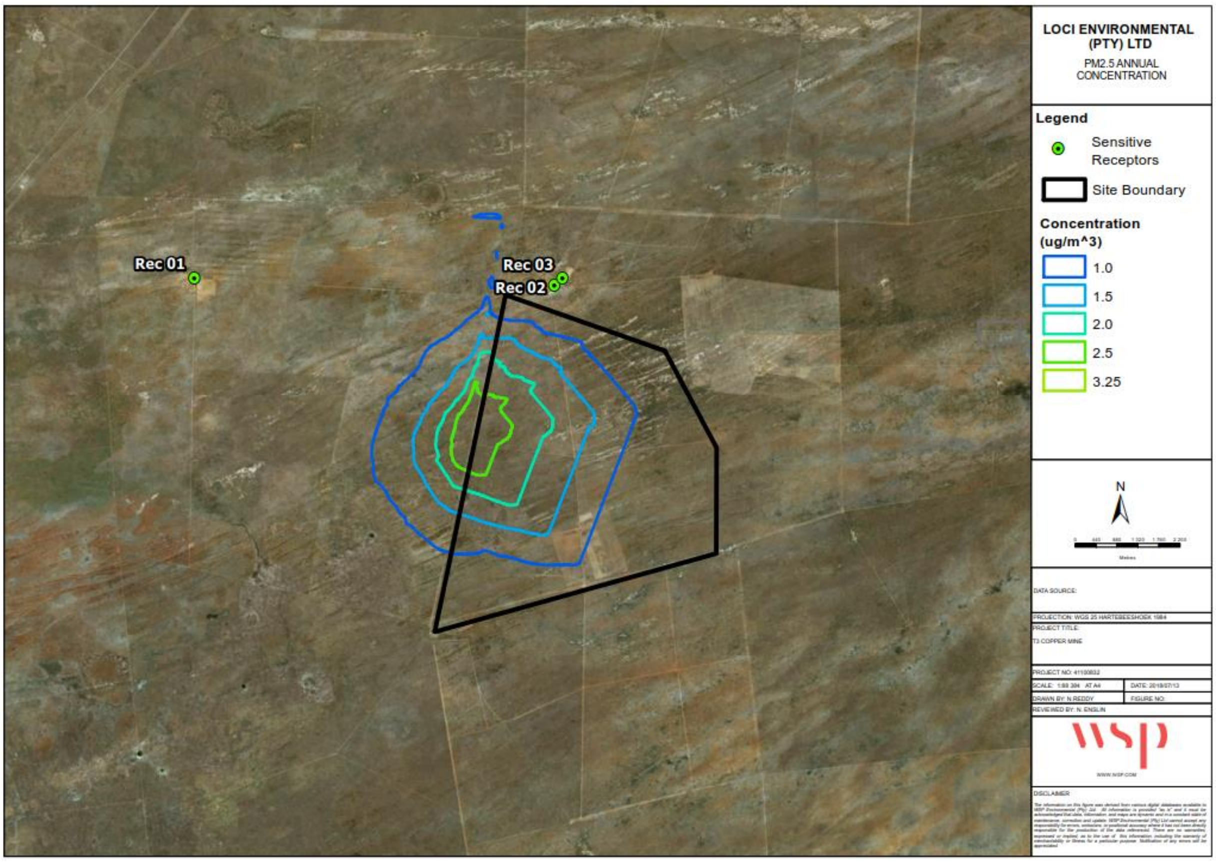


Figure 7.2: Plume isopleths for annual average $PM_{2.5}$ concentrations for the proposed T3 Copper Mine

7.3.3 Impacts for construction phase

- Decline in Air Quality: Dust will be generated from mining pit and processing plant areas and access road in preparation for the operation works of the T3 project. The impact is classified as **negative, moderate and short term**.

7.3.4 Impacts for operation phase

The anticipated impacts for operation of the proposed project are outlined below:

- Decline in air quality: Several activities from the mine area such as windblown dust, stockpiling, crushing, and unpaved roads will cause dust production/generation and dust clouds. Similarly, haul roads and access roads are used extensively in mining operations by mobile equipment to move material in and out of the mining areas. The road network at a mine site can have the potential for dust generation is dependent upon the traffic patterns at the site. This impact is classified as **negative, slight and medium-term.**

7.3.5 Impacts for decommissioning and rehabilitation phase

Dust will be produced during decommissioning activities or mine reclamation at areas such as mining pit, stockpiles, processing plant, infrastructure and accommodation areas. The production of dust during decommissioning works of the access road and mine infrastructure can also cause ecological problems for both flora and fauna. It would be advisable that dust management continues through this period and vehicles adhere to strict speed limits which will reduce the dust production. This impact is classified as **negative, slight and temporary.**

7.4 Noise impact assessment

The noise impact assessment was carried out for the proposed project and impacts identified were construction phase impacts and operational phase impacts of noise on sensitive receptors. Ambient sound level monitoring results are presented in Section 5.4.8 in Chapter 5. The field log sheets are presented in in the specialist report in Appendix E.

7.4.1 Impacts for construction phase

Predicted results at specified distances from the construction sources during the construction phase are presented in this section.

Based on a worst-case cumulative sound power of 115.96 dB(A), stemming from the predicted noisiest equipment that could be used during the construction phase (based on a modelling database and not actual measured results), the resultant noise levels at specified distances from the source are presented in Figure 7.3 and Figure 7.4.

7.4.1.1 Day-time noise levels

Noise levels in the immediate vicinity of the construction activities are predicted to be high. Noise levels at 500m from the source (which covers all receptors) drop below the BOBS 575:2013 standard (residential building rating day-time guideline level of 50 dB(A).

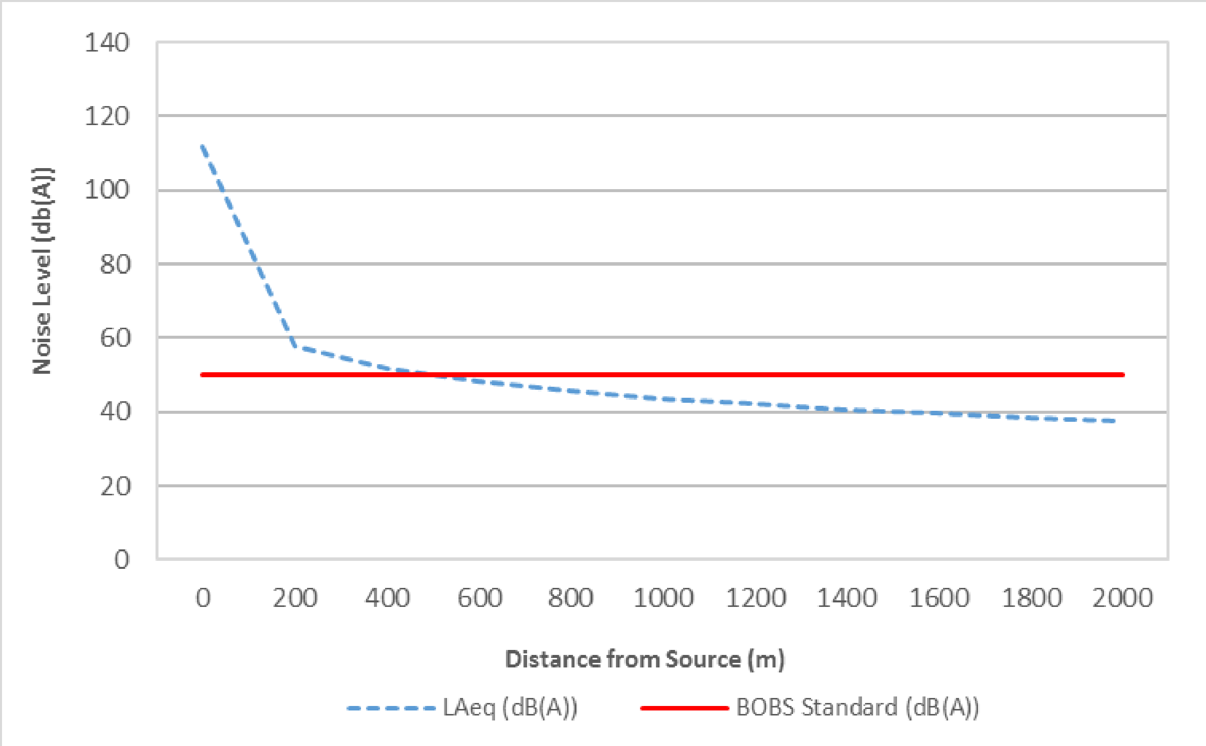


Figure 7.3: Worst-case predicted day-time noise levels associated with the construction phase

Resultant noise levels and predicted impacts at the receptor locations are presented in Table 7.3. These changes are assessed using the classifications presented in Chapter 4. It must be noted that these results represent a worst-case scenario (without mitigation) when construction activities are occurring on a portion of the proposed development and does not represent noise levels that will occur all the time.

Increases in noise levels at the sensitive receptor locations as a result of the construction activities will range from +3.6 to 7.7 dB(A). Such increases will result in “little” and “little to medium” community response when the construction activities are occurring in closest proximity to each of the receptors. Furthermore, the increase at Rec 02 and Rec 03 are above the 5 dB(A) threshold for annoyance as per the Gaborone Noise Control By-Laws. It is important to note that the construction phase is only temporary in nature. Additionally, the results represent a worst-case assessment with all the noisiest equipment operational simultaneously during the construction phase, which is unlikely to occur. Such increases are therefore expected at Rec 02 and Rec 03 in such close proximity to the proposed development.

Table 7.3: Predicted day-time noise levels at the receptors during the construction phase

Receptor ID	Predicted noise level (dB(A))	Existing day-time noise level (dB(A))	Cumulative noise level (dB(A))	Change in noise level(dB(A))	Estimated community response
Rec 01	29.6	43.4	43.6	+0.2	Little
Rec 02	41.1	47.6	48.5	+0.9	Little
Rec 03	40.6	47.9	48.6	+0.7	Little

7.4.1.2 Night-time noise levels

Noise levels in the immediate vicinity of the construction activities are predicted to be high, as would be expected. At 1,000m from the source, noise levels will reduce considerably, with noise levels at 2,700m from the source dropping to below the BOBS 575:2013: residential building rating night-time guideline level of 35 dB(A).

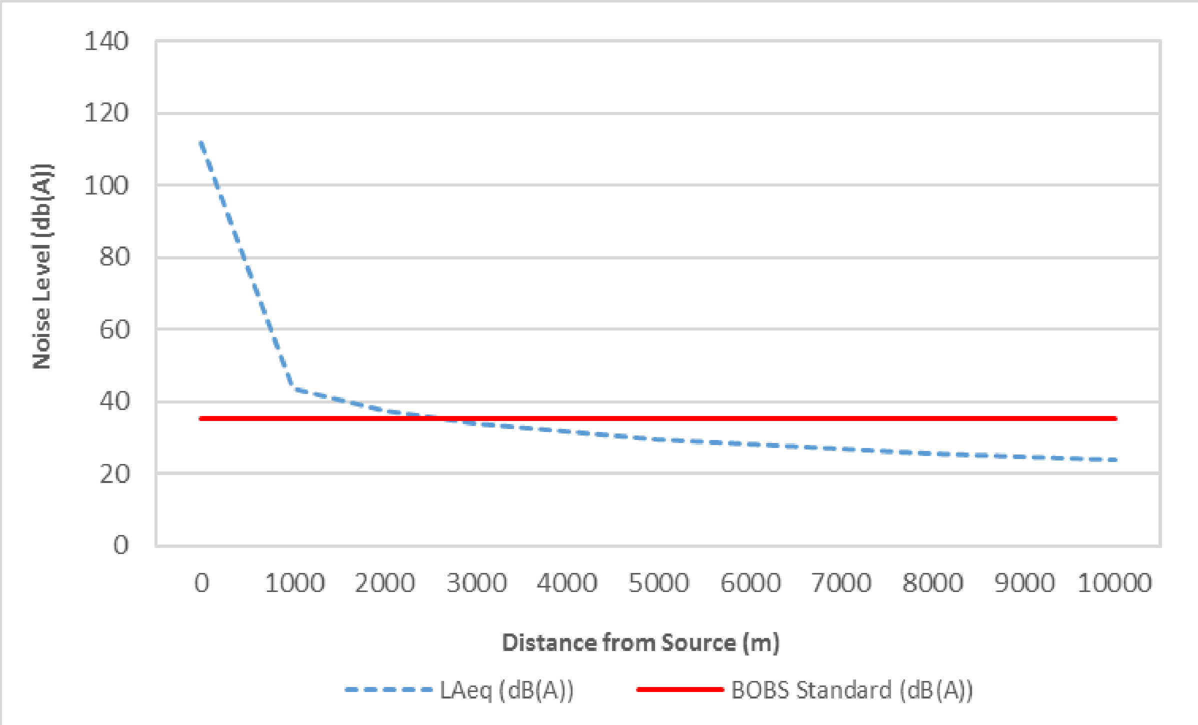


Figure 7.4: Worst-case predicted night-time noise levels associated with the construction phase

Resultant noise levels and predicted impacts at the receptor locations are presented in Table 7.4. This includes baseline noise levels to assess changes in noise levels at each location. These changes are assessed using the classifications presented in Chapter 4. It must be noted that these results represent a worst-case scenario when construction activities are occurring on a portion of the proposed development, and does not represent noise levels that will occur all the time.

Increases in noise levels at the sensitive receptor locations because of the construction activities will range from +2.8 to 11.8 dB(A). Such increases will result in "medium to strong" to "very strong" community response when the construction activities are occurring in closest proximity to each of the receptors. These increases are above the 5 dB(A) threshold for annoyance as per the Gaborone Noise Control By-Laws.

It is important to note that the results represent a worse-case assessment with all the noisiest equipment operational simultaneously during the construction phase, which is unlikely to occur. Additionally, the construction phase is only temporary in nature. **It must also be noted that most of the construction will be undertake during day-time only, and night works are expected to be limited.**

Table 7.4: Predicted night-time noise levels at the receptors during the construction phase

Receptor ID	Predicted Noise Level (dB(A))	Existing Night-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change in Noise Level(dB(A))	Estimated Community Response
Rec 01	29.6	30.0	32.8	+2.8	Little
Rec 02	41.1	29.6	41.4	+11.8	Medium to strong
Rec 03	40.6	33.3	41.3	+8.0	Little to medium

The potential intensity of the impact is **negative**, **significant and short term.**

7.4.2 Operation phase

Predicted day-time and night-time noise levels from the proposed T3 Copper Mine at the three receptor locations during the operational phase are presented in Table 7.5, 7.6 and 7.7. Graphical outputs of the modelled results for the operational phase are presented in Figure 7.5 and 7.6. It must be noted that the visual outputs presented here are for the proposed T3 Copper Mine operations only and are not cumulative (i.e. taking the existing background noise levels into account).

7.4.2.1 Predicted day-time noise levels during blasting

Cumulative day-time noise levels in the immediate vicinity of the site are predicted to be below the BOBS 575:2013: residential building rating level of 50 dB(A). Changes in noise levels ranging from 0 to +1.7 dB(A) are anticipated at the receptor locations, with the largest change predicted at Rec 02 (Farm 153-NL), located approximately 470m from the proposed T3 Copper Mine. In line with the SANS categories of community/group responses, such increases are considered to have “little” impact to the receptors. Furthermore, increases in noise levels do not exceed the 5 dB(A) threshold for annoyance as per the Gaborone Noise Control By Laws.

Table 7.5: Day-time acoustic model results during the blasting operational phase of the proposed T3 Copper Mine

Receptor ID	Predicted Noise Level (dB(A))	Existing Day-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change in Noise Level(dB(A))	Estimated Community Response
Rec 01	16.2	43.4	43.4	+0.0	Little
Rec 02	44.5	47.6	49.3	+1.7	Little
Rec 03	43.9	47.9	49.4	+1.5	Little

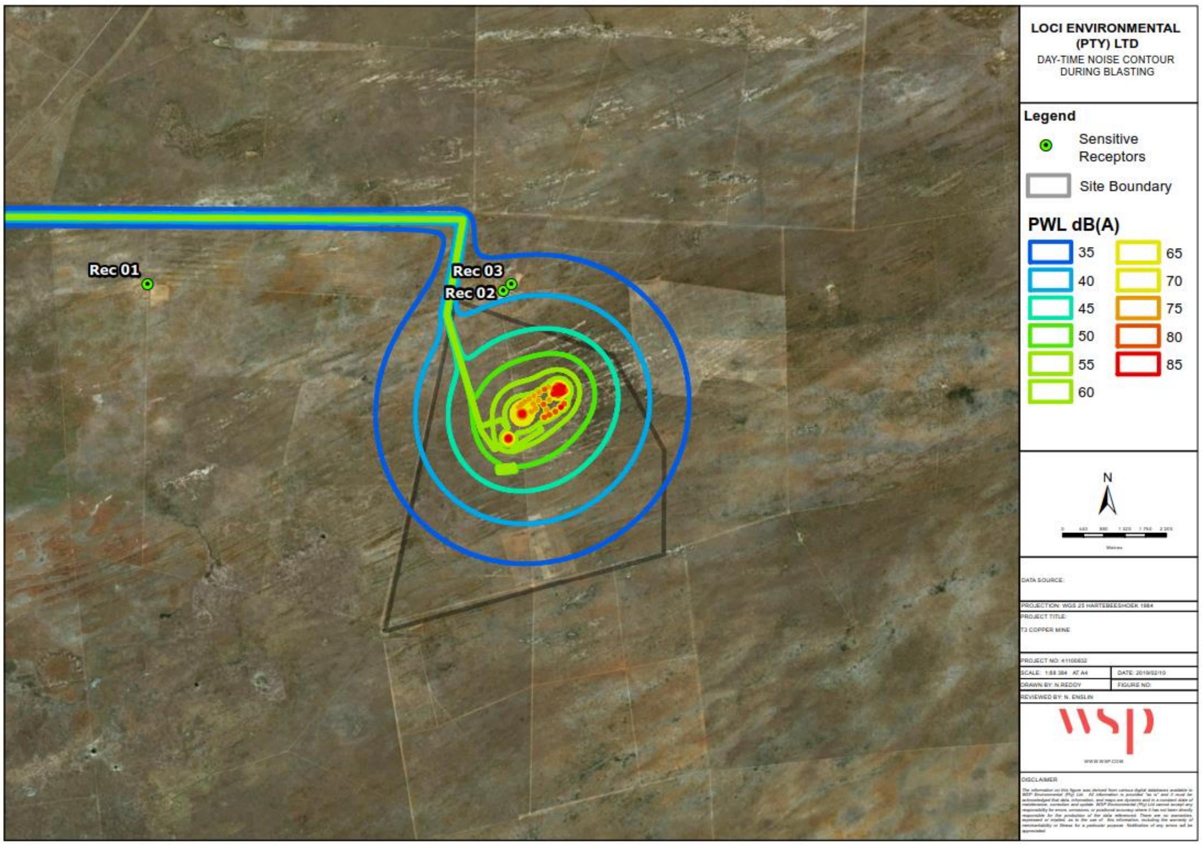


Figure 7.5: Day-time noise contour <u>during blasting (worst case)</u>

7.4.2.2 Predicted day-time noise levels without blasting

Cumulative day-time noise levels in the immediate vicinity of the site are predicted to be below the BOBS 575:2013: residential building rating level of 50 dB(A). Changes in noise levels ranging from 0 to +0.8 dB(A) are anticipated at the monitoring locations, with the largest change predicted at Rec 02 (Farm 153-NL). In line with the SANS categories of community/group responses, such increases are considered to have "little" impact to the receptors. Furthermore, increases in noise levels do not exceed the 5 dB(A) threshold for annoyance as per the Gaborone Noise Control By-Laws.

Table 7.6: Day-time acoustic model results during the operational phase without blasting of the proposed T3 Copper Mine

Receptor ID	Predicted Noise Level (dB(A))	Existing Day-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change in Noise Level(dB(A))	Estimated Community Response
Rec 01	16.2	43.4	43.4	+0.0	Little
Rec 02	40.5	47.6	48.4	+0.8	Little
Rec 03	40.3	47.9	48.6	+0.7	Little

7.4.2.3 Predicted night-time noise levels

During the night-time, predicted noise levels (cumulative sound levels) are expected to be in excess of the BOBS 575:2013: residential building rating level of 35 dB(A), with the exception of Rec 01. Changes in noise levels ranging from 0 to +12.4 dB(A) are anticipated at the monitoring locations, with the largest change predicted at Rec 02 (Farm 153-NL). The change in noise levels will result in "little" to "medium to strong" estimated community response. Furthermore, increases in noise levels at Rec 02 and Rec 03 exceed the 5 dB(A) threshold for annoyance as per the Gaborone Noise Control By-Laws. The resultant impact on these receptors can be attributed to the mining activities occurring in the pit which is located in close proximity to Rec 02 and Rec 03.

Table 7.7: Night-time acoustic model results during the operational phase of the proposed T3 Copper Mine

Receptor ID	Predicted Noise Level (dB(A))	Existing Night-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change (dB(A))	Estimated Community Response
Rec 01	-	30.0	30.0	+0.0	Little
Rec 02	41.7	29.6	42.0	+12.4	Medium to Strong
Rec 03	41.4	33.3	42.0	+8.7	Little to medium

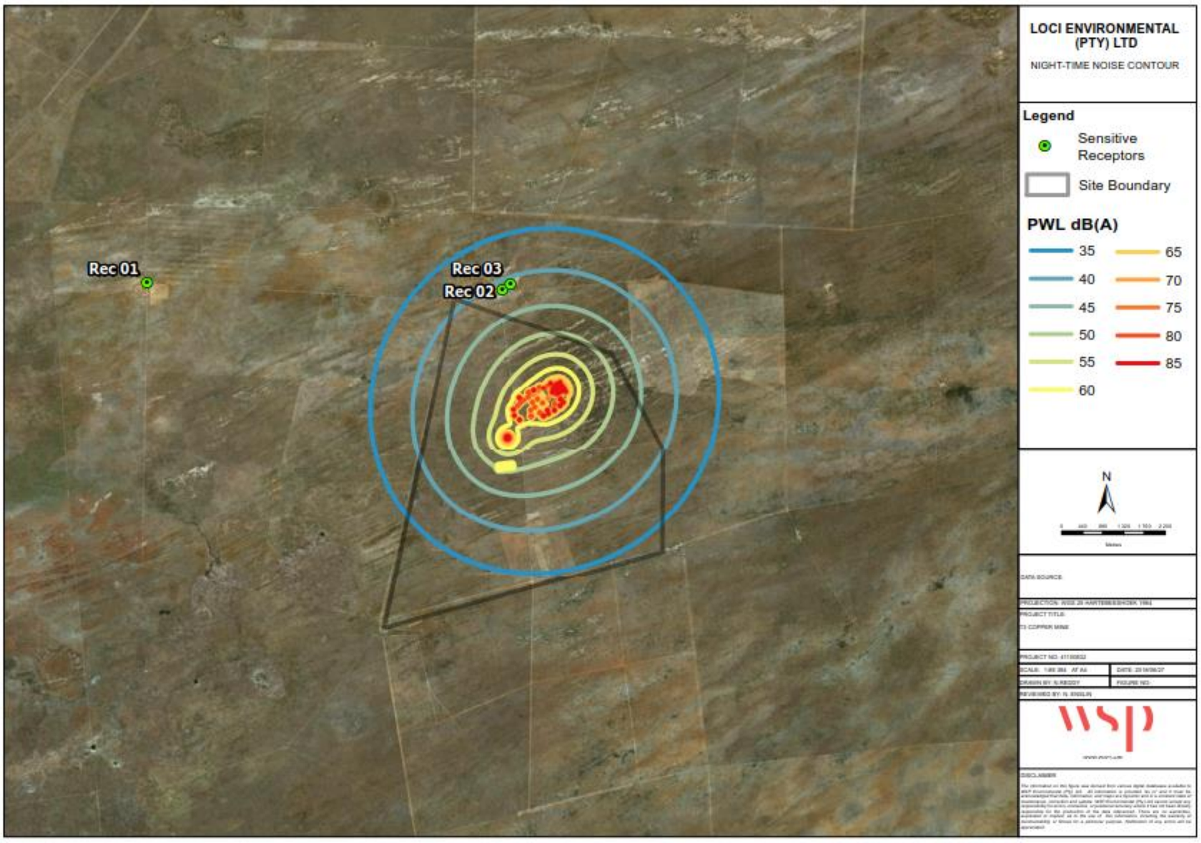


Figure 7.6: Night-time noise contours

The potential intensity of the noise impact during the operational phase is **negative**, **moderate and medium term.**

7.5 Soils

The soil impacts are expected to commence during the construction stage, and as the majority of the site preparation and soil stripping will take place during this stage, this is the main project phase the impacts will occur (approximately 400 ha plus the areas for the infrastructure corridors, construction camp). However, the mine pit footprint will continue to expand as the operation of the mine continues, and impacts on soils will continue during this phase. The following impacts are anticipated:

7.5.1 Soil fertility

When topsoil is stripped and stockpiled for mining, the A horizons (topsoil) and B-horizons (subsoil) are mixed with lower-laying horizons that are often lower in nutrients and organic carbon, resulting in a soil mixture that has different (and most likely) lower soil fertility properties than the original soil profiles. Apart from the change in plant nutrient concentration for this “new” soil, the texture is also altered by the mixing of the soil horizons.

Based on the soil chemistry study done by Terra Africa (2017) (refer to Appendix G) for the largest part of the site, the difference between the topsoil and subsoil chemical properties is not significant enough to require separate stripping and stockpiling of the A and B horizons.

There was one point in the study marked V4, and the area around this point should be re-examined before the mining project commences and the area affected by sodicity delineated from the unaffected areas. Based on the designs the area around V4 is not affected by the mine development. Should the area be affected, it is of utmost importance that soil stripping in this area be handled separately from the rest of the site. The sodic soil should be stripped and stockpiled separately and not be mixed with the rest of the topsoil stockpiles. This area should also be carefully rehabilitated with indigenous vegetation with a high sodium tolerance. Further mitigation is described in Chapter 9. The impact is **negative, negligible and long term.**

7.5.2 Increased erosion and loss of topsoil

Clearing of vegetation, creation of access roads and use of heavy machinery will disrupt the soil substrates which could result in erosion, particularly during the wet season. Vegetation stabilizes and anchors soil and increases the infiltration of water into the soil layers. Proper drainage systems are required to limit erosion, should excessive erosion occur, the nutrient concentrations of the surface substrates would become depauperate and this would then impede rehabilitation efforts following mine closure phase. High particulate content in groundwater sources also impacts water quality which directly affects the local biota. This impact is **negative, moderate and long term.**

7.5.3 Soil contamination by hydrocarbon spillages

The use, improper storage, and, the refuelling of heavy construction machinery can easily result in spillage of hydrocarbons, which are harmful to both flora and fauna in biotic communities. Spills are easily managed and are short term. A hydro carbon management plan is normally put into action, and in some cases, a bio-remediation system is set up for contaminated soils. The impact is **slight**, **negative and long term.**

7.6 Water resources

Mining is perceived as being an inherently polluting activity due to it disturbing the natural environment by removing the underground strata and redistributing waste material, the human/mechanical activity involved in this process and the chemicals used in their operation.

The potential hydrogeological impacts from the proposed T3 mine can be considered in two ways; firstly, the effects of groundwater abstraction and secondly those activities that have the potential to pollute to groundwater. Mine infrastructure facilities such as fuel storage and workshops should be considered as potential point source risks to the environment, and as such, precautions and mitigation measures are required to protect the environment from them. A hydrogeological model was developed to assess the groundwater impacts.

7.6.1 Conceptual hydrogeological model

The perceived (conceptual) hydrogeological model is presented in Figure 7.7. The T3 mine area is hydrogeologically complex with water flow and storage controlled by a combination of major and minor faults.

The Kalahari layer (refer to Figure 7.7) consists of sand and calcrete is thin being generally <10m thick and overlies a weathered and fractured mudstone, thus there is the potential for direct infiltration as a result of heavy intensive rain events. Chloride mass balance calculations give a preliminary estimate of groundwater recharge of 9.8mm/yr. These estimates are based on the annual chloride deposition rate value of 336mg/ m^2/yr determined by Selaolo (1998) and an average rainfall of 450mm/yr.

The analysis of drill core and of recorded water strikes showed that the top 140m from surface is the most fractured and where the majority of water was encountered. Thus, the perceived hydrogeological regime is recharged by direct infiltration through the Kalahari layer to the underlying strata, where water percolates downwards through minor fractures intersecting the major faults/thrusts with a localized flow to the northeast. The water quality reflects this with $CaHCO_3$/ Ca-(Na)-Mg-HCO_3 type waters in the mine area changing to $NaHCO_3$ type waters down gradient.

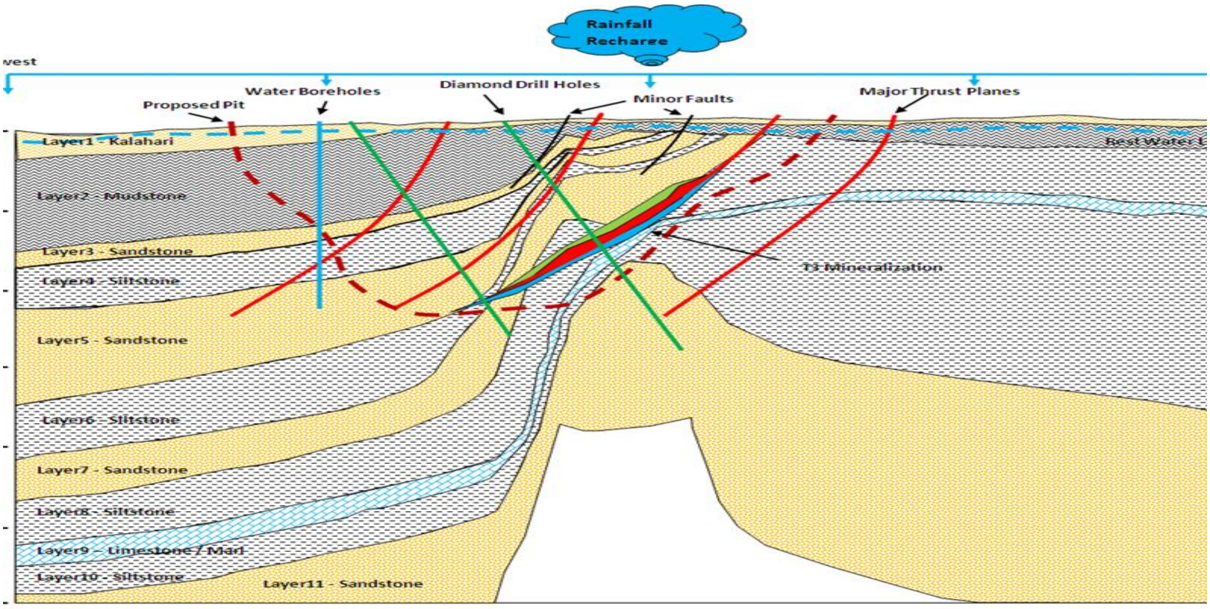


Figure 7.7: Conceptual hydrogeological model (WSB, 2018)

7.6.2 Construction impacts

Construction impacts are considered short-term duration and are probably less likely to cause any significant long-term impact. Oil spills and leaks from heavy equipment plant (excavators and trucks moving materials, soils etc) and oil and fuel storage areas are some potential hazards. The actual construction works do not appear to be a hazardous activity in terms of groundwater impact.

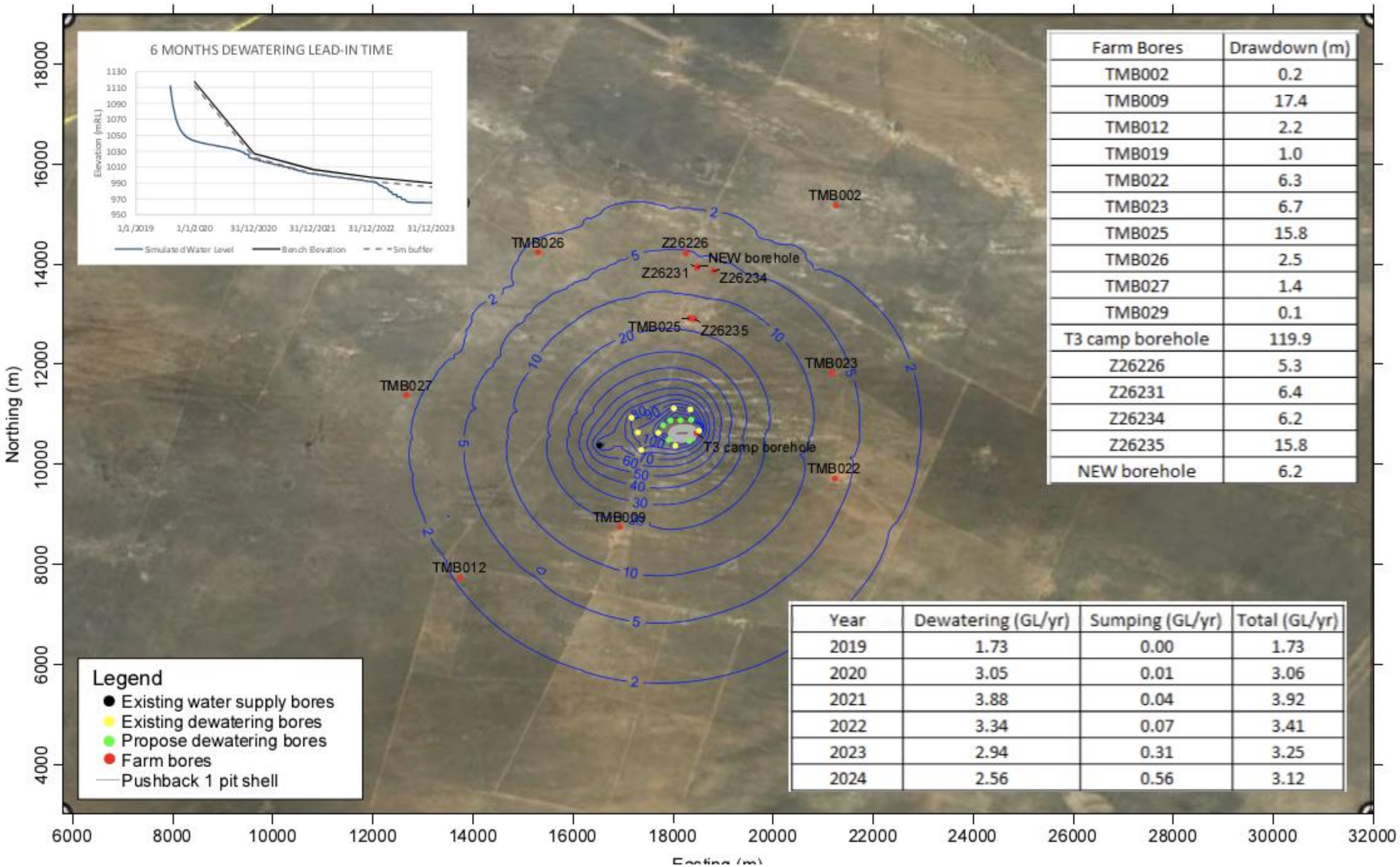
7.6.3 Groundwater abstraction impacts

The following impacts due to groundwater abstraction to meet the water demand of the mine have been identified and are summarised in Table 7.8. The impacts will start to occur as soon as abstraction commences (during construction phase).

- Declining borehole yields due to fracture dewatering of the mine site:
  - The proposed T3 mine has a water demand of 2,664Mm^3/annum (7,992m^3/day), which is to be supplied from boreholes drilled within the T3 mining area. However, to allow for mining there will be the need to de-water the area around the pit to limit pit in-flows and maintain dry pit walls for pit stability, and active aggressive dewatering is anticipated. The result of which, would be the dewatering of the water bearing fractures near the pit and their subsequent declining yields, which has been shown to be where the majority of water strikes and thus water bearing fractures occur. Thus, over time (based on preliminary modeling, which requires additional testwork to confirm), potentially more boreholes would be required to maintain water supply and meet the mines water demand because of lower borehole yields.
- Declining water levels near the mine and surrounding areas:
  - As a result of groundwater abstraction at the T3 mine, the water levels within the area immediately around the pit and adjacent areas will decline. Due to the abstraction at the T3 mine site (primarily dewatering), a local cone of depression will be developed preferentially along strike of the major water bearing fractures.
  - Pump testing showed that boreholes located on the same water bearing fractures declined, consequently private boreholes located on these fractures may be impacted, as shown by the numerical groundwater modelling. Based on the preliminary modelling (which will require additional test work) the radius of this impact is small and only 3 or 4 boreholes (mostly within farm 153-NL) are impacted.
  - The aquifer is a secondary porosity aquifer with no primary porosity, the water being stored and flowing along fractures. The major water bearing fractures trend northeast-southwest and dip to the north, thus shallow boreholes north of the mine are unlikely to be affected by abstraction at the mine.
  - As indicated above, the depth of most of the private boreholes is unknown. However, they are not likely to be deeper than 60m (the deepest known borehole), as private boreholes tend to be terminated after the first significant water strike, which conforms to the water strike statistics around the T3 proposed pit.
  - On cessation of pumping, the water levels would slowly recover.
  - The pit will not be filled in thus a post mining pit lake will develop.
- Decline in water quality:
  - Regionally the TDS increases north wards away from the T3 mine area, thus the water quality of private boreholes north of the mine is unlikely to deteriorate. However, it must be noted that at the time of completing this report a full year of groundwater monitoring had not been completed, and baseline in relation to groundwater quality and flow direction is still further developed.

- Poorer quality water could be drawn towards the mine because of abstraction (reversal of the groundwater flow) direction. This is based on preliminary modeling, which requires additional testwork to confirm,
- There is no indication of an increase in TDS with depth, thus the up-coning of deep poorer quality water is unlikely.

The abstraction impacts (worse case, based on current test work) is illustrated in Figure 7.8. Based on the current groundwater test work and modelling it shows that the groundwater drawdown as a result form the project is limited almost entirely within the boundaries of farm 153-NL (5 year drawdown). Further test pumping and modelling is planned as part of the feasibility studies to confirm this predicted impact, and groundwater monitoring is ongoing/continued.



Farm Bores	Drawdown (m)
TMB002	0.2
TMB009	17.4
TMB012	2.2
TMB019	1.0
TMB022	6.3
TMB023	6.7
TMB025	15.8
TMB026	2.5
TMB027	1.4
TMB029	0.1
T3 camp borehole	119.9
Z26226	5.3
Z26231	6.4
Z26234	6.2
Z26235	15.8
NEW borehole	6.2

Year	Dewatering (GL/yr)	Sumping (GL/yr)	Total (GL/yr)
2019	1.73	0.00	1.73
2020	3.05	0.01	3.06
2021	3.88	0.04	3.92
2022	3.34	0.07	3.41
2023	2.94	0.31	3.25
2024	2.56	0.56	3.12

Figure 7.8: Predicted 5-year water table drawdown – worse case scenario (Knight Piesold, 2019)

Table 7.8: Groundwater abstraction impacts

Impact	Scale of change	Severity level	Duration	Comment
Declining yield	Negative	Moderate	Medium term	Reversible
Declining water levels	Negative	Moderate	Medium term	Reversible
Decline in water quality	Negative	Slight/low	Medium term	Reversible
Formation of a pit lake	Positive	Low	Long term	Has the potential to be used as a source of water

7.6.4 Potential pollution source impacts

The method used for assessing contamination or potential contamination was the source - pathway - receptor model. Generally, the worst case scenario (or worst case receptor) is to judge whether groundwater at a location or outside a site is fit for human consumption i.e. within the BOS32:2015 standard. As indicated above the groundwater at the mine site is generally within the standard, apart from a few boreholes that have elevated iron and manganese concentrations. There is some localised nitrate contamination from farming activities as well, but this was not shown in the groundwater monitoring data collected to date. The present quality data marks the baseline parameters to which any changes will be measured.

Prior to discussing the potential pollution impacts, it is necessary to consider firstly what, if any, potential pollutant sources there are within the development of the mine, and secondly the pathways down which any contaminant might travel.

Without leakage, spillage, or bad housekeeping of any materials on site, there is no source material available to migrate from site. Pollution Control on site is therefore a key area of importance. It will be of key importance to consider potential problems, management and infrastructure controls.

Secondly, removing the pathway or routes for any contamination to leave the site eliminates the potential risk altogether, that is all potential sources are constructed with protection measures to eliminate any leakage. Conversely, operations or developments which open new pathways are a considerable risk.

However, for the release of any substances to have an impact on the environmental regime not only does there need to be a source (i.e. leakage or spillage) and a pathway or conduit for that source to move down, there also needs to be a receptor for the source to impact on, i.e. the groundwater.

Figure 2.3 (on page 22) shows the mine infrastructure development layout, and the potential impacts, if they are not controlled, are summarised and discussed below.

The identified potential pollutant sources, identified from the Feasibility study flowsheet, and their potential pollution impacts are discussed below. All these sources can be considered as point risk sources that could occur if no control measures were put in place in their design, construction and use.

- Process plant:

- The method to produce a copper concentrate and tailings will involve the crushing and grinding of the ore followed by rougher, cleaner and recleaner flotation. The concentrate will be thickened, filtered and stockpiled prior to being loaded into containers for storage and subsequent transport to third-party smelters. The flotation tailings will be dewatered by thickening and disposed at the Tailings Storage Facility.
- A variety of chemicals (not all hazardous to groundwater) including Lime, Potassium Amyl Xanthate (PAX), Sodium Isobutyl Xanthate (SIBX) and Flocculant delivered in dry form and mixed on site and Thionocarbamate (XD-5002) Polyfroth H57 delivered in liquid form will be stored on site and used in the process.

- Waste Rock Dump:
  - The principal risk from the waste rock dump is from the leaching of minerals as a result of rainfall and the subsequent drainage into the groundwater. Geochemical characterisation studies (Knight Piesold 2018) of the waste rock showed the waste rock to be non-acid forming (81%) or acid consuming (19%), due to low sulfide content and high acid neutralising capacity, the majority of which was indicated to be derived from carbonate minerals. Thus, acid generation and drainage from the waste dumps was considered unlikely to be a risk. The study concluded that any leachate was unlikely to meet drinking water guidelines and should not be permitted to enter potable water supplies (refer to Section 7.7)
  - During the rainy season the rock dumps could cause increased run-off, which may pool around them or flow around the mine site if a suitable drainage system is not in place.
- Tailings Storage Facility (TSF):
  - As with the waste rock dump the leakage of minerals into the groundwater is the principal risk posed by the TSF. If leakage occurs apart from chemical contamination it will also provide a groundwater mound underneath the dam. The supernatant liquid from the dam will be decanted off and reused as process water. The natural calcrete layer and the lining on the tailings dam will help manage these issues.
  - Pipelines for the transmission of tailings and for recycling water will potentially pose a leakage risk along their whole length.
- Sewage Works:
  - The proposed waste water treatment plant is an Activated Sludge Bioreactor (ASBR) type sized to service the process plant and overall site infrastructure. The unit specified achieves “Class C” treated effluent, which is suitable for reuse in “low risk” applications. The treated effluent will be discharged to the TSF, whilst the solids/wastewater treatment sludge will be stored in a sludge tank to be periodically collected by a sludge truck for disposal.
  - The main impacts of contamination from sewage are: chemicals which are regarded as persistent in groundwater, such as the dissolved inorganic ions of nitrate and chloride. These are described as “mixers”, as they are mix with and move with the body of groundwater; micro-organisms including pathogenic bacteria, viruses and parasites, all of which eventually die and are non-persistent; organic waste material which in ideal soil conditions could be fully oxidised to carbon dioxide, water, nitrates, sulphates and phosphates, etc. Excess organic waste results in elimination of dissolved oxygen and hence anaerobic conditions, mobilisation of trace metals and inorganics, higher levels of dissolved and suspended solids and clogging of pores in the aquifer. This is a combination of persistent and non-persistent factors. It must be noted that these chemicals are also common in areas where farming is present.

- Waste Material Storage:
  - No landfill is planned to be constructed, rather waste will be collected at a waste holding/transfer station. Domestic waste can cause contamination of the groundwater, especially during the rainy season, by leaching of organic materials such as putrescible food wastes and of waste oil and solvents. Other waste products which could cause this would be the process chemical containers.
- Fuel storage:
  - A bulk fuel storage facility and associated fuelling points will be constructed, however the total storage capacity and optimum configuration have not been finalised. The leakage of hydrocarbons and contamination is a risk (if not stored correctly and other preventative measures are not implemented), given that there is very little protection provided by the unsaturated zone to degrade or prevent rapid downward migration of hydrocarbons. Further, given the secondary permeability nature of the aquifer, (fracture flow) migration of contaminants can occur. However, groundwater abstraction will draw these towards the pit where contaminated fractures intersect the pit, but if contaminated water is used in the processing it will be dispersed to re-enter the system at another location.
- Explosive store:
  - Explosives in common use are ANFO and others for use in wet conditions. ANFO is ammonium nitrate (NH_4NO_3) fuel oil and is usually mixed on-site at the time of use, with detonating material added to the mix in the hole. The incomplete explosion of the explosives may be one source of ammonium and nitrate ions, and possibly hydrocarbon, to the water in the pit sump and another would be direct leakage from the explosives store.
- Workshops:
  - The workshops are a potential low volume point source risk due to the nature of the work undertaken (vehicle repair and servicing) and the hydrocarbon-based chemicals used – engine oil, hydraulic oil, cleaning solvents etc. It must be noted that oil-water separators are planned to be installed (see Chapter 9).

Table 7.9: Pollution source impacts

Impact	Scale of Change	Severity Level	Duration	Comment
Process Plant – groundwater contamination from the chemicals used from inadequate control of spillage and leakage from chemical storage	Negative	Moderate (without adequate control measures – see comment)	Short term (if a spill occurs)	Low with adequate control measures in place
Waste Rock Dump – mineral leaching and downward leakage into the groundwater and laterally from run-off	Negative	Moderate	Medium term	Suitable drainage system to capture run off and sediment collection to be designed
Tailings storage Facility – leakage of minerals and hydrocarbon bi-products from the chemicals used	Negative	Moderate	Medium to long term	Low with adequate control measures in place
Water storage – groundwater contamination due to leakage of recycled process water and from pollution control dams	Negative	Moderate	Medium term	Low with adequate control measures in place
Sewage – chemical, biological and pathogenic contamination	Negative	Moderate	Medium to long term	Low unless the facility does not function properly and contaminated waste leaks from waste water storage facility
Waste Material	Negative	Moderate	Short term	Low with adequate control measures in place
Fuel Storage – hydrocarbon contamination of soil and groundwater	Negative	Significant/high	Long term	Low with adequate control measures in place
Explosives contamination of groundwater by nitrate and hydrocarbon	Negative	Low	Short term	none
Workshop – oil, lubricant and solvent contamination of groundwater from spillage	Negative	Low	Medium term (short term if there is a spill and cleaned up)	Low with adequate control measures in place

7.6.5 Cumulative impacts

The abstraction of groundwater will cause the progressive lowering of the piezometric surface and the expansion of the cone of depression for the period that abstraction occurs. On cessation of pumping water levels would slowly recover and the natural groundwater flow direction would return.

Chemical contamination of groundwater is not expected if adequate control measures are in place. However, if continued leakage were to go unnoticed, the effects would slowly increase the ionic composition of the groundwater. Residual effects would result from either a single major hydrocarbon spillage or a slow gradual leakage and from sewage contamination. This would be due to the fractured nature of the aquifer, which would make the clean-up of hydrocarbon contamination difficult and the long life of pathogens.

7.7 Geochemical impacts identified

A detailed geochemical assessment was undertaken, based on lab analysis of many rock samples selected from the site. Based on the results, the following impacts were identified:

7.7.1 Acid forming potential

The samples from the T3 project site had low sulfide contents and high ANC, the majority of which was indicated to comprise carbonates. Accordingly, 81% of samples were classified as non-acid forming (NAF), with the remainder considered as acid consuming (AC). This is due to low sulfide contents and high ANC, the majority of which was indicated to be derived from carbonate minerals.

Based on these results, acid generation and drainage from the waste dumps is unlikely to be a risk to the project. However, additional testing should be conducted on an on-going basis during mine operation to ensure that the samples tested to date are representative of the overall waste rock to be mined.

The impact has been classified as **negligible**.

7.7.2 Multi-element enrichment

The results of the multi-element analysis and comparison to average crustal abundance indicates that:

- The multi-element testing typically identified a low to moderate number of enriched elements.
- The most commonly enriched elements were silver, arsenic, bismuth, cadmium, copper, lead and zinc.
- The material within the mineralisation halo typically recorded significantly higher levels of enrichment.
- Most samples met the soil quality screening guidelines for human health, although 26% of samples exceeded the threshold for arsenic. No samples met the ecological or soil contamination guidelines, with antimony, arsenic, chromium and sulfur being the most common exceedances. In addition, no samples met the soil remediation guidelines, with antimony, arsenic and barium being the most commonly exceeded.

- Based on the multi-element analysis results, a cover system will be likely be required (planned for, refer the Chapter 12) on closure to prevent the waste from being exposed in the external surfaces of the final landform.

The impact has therefore been classified as **negative, moderate and long term.**

7.7.3 Metal leaching assessment

The distilled water extract testing indicated that the clear majority of samples met the reference surface water quality values, including the average concentrations from all samples, despite exceedances of lead, pH and selenium in some samples. If these sample are representative of the overall waste rock to be mined, this means the following in terms of impacts:

- The runoff and seepage flow from waste dumps may be suitable for release into surface waters, or will be recovered for use as process water.
- In addition, kinetic testing may be warranted in subsequent design phases to assess the leachate quality in response to oxidation and weathering.

The leachate is unlikely to meet drinking water requirements and should not be permitted to enter potable water supplies. This impact has been further assessed in the hydrogeological assessment and contamination modelling.

7.7.4 Waste rock management

Based on the testing completed to date, there is no perceived requirement for segregation of waste rock during mining or non-standard handling requirements such as encapsulation. Any requirement to reduce the permeability across the footprint of the waste rock dump can only be assessed once the risk to potable water supplies is understood.

7.8 Landscape and visual amenity impacts identified

This section describes the potential impacts that may occur in terms of both landscape character and visual amenity.

7.8.1 Landscape impacts

The landscape impacts are outlined below:

- Creating of dumps and unearthing of underground material previously not exposed: Landscape character impacts refer to the existing landscape’s ability to absorb the proposed development and its visible features. In consideration of the existing component of tree and shrub savannah rangeland landscape character type, significant impacts will likely be yielded by the proposed mine, due to a substantial change in the visible land use, landform, and landcover.

  This impact is therefore said to be **significant, negative, direct and long term/permanent.**

- Clearance of existing vegetation: A shift will be made from a landscape of wide open spaces devoid of man-made structures and visible evidence of industrial activity, to a fully operational mine covering a large footprint consisting of many hectares.

  The impact is classified as **significant**, **negative, direct and long term.**

- Alteration of land morphology: An alteration of land will be made through the mining processes and construction of new infrastructure. The new land use type involves the large-scale man-made topographical elements including geometrically-shaped waste rock dumps and tailings.

  The impact is classified as **significant, negative, direct and permanent.**

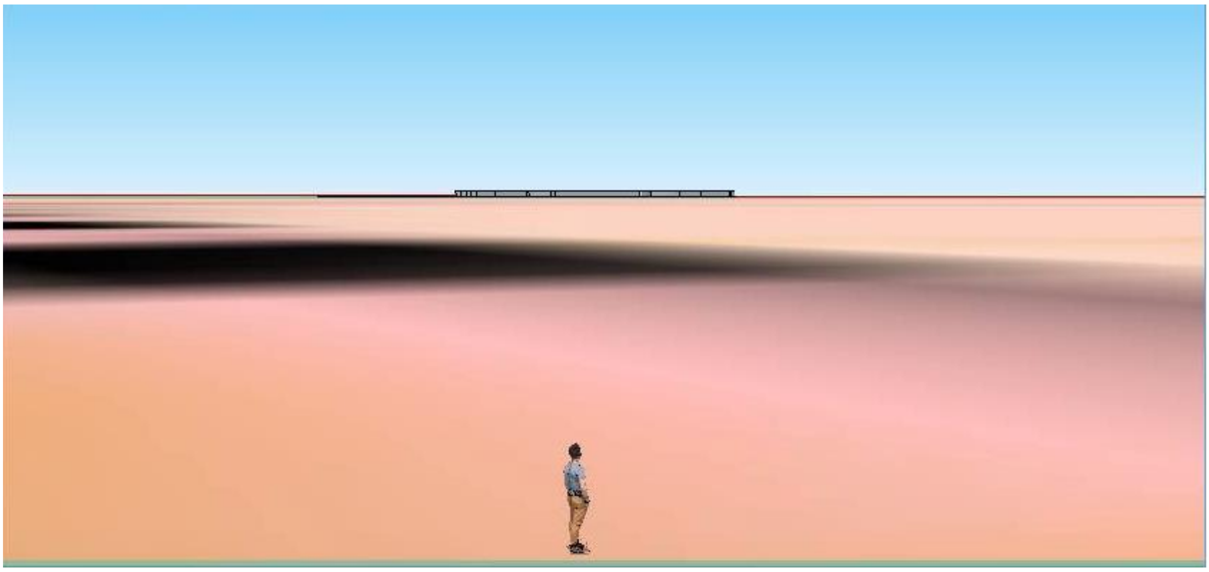
- The project involves the addition of industrial mining elements into rural landscape, causing substantial change in landscape character. The physical characteristics of mining overburden (when stockpiled), degree and length of slope, climate, amount and rate of rainfall, type and percentage of vegetative ground cover affect the vulnerability of mined lands in terms of erosion, which is a significant impact upon local landform and thus upon the landscape character of the study area, overall.

  The impact is classified as **significant, negative, direct and long term.**

7.8.2 Visual impacts

As this is an open pit, the primary visual impacts expected to occur will be related to the substantial, visually intrusive mine dumps (~50m high). At the mine itself, the visible buildings, processing facilities and changes to the landscape (such as tailings dams) will be largely screened from the few viewpoints exposed to such (distance from the A3 road is over 10km), by the existing vegetation in the area

A comparison was made of visibility of 40m high dumps vs. 50m high dumps, as illustrated in Figure 7.9 below. As the difference from main viewpoint (A3 road) is minimal 50m high dumps was recommended to minimise footprint.



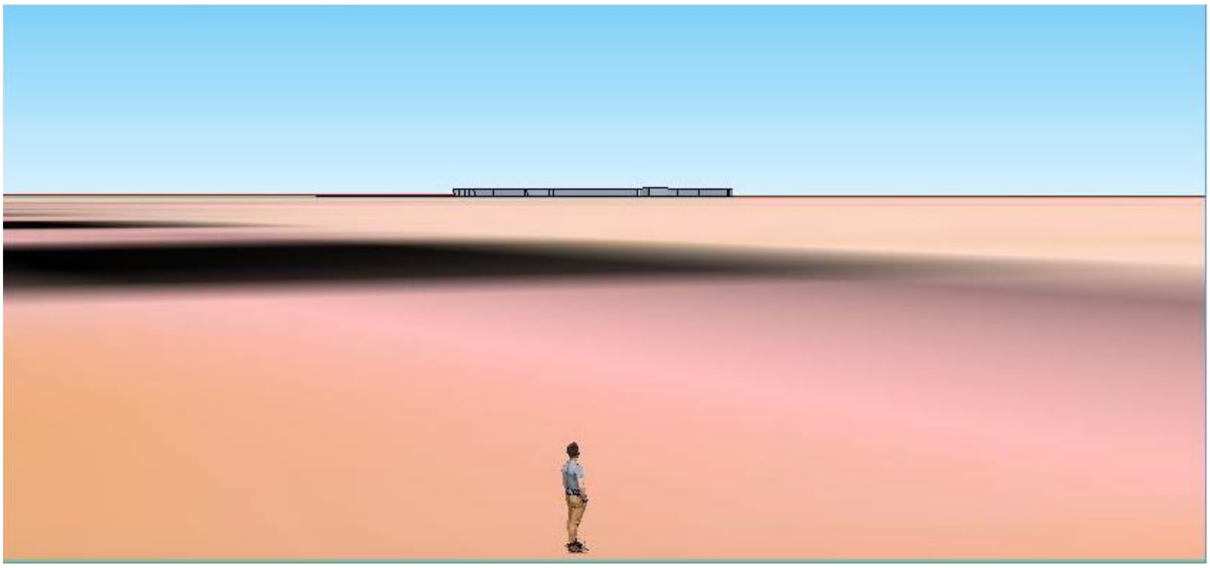


Figure 7.9: View of 40m high dumps (above) compared to 50m high dumps (below)

- Obstruction: Comprehensively, the visual impacts are expected to include (during operation):
  - Dumps (~50m high) and tailings
  - Open pit (at the mine itself)
  - Mine infrastructure
  - Mine lighting at night
  - Access roads
  - Personnel transportation vehicles
  - Dust from the access road
  - Powerline from A3 road to the mine and substation at the mine.

These impacts are classified as **significant, negative, direct and permanent (dumps and pit), medium term for others**

- Addition of visual intrusion by dumps: This impact upon the main landscape character type in the region will be permanent. Once mine activities are completed and decommissioning/rehabilitation has been carried out, the severe degree will be alleviated to a lesser degree through rehabilitation, however, any permanent change to the landform yielded by waste dumps or tailings/slimes dams are un-mitigatable and will be a permanent impact upon the natural landform.

  The impact is classified as **significant, negative, direct and permanent**

Overall, the impacts upon the local visual amenity are predicted to be negative or adverse in nature and will have the highest impact upon those visitors to the farms using the route adjacent to farm 153-NL. It is expected that due to the value that visual amenity may hold for visitors to the neighbouring farms (small in number) to avail of scenic views and the undisturbed rural landscapes, such impacts may be considered severe in magnitude. Alternatively, those affected on the A3 will be less affected due to the already-modified nature of the highway and proposed BPC powerline corridor (under construction). Such motorists are likely to experience a slight impact in terms of magnitude.

7.8.3 Cumulative visual impacts

Traffic related to additional mining traffic (haulage, transport, etc.) is anticipated to increase from its current state, due to increasing traffic which is predicted found in the area due to the development of the T3 mine.

The impact is classified as **slight**, **negative, direct and medium term**

7.9 Waste impacts

Since the Tshukudu Metals T3 Copper Mine is not in operation yet, the site investigation for the waste impact assessment primarily focused on the situation at two existing copper mines similar to the T3 Copper Mine, from which predictions were made on the future waste situation. The investigations undertaken covered the full waste stream generated at the mine in an integrated manner, thereby considering the various waste categories from the point of generation, all the way through to final disposal.

Evaluation of waste management in the Ghanzi municipality also provided a clear understanding of how additional waste generation is expected to impact on waste management service delivery at the Local Municipality.

The following table provides a prediction of what can be expected in terms of waste generation, based on the findings from investigations undertaken at the two existing mines in the SADC Region. Full details of the waste streams identified are provided in the Waste specialist report in Appendix I.

Table 7.10: Expected waste generation quantities for the proposed T3 Copper Mine

Waste Category	Monthly generation rate (tons)
General Waste	
Paper, cardboard and timber (pallets/ crates)	20t
Plastics (recyclable)	10t
Scrap metal	5t
General or household type waste (food scraps, Styrofoam packages)	10t
Hazardous Waste	
Used engine oil	38.4t
Grease / greasy waste in a semi-solid state	9.5t
Chemical reagent bags (PAX)	1t

7.9.1 General (non-hazardous) waste

Although not to the same extent as hazardous waste, inappropriate management of general waste can have a negative impact on the environment. This section narrates the possible impacts that may arise under waste management during construction, operation and decommissioning of the T3 Copper Mine project.

Waste around the site will consist of various types/streams such as:

- Paper
- Glass
- Plastic
- Cardboard
- Cans and plate metal
- Ferrous metals (iron and steel)
- Non-ferrous waste (electronic waste)
- Food waste
- Rubber tyres and conveyor belts
- Green waste and discarded wood (mainly generated during the initial site clearance).

All impacts discussed below and mitigations to follow are to be considered as part of an integrated waste management system, ensuring that prevention of pollution to one medium does not impact on another.

7.9.1.1 Disturbance in aesthetic view

Indiscriminate waste disposal and scattered windblown litter (paper, cardboard, plastics), scattered glass bottles, cans and plate metal can contribute to poor aesthetic view. In addition, scattered or illegally dumped ferrous metals, tyres and conveyor belts, insulation materials, litter that may have been mixed with food waste and plant material can also spoil the scenic view of an environment.

The impact is summarised as **negative, slight to moderate, long term**.

7.9.1.2 Risk of veld fires in surrounding areas

Veld fires can be caused by the spread of burning paper, cardboard, green waste and wood and plastic setting dry grass alight. Similarly, the spread of burning combustible materials and/or dropping of burning cigarette butts can set dry grass alight. The mine site will be cleared of vegetation and the risk applies to surrounding areas. During construction and site clearance fires will not be allowed under any circumstances to remove green waste. The Client intends to use the green material for rehabilitation purposes, which should largely eliminate this risk.

The impact is therefore summarised as **negative, slight, medium term.**

7.9.1.3 Reduction in landfill capacity

Landfill airspace will be consumed by paper, cardboard, plastic, cans, building rubble from construction and decommissioning, as they will be disposed to landfill. Food waste, green waste and discarded wood will also be regularly disposed thus reducing capacity of the Ghanzi landfill.

Ferrous metals are not biodegradable and will therefore take up significant amounts of airspace on landfills for extended periods of time (if not recycled). Even though ferrous metals will not be scattered through wind action, they can be dumped illegally. Tyres are however prohibited in landfills due to elasticity. The impact is classified as **negative, slight and long term.**

7.9.1.4 Risk of poor human health

Attracting and breeding of rodents and vectors through improper food waste disposal can cause harm to human health. Sharp edges from rusting cans and plate metal can also cause injuries to both humans and animals and should therefore disposed of adequately. In addition, used tyres also accumulate water creating suitable breeding conditions for mosquitoes. The impact of is classified as **negative, slight and long term**. The impact has been further assessed in the Health Impact Assessment (refer to Appendix I).

7.9.1.5 Safety

There is a risk of injuries to humans and animals by broken glass, sharp cans and plate metal, ferrous metal at the mining area. The impact is classified as **negative, slight and medium term.**

7.9.2 Hazardous waste

The hazardous waste can be broken down into 3 main categories, i.e. industrial hazardous waste (e.g. oils, grease, batteries, E-waste, fluorescent tubes), health care waste and waste rock or tailings containing heavy metals. Some of the hazardous waste anticipated to be produced as part of the project include the following:

- Used Oil, grease, oil filters, oil rags and oil containers
- Used batteries
- Health care waste
- Sewage sludge
- Mining waste (waste rock and tailings)

The (un-mitigated) impacts discussed below are for the construction, operation and decommissioning phases of the project.

7.9.2.1 Risk of water pollution

Used lubricants often pose serious pollution risk through illegal dumping or improper disposal resulting in groundwater, surface water and soil pollution. Pollution of groundwater and surface water because of sulphuric acid from batteries is also a possibility. Pollution from chemicals (Xanthate) contained in the tailings and pathogens from sewage sludge also contaminates groundwater and surface water. The impact was assessed as part of hydrogeological studies (refer to Section 7.6)

7.9.2.2 Land and soil pollution

Used oil and grease, sulphuric acid and infectious pathogens from sewerage have potential to contaminate land and soil. Ash from the incinerator (at the Ghanzi Landfill) also adds on to the possibility of soil being contaminated if illegally disposed. Polluted soil from chemicals contained in the tailings is a high possibility as well. The impact is **moderate negative and short term.**

7.9.2.3 Human health

Exposure to sulphuric acid and associated fumes from batteries and infectious pathogens from sewage sludge may cause harm to human health. This impact is **slight, negative and short term.**

7.9.2.4 Landfill capacity

Airspace consumed by disposal of ash residues from incinerator litter such as paint and oil containers will reduce the landfill capacity. This impact is **slight, negative and long term.**

7.10 Archaeological impacts

Archaeological impacts identification and assessment was carried out for the T3 mine footprint and road corridor, and no archaeological sites were found. Nevertheless, there were four observations of archaeological interest and these are described in detail in Chapter 5. There is always a risk of archaeological material being encountered during the clearing and excavation works. The impact is therefore **slight, negative and permanent**, as any impact on archaeological sites would be a permanent impact (destruction). The risk/impact is mainly applicable to the construction phase of the project, where the site preparation and clearance work takes place. It does remain a risk during the operational phase, where the mine footprint will be extended as mining continues.

Based on the findings of the AIA and Cultural Heritage Assessment report, and the interviews with key informants, it can be concluded that the site has not been used by indigenous people (Basarwa people for hunting or burial) whose descendants now live in Kuke or D'Kar. This was noted by both the farmer and his employees during the household survey interviews. It can be concluded that the mine development will not result in any impacts on the archaeological and cultural heritage of the site, resulting in a slight impact.

From the heritage perspective, there is no need to consider any mitigation measures once the development is fully operational. The only recommendation regarding closure is that, in the unlikely event of an important site being found, due consideration must be given to creating an interpretive centre. This is however highly unlikely, and the impact is rated as negligible.

7.11 Health impacts

The following impacts/issues were identified for the project, refer to Appendix J (Community Health and Occupational Health Impact Assessment) for a detailed classification of impacts, mitigation and monitoring plans.

7.11.1 Increase in HIV and AIDs and STI prevalence rates

HIV/AIDS prevalence in adults aged 15 – 49 years in Botswana is 21.9%. The HIV/AIDS prevalence in Kuke and D’Kar is higher than this: 250 of the D’Kar population (1 668) is on ARV (15%) and 270 of the Kuke population (870) is on ARV (31%). These are population figures so age specific rates (particularly those of working age) would be higher. Kuke Health Post treated 121 new cases of STI in 2017. Mining exploration personnel are frequent visitors to the villages (for transactional sex) and the health posts for STI treatment. Project related influx of labour, has the potential to exacerbate the HIV/AIDs and STI rates in nearby villages and in Ghanzi. The impact of HIV and AIDS and STI on the community is **negative, significant and permanent** if not mitigated.

7.11.2 Increase in TB prevalence rates

The TB incidence rate in Botswana is 326 per 100,000. The TB incidence rate in Kuke and D’Kar is higher than in the general population of Botswana. At the present time there are 18 clients on TB treatment in D’Kar (population 1,668) which gives a crude TB incidence rate of about 1,079 per 100,000 and there are 13 clients on TB treatment in Kuke (population 870) which gives a crude TB incidence rate of 1,641 per 100 000. Of the 13 TB patients in Kuke, 3 are multidrug resistant (MDR). These TB incidence rates are extremely high and likely the result of a number of variables including HIV/AIDS, alcohol abuse, smoking, poor nutrition and overcrowding of accommodation. Project related influx of labour may exacerbate these variables. In addition, the high rates of TB in the area will increase the TB risk amongst Project employees and contractors. The impact is **negative, significant and permanent** if not mitigated.

7.11.3 Road traffic accidents

The location of the Project main accommodation camp is on the outskirts of Ghanzi, approximately 84km distance from the mine site. There will be a daily commute of 400 - 500 employees and contractors, much of this before and after sunrise, on the A3 highway and this will increase the risk of road traffic accidents. The impact is classified as **negative, moderate and medium term.**

7.11.4 Fatigue

An 84km daily commute to and from work has the potential to increase fatigue amongst (some) employees and contractors, which will impact negatively on health, safety and productivity. The impact therefore is **negative, significant and medium term.**

7.11.5 Lacking medical emergency response

The possibility of multiple causalities resulting from road traffic or mine accident requires a level of medical emergency response not currently available in the Ghanzi District. Such medical emergency response should be at an Advanced Life Support (ALS) level. The impact therefore is **negative, significant and short term.**

7.11.6 Insufficient space - emergency room at Ghanzi Primary Hospital

The emergency room at Ghanzi Primary Hospital is unable to provide care in the event of there being multiple causalities. The impact therefore is **negative, significant and short term**.

7.11.7 Risk of malaria outbreak

Although the project is located in a malaria free area, many employees and contractors may travel through Maun/Okavango, where there is malaria risk. There were 1,646 malaria cases reported in Botswana during 2016/17 and 11 deaths. 60% of these cases were from the North West / Okavango District. The impact is based on frequency of travel and potential exposure, and exposure risk is mostly seasonal. However, the consequences can be longer lasting, and the impact therefore is **negative, moderate and long term.**

7.11.8 Occupational health risks

Occupational health aspects have been discussed under the following subheadings: i) occupational health risk, ii) occupational medical surveillance, iii) primary health care on site, iv) population influx and overcrowding of accommodation, v) risk of insect bites such as scorpions

- Occupational Health Risk Assessment: This new mining project requires a comprehensive OHRA to determine the work-related health risks. Such OHRA will provide information on which appropriate controls may be based. The work related health risks are **negative, significant and medium term.**
- Occupational medical surveillance: Occupational medical surveillance is undertaken for two reasons: To ensure employees meet the minimum fitness levels required by the job (vision, hearing, etc.) and to assess health in the light of occupational environmental risks (dust, noise, heat, etc.). Risk-based medical surveillance (initial, periodical and exit medical examinations) based on man job specifications and occupational risk exposure profiles are key to health, safety and productivity. Robust occupational medical surveillance is especially important on the Project given the relatively high prevalence of background illness (HIV/AIDS, TB, hypertension and diabetes). The impact therefore is **positive, significant and medium term**.
- Primary health care on site: HIV/AIDS, STI, TB and NCDs are prevalent in the mining population of Botswana. Provision of onsite primary healthcare will contribute significantly to

health, safety and productivity. The impact therefore is **positive, significant and medium term**.

- Population influx and overcrowding of accommodation: Population influx to the Project area (including Ghanzi, D'Kar and Kuke with limited available accommodation) has the potential to overload available housing and services. This may increase the risk of respiratory illness as well water and sanitation related disease. The impact therefore is **negative, significant and permanent.**
- Risk of scorpion stings, snake and spider bites to project personnel: During bush clearing and construction, project workers are at risk of being stung by scorpions or bitten by spiders or snakes. There are several known venomous snakes that occur in the area therefore project workers must be informed of the dangers that these animals pose and be educated on the correct procedure to follow when stung or bitten. This impact is classified as **negative, slight and medium term.**

7.12 Social impacts identified

As outlined in Chapters 4 and 5, a detailed social impact assessment was undertaken for the Project. The full specialist report is available in Appendix L. The social impacts identified during this process are described in the following sections.

7.12.1 Construction and operation phase

The following impacts related to the construction and operational phase of the project.

7.12.1.1 Creation of employment

According to the SIA survey findings (household and qualitative), most of the population enumerated were noted to have no formal employment and construction or mining related experience. This was associated with limited economic activities within the District, which has led to the impoverished status of the study area communities noted during the SIA survey.

Considering the scale of the mine construction and operational works, the Project has the potential to provide considerable amount of employment opportunities (800-850 people during construction and 450-550 people in direct employment during operation. The local communities are likely to benefit mostly from employment opportunities as unskilled labour, and less from semi-skilled and skilled labour due to lack of skilled workforce at the study area.

This impact has been classified as **positive, moderate and short term** for construction phase while for operation phase it is **positive, significant and medium term.**

The main challenge noted by the social expert is the lack of construction and mining related experience, skills and qualifications likely to be required. It is not clear if the local communities will be willing to be engaged in employment at the mine, given that Basarwa are said to not stay in employment for long periods due to their nomadic nature and excessive drinking problems (Source: key informants interviews).

7.12.1.2 Increased local and regional economic activities due to multiplier-effects

The Project's large-scale construction and mining activities will increase demand for wide a variety of goods and services, and as a result stimulate the local (including regional) manufacturing and service sectors. Local and regional procurement will enhance the economic status of the study area. Localisation of procurement will result in a positive, direct and indirect impact on the local and regional economies. This will likely generate more opportunities for small scale businesses through supply chain practices, where formalised medium scale businesses acquire goods or services from small scale businesses to supply the mine.

During the construction phase, this impact is expected to be positive, moderate due to number of employment opportunities to be created, direct and indirect, as well as short term as the construction works are to be undertaken within two years.

During the operational phase, this impact will be positive and significant due to the number of people to be employed, as well as well as direct and indirect, and long term due to the anticipated LoM (10 to 12 years).

The impact has been summarised as **positive, moderate and short term** for construction phase while for operation phase it is **positive, significant and medium term.**

7.12.1.3 Improved markets for goods and services due to influx of people to the study area

The Project will likely result in considerable population influx, which is mostly associated with negative socio-economic impacts such as increased demand for social services, increased crime and other social issues discussed in Subsection 7.3.12. However, influx of people at the study area will also have some positive effects on the local economy. Small businesses may experience improved markets and increased numbers of customers for consumable items and services. This will particularly be the case if workers recruited from elsewhere represent higher-level occupations and have relatively high disposable incomes, which may be the case due to limited skilled manpower at the area.

The impact has been summarised as **positive, moderate and short term** for construction phase while for operation phase it is **positive, significant and long term.**

7.12.1.4 Regional economic development

The government will receive royalty and tax payments from Tshukudu Metals for copper concentrate produced from the T3 mine site. The District council will also receive rates from Tshukudu Metals the municipal services provided for the Project. Considering the scale of the Project and the number of people to be employed, significant amount may be generated. The funds generated by Ghanzi Council will be used to finance service provision and infrastructure development at the study area, particularly given the fact that the mine will attract lots of people to the area. In addition, the government may be required to increase the budget allocated for the District due to an increase in economic activities and people at the area.

Tshukudu also intends to undertake Corporate Social Responsibility (CSR) and Local Empowerment Drive (LED) programs at the study area throughout the project operational phase. To support this, a plot has been secured located near the township for a community project during the construction and operation phases of the project.

Considering the scale of the project and the operational period of 10-12 years, this is expected to have a moderate to significant impact, with long term effects, particularly if Project opportunities are localised.

The impact has been summarised as **positive, slight/moderate and short term** for construction phase while for operation phase it is **positive, significant and long term.**

7.12.1.5 Skills transfer and development

The Project will employ a considerable number of people from the site-specific and local study areas for unskilled employment opportunities. Given that the skills levels in the local area are low, skilled labour is likely to be acquired from the region or even at national level.

A significant proportion of the construction and operational workforce will benefit from work experience and on the job training to be developed by the mine, especially those individuals who will start with no or low-level skills and proceed with the Project to the operational phase. Tshukudu is likely to develop human resource and skills development programmes, prior to the project commencement, resulting in development of skill for the area communities. Considering the number of employees required for the project, this will have a positive, long term impact on the local communities.

The impact has been summarised as **positive, moderate and short term** for construction phase while for operation phase it is **positive, significant and long term**

7.12.1.6 Loss of agricultural land (for the directly affected freehold farmers) and competition for skilled workforce

As detailed in Chapter 2, the proposed mine pit and related mining facilities (waste dumps, processing plant and tailings storage facility) will be developed within a section of Farm 153-NL, currently used for beef farming activities. In addition, a service corridor, of approximately 12.5km will be developed along Farms 111-NL and 110-NL. It is expected that small sections of the farms along the access road will be directly affected by this development. Negotiations for acquisition of land for the Project have been completed and the expectation is that the farmers will be paid prior to the commencement of the construction activities. Purchase of the land for the project (farms 153-NL for the mine and 111-NL and 110-NL) has been agreed based on commercial land negotiations and is sold to Tshukudu Metals voluntarily. No resettlement is required for the project development.

The degree of loss of land varies for each farmer, but it must be noted that farmers will be able to continue with their farming activities on the sections of their farms not affected by the Project. This impact is expected to be negative, long term and slight to moderate for Farm 153-NL owner and insignificant for both Farms 110-Nl and 111-NL based on the size of the farms affected and the fact that they will continue to use the remaining areas of their land. In addition, compensation is based on free negotiations between the affected farmers and Tshukudu Metals.

In addition, it is likely that the implementation of the project will result in competition for skilled workforce between the mine and farming operations, due to limited skilled manpower in the region (mechanics, welders, electricians, plumbers etc.).

The impact has been summarised as **negative**, **slight** to **moderate** (153-NL) and **insignificant** (Farms 110-NL and 111-NL), **long term** in duration. The impact will occur prior to the construction phase and continue for the life of mine. It must be noted that there will be an option for farmers to buy the land back (at market rates) at the completion of rehabilitation, which would make the impact medium term.

7.12.1.7 Social disruption

Significant construction and mining activities are to be undertaken within the boundaries of Farm 153-NL, therefore neighbouring farmers and communities will not be directly impacted due to limited access to this land (e.g. for grazing activities or gathering of foods). However, staff employed by the contractor may be visiting the communities for purchase of goods in local shops, visit bars and entertainment centres, given the location of the accommodation camp (under construction) to Ghanzi Township. This will lead to interaction with the Ghanzi Township community. There are documented examples from construction activities at other areas in Botswana where this has led to significant social stress and disruption, with unexpected pregnancies causing family strains and risks of spread of HIV and AIDS and other communal diseases. Without management this impact is predicted to be negative, significant and short term, although some consequences can be long term.

The proposed project may also disrupt the daily movement patterns and lives of people due to increased traffic on local roads, particularly on the A3 road, which forms a transport corridor between Ghanzi, Kuke, D'kar, the Ghanzi Farming block farms and Maun. This impact is predicted to be negative, moderate to significant and short term during the construction phase and long term during the operational phase.

The impact has been summarised as **negative, moderate to significant and short term** for construction phase while for operations phase it is **negative, significant and long term**.

7.12.1.8 Increased health and safety risks

Potential health and safety effects expected to be yielded by the mine activities are mainly related to risks posed by construction and mining equipment, transport/haulage activities, interaction of locals with employees, influx of people at the study area and those that involve injury to workers. The main occupational health and safety risks (see Section 7.11) assessed in this study, include:

- Increase in HIV/AIDs and STI infections
- Increased TB occurrence
- Road traffic accidents
- Population influx and overcrowding of accommodation.

These impacts are discussed further as an overall health impacts identified from health impact assessment study (Section 7.11). The following associated social impacts likely to result due to an increase in HIV and AIDS (as a significant impact) are:

- On the affected communities:
  - Loss of economically active people
  - Decrease in monthly income per capita, monthly consumption per capita and savings for households
  - Dissolution of households

- Decrease in school attendance as children leading households no longer attend school
- Destruction of community social cohesion
- Increased stigmatism and isolation of people living with HIV and AIDS
- Increased abandonment of women infected with HIV
- Increase in numbers of street children
- Overburdening of HIV and AIDS social support systems
- Poor morale and stress.

- On the project:
  - Loss of manpower
  - Loss of production time due to time required by the engaged personnel to get HIV and AIDS health care/treatment and sick leaves
  - Increased costs of training and staff replacement

The impact has been summarised as **negative, significant and permanent** for construction phase while for operation phase it is **negative, significant and permanent** if not mitigated**.**

7.12.1.9 Conflict or competition between jobs/opportunity seekers and locals

It is expected that a proportion of the unskilled workforce be locals, however the survey showed that issues such as illiteracy may limit how many people can be employed in unskilled roles. Semi and highly skilled employees may be sourced from elsewhere in the country.

During the SIA survey, it was indicated that the local communities will likely react negatively towards migrant workers, especially if those workers fill positions that could have been filled from within the local communities. This is likely to create tension between the locals and the in-migrants. One possible reason for such conflict would be the perception among locals that the outsiders will deny them opportunities due to their vulnerable or marginalised status. The likelihood of this impact will increase because of the high unemployment rate in the local study area. Furthermore, if any in-migrants initiate sexual relationships with partners, daughters or girlfriends of locals, this would certainly intensify this issue (Source: key informants interviews).

The impact has been summarised as **negative, moderate and short term** for construction phase while for operation phase it is **negative, moderate and medium term.**

This is because Ghanzi District has one of the highest indigenous populations that are generally marginalised and therefore have a limited representation and ‘voice’. Conflict such as this can also be partially attributed to the legacy that mining projects leave communities worse off and unable to sustain themselves. Thus, there is a large amount of perpetual anger that can be triggered by migrant workers if locals are denied opportunities.

7.12.1.10 Increased pressure on local services and infrastructure

An influx of job-seekers into the area will place considerable pressure on local infrastructure and social services. There is a risk that the local municipality would not be able to supply additional services required by the residents of the study area. This risk derives from the fact (evident from the information provided by the consulted key informants) that the Government is already experiencing backlogs in the provision of services, especially land and water. It is important to note that during times of stress on land services, there is possibility of a mushrooming of informal settlements.

The impact has been summarised as **negative, moderate and short term** for construction phase while for operation phase it is **negative, significant and medium term.** The impact may decrease over time.

7.12.1.11 Establishment and growth of informal settlements

The establishment and growth of informal settlements needs special attention, as it underlies an increasing social problem at the study area. Informal settlements are noted to occur due to lack of access to services such as water, sanitation and electricity in rural settings of the study area. It has also been associated with the increased dependency on government for livelihood by Basarwa. Accordingly, Basarwa ethnic group has developed a tendency of selling their plots to in-migrants at cheap prices and turn to the Government for allocation of land for residence. If their requests are not met, they are said to develop informal settlements in Ghanzi Township or within nearby villages.

It was mentioned during the stakeholder meeting with the Ghanzi District Council key informants that there are a number of informal residences in the area. Accordingly, these settlements are either stand-alone settlements or informal extensions of formalised settlements. Ranyane was given as an example. It is located in the Ghanzi District close to its border with the northern Kgalagadi District and as of the 2011 census it had a total population of 182, up from 94 recorded in the 2001 census. The community, like most in Botswana is, moreover, of mixed ethnicity, notably including people of Kwe/San (Basarwa), Chiherero and Shekgalagari cultural heritage.

Unless properly managed, an influx of job-seekers and workers from elsewhere are to contribute to the growth of such settlements, and possibly also the establishment of new ones. An increase in transactional land in Ghanzi Township and Kuke villages will escalate this issue.

This impact is classified as **negative, moderate and long term** as the Ghanzi land Board mentioned that measures can be implemented to avoid transfer of land from Basarwa communities to non-Basarwa groups. Without the mentioned measures the impact will be more significant. The impact applies to construction and operation phase of the project.

7.12.1.12 Resistance to the mine development due to expected negative impacts

Strained community relations could have a very detrimental impact on the successful implementation of the Project. One notable issue regarding the Project is that of the accommodation camp development, which is currently being developed near Ghanzi Township. A consideration has been made to have the temporary accommodation camp at the mine site, to avoid long staff transportation between the camp and the mine site, as well as to avoid social issues likely to be experienced due to constant interaction of the construction workers and the locals. However, locating the camp away from the Township will be perceived as denying the communities the chance to benefit from the project, consequently resulting in opposition from the locals. This may damage Tshukudu public image through bad publicity. In extreme cases, unfriendly community relations can give rise to active social mobilisation against the Project.

The farming community represented by the Farmer's associations (GBPA) are likely to oppose the T3 Project as it would be seen as a direct threat to their main livelihood (the beef industry). The biggest concerns were around the adverse effect on the aquifer and development of man-made water body (pit lake) ((after decommissioning of the project) refer to Chapter 6). These stakeholders' "voice" may be louder through the association, however, their capacity to influence the Project in any serious negative way is likely to be low given the significance of the Project to the region and support from the broader community. The impact of the project on the farmers has been put as moderate as they are not considered to be vulnerable groups in this project. The farm labourers and their families are considered to be the vulnerable groups as they are residing on the farm but do not own the land. They may also oppose the Project but have a very low capacity to influence the project and therefore demonstrate their vulnerability. It is thought that the labourers are dominated by the indigenous Basarwa who are vulnerable generally in Botswana as they are a marginalised group (Karunya, 2016).

The conservation organisations such as Kalahari Conservation Botswana (KCB), Cheetah Conservation Botswana (CCB), and Raptors Botswana may oppose the T3 Project as it poses a direct threat (although in a relatively small footprint) to the wildlife in the area. Due to their lobbying capacity they have some capacity to influence the project. However, along with the Department of Wildlife and National Parks they could also serve as resource to helping avoid, managing and mitigating the impacts on wildlife.

Tshukudu Metals has intentions to foster positive community relations, through mitigation of impacts, CSR and LED initiatives, which will lessen the probability of this issue. This impact is classified as **negative, slight and medium term** as measures are recommended in this report to ensure mitigation of all adverse impacts, including those that promote positive relations between the Project and its stakeholders.

7.12.1.13 Impacts of change of groundwater levels and risk contamination on farming

As discussed in Chapter 5, water is an important resource for the economy of the study area, as it sustains the beef industry of the District, which is the backbone of its economy. Therefore, any contamination and depletion of ground water will have significant consequences on the livelihoods of the area communities, the beef farmers located within the Ghanzi Farming block.

As outlined in Section 7.6, mine dewatering will take place during the operational phase to ensure a safe working environment in the mine. This will cause a localised drawdown in groundwater levels near the mine site (2 farms impacted based on current studies). It is expected that the groundwater levels will recover once mining is completed. In addition, risks related to impacts of contamination of ground water exist due to leakage or seepage from the mine infrastructure (mine plant and tailings storage facility (TSF)) and waste rock dump (WRD). Overall, impacts on groundwater will be **negative, signficant and medium term** in terms of effects on the agricultural economic activities of the study area, if not mitigated.

7.12.2 Decommissioning Phase

The eventual end of a mine's operating life is common to most extractive operations, and socio-economic consequences are inevitable. Several socio-economic impacts could arise when the mining operation is decommissioned and include:

7.12.2.1 Dependency on mine for sustaining local economy

Due to limited major economic activities at the area, there is a high possibility of the local economy becoming dependent on the Project due to the lack of other opportunities. While this proposed mining operation can contribute significantly to economic development through its lifetime, this positive impact also has a negative aspect, in that mining is not a permanent activity. Inevitably, the mine will be decommissioned after 12 years, unless further deposits are found, which can have negative consequences for an area that has not invested in economic diversification. This has been noted during the key informants' interviews, and Selibe Phikwe was frequently mentioned as an example, following the recent closure of BCL mine.

Upon closure, the employment opportunities associated with the project (approximately 550 jobs) will be lost, as well as the associated benefits. Retrenchments before the end of life of mine is another possibility and could be necessitated by downscaling as a result of external forces such as reduced profitability, technical innovation, the need to remain globally competitive or changes to the mine's strategic business plan. At such a time, project employees may not be able to secure alternative employment. Economic downturn and the resultant loss of employment could result in increases in social pathologies, such as crime, prostitution, substance abuse, and social unrest - as was evidenced by recent closure of BCL at Selibe Phikwe. The loss of income will have considerable negative impacts on the wellbeing of households where employees were the sole breadwinners, resulting in a long term effects on the well-being of the local communities and the economy of the study area.

The impact has been summarised as **negative, significant and long term.**

7.12.2.2 Loss of employment

Loss of employment was noted as the key direct impact associated with the mine closure. The key informants within the affected communities noted that loss of jobs may lead to deteriorating living standards for many within the District, which may result in emergence of informal, insecure forms of employment at lower wages with fewer legal and social safeguards, as well as the emergence of groups that are particularly vulnerable in these highly competitive job markets. The deteriorating socio-economic situation of Selibe Phikwe township was given as an example, following the recent closure of Bamangwato Concessions Limited (BCL) Copper Nickel mine.

The impact has been summarised as **negative, significant and permanent.**

7.12.2.3 Loss of business opportunities

The closure of the mine is expected to adversely affect goods and service provision within the study area. According to the key informants, the closure of the mine will reduce demands for goods and service requirements at the study area. Accordingly, majority of the affected business operations are likely to relocate to other areas in search of markets. Relocation or closure of business operations are likely to lead to further loss of employment.

The impact has been summarised as **negative, significant and permanent**.

7.12.2.4 Labour migration

The closure of the mine may result in migration of labour to other regions of Botswana (or internationally) in search of jobs. It was noted that local youth are likely to emigrate too, leaving behind elderly women to care for the families and undertake home chores.

The impact has been summarised as **negative, moderate and long term**.

7.12.2.5 Loss of community cohesion and structures

Unemployment and emigration of youth in search of jobs at other district/regions/countries are expected to lead to social ills such as alcohol abuse, domestic violence and collapse of the social structures. The Chief at Kuke village noted that majority of the households are being cared for by elderly people, as young people have migrated to Maun and Ghanzi Township in search of jobs.

Loss of jobs as well as long-term unemployment, especially in the absence of effective social policies/programs to mitigate unemployment can create financial insecurity, crime and excessive alcohol consumption by the local communities. In the absence of alternative employment, bread winners may not be able to support their families financially, and community members may not be able to support community projects (due to no employment).

The impact has been summarised as **negative, moderate and long term.**

7.12.2.6 Loss of revenue for the Government and effects on social services

The closure of the mine is expected to reduce revenue (mine royalties) collected by the government. This is expected to reduce financial assistance that would be provided for the district for social service provision and infrastructure development. In addition, the mine may consider assisting the municipality (Ghanzi District Council) in provision of infrastructure and social service provision, through the Corporate Social Responsibility initiative likely to be developed for the Project. Therefore, after the closure of the mine, any assistance from the mine will end.

The impact has been summarised as **negative, moderate to significant and permanent**.

7.12.2.7 Safety risks associated with improper mine site rehabilitation

Improper mine rehabilitation has the potential to result in environmental impacts such as water pollution, safety risks to animals and people accessing the site as well as unusable land for any economic activities after mine closure. A conceptual mine closure study was undertaken for the Project.

The impact has been summarised as **negative, significant and long term**.

7.12.3 Cumulative social impacts

These are impacts arising from the combined effects of two or more projects or actions. The importance of identifying and assessing cumulative impacts stems from the fact that, in social as well as natural systems, the whole is often more than the sum of its parts – implying that the total effect of multiple stressors or change processes acting simultaneously on a system may be greater than the sum of their effects when acting in isolation.

The aim of this section is to highlight the nature of the cumulative socio-economic impacts that are expected to occur as a result of the combined effect of the proposed project and other current or planned operations in the area. Three possible cumulative impacts were identified in relation to population influx, dependency on mining to sustain the local economy, and on the visual environment and sense of place.

7.12.3.1 Job creation and multiplier effects on the local economy

Approximately 400-450 people will be employed by the mine and its contractors during the operational phase of the Project, and even more during the construction phase. There is other infrastructure development project planned for the study area, and the notable one is the Botswana Defence Force Camp, proposed to be developed opposite the mine accommodation camp near Ghanzi Township and the North West Grid Transmission Lot 4 Project to be constructed from Toteng to Ghanzi. Due to the sensitivity of the BDF camp project, more information could not be provided for this study for security reasons, however it has been established (in consultation with key informants) that it is likely to employ substantial numbers of people, resulting in more influx of people at the study area. This planned development will therefore contribute to the social issues likely to be generated by the proposed mine development.

Secondly the proposed project, together with other existing and planned mining operations such as Khoemacau Copper Mine will result in several economic benefits for local communities through direct and multiplier effects. These effects are usually stimulated by wage bills, local and regional procurement spend, and investment into LED. The proposed project will therefore add to the expected positive effect of other planned projects on the local economic development by applying best practice in terms of local employment and procurement, as well as LED.

The impact has been summarised as **positive, significant and long term.**

7.12.3.2 Impacts related to population influx

It is likely that this existing impact will be exacerbated once it becomes known that recruitment for the Project has started. Population influx is also likely to exacerbate the social pathologies, pressure on existing infrastructure and services, and the growth or establishment of informal settlements.

The impact has been summarised as **negative, significant and long term.**

7.12.3.3 Loss of sense of place

The more “alien” elements that are added to a landscape, the more the character of the landscape will be altered. Thus, the effect of the proposed mine on the area’s sense of place cannot be considered in isolation from other current and planned activities. For example, planned development within the area will leave their mark on the landscape and the Project will add to the impact on the area’s sense of place. Surface infrastructure associated with the proposed project will therefore represent a new wave in the transformation of the landscape.

The incremental change in the visual character of the area that will be brought about by the Project can thus be interpreted as a cumulative impact on the sense of place stemming from the combined effect of the project and other infrastructure developments within the study area. However, the project is implemented within the boundaries of a private farm (restricted access) and at over 10km from the A3 road.

The impact has been summarised as **negative, moderate and long term.**

8 Analysis of alternatives

One of the pivotal functions of the ESIA process is to provide an analysis of the possible alternatives available for the Project. It is imperative that the alternatives are appraised in a comprehensive and objective manner. This section will detail the alternatives considered for the proposed development. Due to the nature of mining activities, which are based on the discovery of a mineral resource at a certain location, there is no opportunity to consider alternative locations as is usually done for infrastructure developments. The mineral resource can simply only be mined at the area where it is found. The same applies to a certain extent for the location of the boreholes or wellfield providing water to the operation. The water resources are found based on exploration and can only be pumped from an area where water of sufficient quantity and quality can be found.

The alternatives for the Project have been divided into the following categories:

- Design alternatives
- Planning related alternatives
- “No-Development” alternative.

8.1 Design Alternatives

Design alternatives are project considerations and options that can be considered through different design options. As shown in Figure 2.1, the development of a mining project goes through a number of different design and feasibility stages. “Avoidance through” design” is the most effective way to mitigate any anticipated impacts, this is a key aspect of the ESIA study, which feeds into the Feasibility Study design work and the front-end engineering designs, prior to the construction of the proposed mine.

When considering alternatives, environmental and social impacts are compared with cost aspects (capital and operational costs) and technical suitability, to make an overall recommendation on the proposed implementation of a certain alternative. As stated in the introduction, certain alternatives may not be available due to geographical or technical limitations.

8.1.1 Mining method

For the mining method, there are two clear and distinctive methods, which each have a very different set of environmental implications and impacts, and these are:

- Open pit mining
- Underground mining.

The decision between these two mining methods is mostly dependent on the depth and orientation of the mineral resource. Underground mining methods are generally more complicated and have a higher capital cost compared to open pit mines. Based on the current exploration works, the T3 deposit is quite unique in the area when comparing it with other deposits in the Kalahari Copper Belt, the difference being that:

- The T3 deposit is relatively shallow

- The T3 deposit is very flat, compared to other deposits in the belt which are found at an angle.

Because of the above features, the T3 deposit does present an opportunity for open pit mining. For underground mining the geotechnical conditions and hydrogeological conditions become very important. For deeper ore bodies, underground mining usually becomes the preferred mining method, as the quantity of waste material to be removed becomes bigger, making open pit mining economically unattractive.

There is a possibility that the T3 deposit does continue deeper than the current modelled resource. Some limited drilling to greater depths suggests that there is copper mineralisation at further depths, but much more drilling will be required to further investigate this. This is something the Client will undertake during the mining phase of the project, to extend the life of mine. Based on these results the mining method could change (e.g. the mine would first operate as an open pit mine and later develop into an underground mine.

It is important to note that the orebody geometry, grade and depth only allow for open pit mining. Underground mining requires a +2.0% head grade, however the indications derived from the exploration activities indicate that this particular deposit has a head grade of 1.0%.

Table 8.1: Comparison of mining method

Aspect	Comparison	Preferred option
Capital cost	The capital cost for an underground mine is much higher than for an open pit mine. Orebody geometry, grade and depth only allow for open pit mining. Underground requires a +2.0% head grade, this deposit is 1.0%.	Open pit
Operational (recurrent) cost	An underground mine requires ventilation and other services to operate safely, which usually consume significant amounts of power. Labour costs and equipment costs in underground mines are generally higher compared to open pit mines. However, with open pit mining there are large quantities of waste to be moved, whereas in underground mining the company can target and mine the mineralised zones, and minimise waste mining	Open Pit
Technical suitability	Due to the relatively shallow and flat nature of the deposit at T3, it is technically suitable for open pit mining	Open pit
Environmental/social impacts	The surface footprint of an open pit mine is much larger compared to an underground mine. With underground mines some of the existing surface uses could remain in place, where with an open pit mine the pit and waste dump footprints take up significant amounts of surface space. It must be noted that the proposed T3 project is in a very low populated area, and only impacts the footprint of farm 153-NL. Local mining practices are generally open pit and therefore more people can be employed from within Botswana as they have the required skills with the open pit equipment.	Underground

It is anticipated that many future deposits in the Kalahari Copper Belt will be more suitable to underground mining instead of open pits. The proposed Khoemacau Zone 5 Copper mine is an example of such development. However, due to the physical features of the T3 deposit, combined with the limited impact of the open pit and waste dumps on environment and communities, open pit mining is the preferred alternative for the T3 project.

Alternative selected: Open pit mining

8.1.2 Processing location (concentrator)

The processing method of the ore involves a complex number of stages, which is developed based on the geochemical composition of the deposit, the metallurgical testwork done on the ore, and design work done by the process engineering company. Considering the specialist engineering nature of this work, the alternatives in this ESIA study have been limited to:

- Development of a concentrator at the project site
- Transport of the ore to a concentrator elsewhere

The only copper concentrator plant in Botswana for recovery of copper/silver deposit is the plant located at the Boseto Copper mine (owned by Khoemacau Copper Mining), located approximately 100km north of the T3 project. Other plants in Botswana, such as at BCL Mine or Mowana Mine are Copper/Nickel recovery plants, and not suitable for the ore from T3. In addition, there is no alternative concentrator available within an economic trucking distance, which is generally considered to be up to 50km.

Table 8.2: Comparison of processing location

Aspect	Comparison	Preferred option
Capital cost	Transport of the ore to a concentrator elsewhere (assuming toll treating is a viable option and it is within a 50km radius) would reduce the capital cost for the development of the project.	Concentrator elsewhere
Operational (recurrent) cost	The operational cost of transporting ore to other concentrators (even the nearest at Boseto Mine) will be very large	Concentrator at T3
Technical suitability	The concentrator plant at Boseto is planned to process ore for the Khoemacau Zone 5 mine, and does not have further capacity, unless it would be expanded. Concentrators in other parts of Botswana are for copper/nickel ore, and not the copper/silver from T3	Concentrator at T3
Environmental/social impacts	The most significant environmental impact (in terms of footprint/topography change) is the mine pit and waste dumps. Having the concentrator on-site avoids impacts related to traffic and haulage. However, processing on-site does mean the construction of a tailing disposal facility, which requires additional footprint and management (this will still be required at the processing facility	Neutral

	elsewhere if available)	

Due to the lack of other plants in the vicinity that could concentrate the ore from T3, the only viable option is the development of a plant at T3.

Alternative selected: Development of concentrator at T3

8.1.3 Mine and processing plant development (scale)

For the development of the project (mine and plant), the Client has considered a couple of different scenarios:

- Development of a starter phase / base case and expand from there based on results from the further exploration (development of the plant with modular units to allow for increase of capacity)
- Development of a full anticipated scale of the plant right away

The pre-feasibility study (PFS) for the project was based on a "base-case" scenario of 2.5Mt/a and an "expansion-case" of 4Mt/a. In the environmental scoping study both scenarios were described, and for assessment purposes the "expansion-case" scenario has been used as the worst-case scenario in terms of environmental and social impacts.

The Client announced in July 2018 that based on further exploration results and update of the resource model, the scale for the "base-case" for the feasibility study will be 3.2Mt/a, which is a slight increase from the PFS scenario. When considering the options in terms of scale, the balance between ore availability and supply from the mining operation and processing capacity needs to be made. In addition to this, the Client seeks to find the optimal balance between development cost (larger plant would require more capital to develop) and life of mine, which has an impact on operational cost.

Table 8.3: Comparison of scale of the development (mine and processing)

Aspect	Comparison	Preferred option
Capital cost	A smaller scale start-up phase would require less capital initially. Then when the project starts generating income, this can be re-invested to increase the scale.	Starter phase with modular expansion
Operational (recurrent) cost	The operational cost of a larger scale plant may work out cheaper (in cost per ton processed), as the scale increase does not necessarily mean an increase in number of people required to operate, and other overhead costs may also be fixed, regardless of the scale of the plant.	Full scale plant right away
Technical suitability	The ability to add modules to the plant creates much more flexibility in terms of future development. Especially with the ongoing exploration for T3 underground potential, and other resources at T4 and T1 (which may be processed at the T3 plant), this is a large advantage.	Starter phase with modular expansion

Environmental/social impacts	The footprint of the "base-case" vs the "expansion case" is similar. Water requirements do increase when plant capacity increases, but the hydrogeological studies have shown sufficient water available for the operation. Having the ability to add modules/capacity to the plant, and process ore from other deposits, would possibly eliminate the need for development of separate plants at locations such as T4 and T1. This would minimise the impact area/footprint at these locations, and therefore minimise the environmental/social impact.	Starter phase with modular expansion

As can be seen from the table above, the ability to expand the plant capacity by adding modules has a number of significant advantages.

As mentioned above The Scoping study adopted 2 Mt/a, The PFS study looked at a staged rate of 2.5 to 4 Mt/a. The FS rate of 3 Mt/a was selected based on overall project NPV outcomes rather than capital or operating costs.

Alternative selected: Development of a starter phase / base case and expand from there based on results from the further exploration (development of the plant with modular units to allow for increase of capacity)

8.1.4 Tailings dam design

There are several technical alternatives in relation to the tailings dam design, such as the method of disposal, number of cells, rate of disposal etc. The decisions in relation to these alternatives are engineering decisions based on:

- Composition of the tailings disposed
- Quantity of tailings disposed
- Climate factors such as storm water rainfall
- Geotechnical conditions.

For the PFS, the Client had selected a spigot and decant system, with 2 cells. This is a common system in modern mines. However, as part of the current feasibility studies, the Client is still considering a few options to maximise the water recovery from the plant. This may ultimately affect the final decision on the tailings disposal method.

The more critical issue from an environmental point of view is whether or not the tailings facility will be lined. In most mines in Botswana the tailings facilities are unlined. Whilst the geochemical studies undertaken as part of this ESIA also show that the risk of acid generation or metal leaching at the T3 mine is minimal. To avoid any contamination risks, and to maximise the water recovery during the initial deposit of the first rise (layer) of tailings, the Client had allowed for a liner. The design had allowed for a composite liner over entire TSF basin area, comprising compacted soil liner overlain by 1.5mm smooth HDPE geomembrane liner. Compacted soil liner comprises primarily in-situ soils, scarified and re-compacted throughout basin area to form a 300mm thick soil liner. Where in-situ materials are unsuitable for soil liner, low permeability material (Zone A) will be imported to provide the liner.

Lining tailings facilities rules out any risk of groundwater contamination, if the liner is constructed and maintained properly. The only challenge or risk with lining the facility is that within the lined area, minerals concentrations (such as salts) will increase significantly as water is recovered or evaporated. Should there be a damage to the liner, and this water with high concentrations of minerals is leaking, this could negatively affect the groundwater.

The HDPE liner is far more expensive however it provides the greatest environmental benefit.

Table 8.4: Comparison of tailings disposal designs

Aspect	Comparison	Preferred option
Capital cost	Lining the tailings dam adds to the capital cost, as lining adds a significant cost. The liner cost is estimated to be an additional BWP 50 million over the life of the facility.	Unlined
Operational (recurrent) cost	The lined facility will retain more water (which would otherwise be lost to layers below and would need to be recovered with scavenger boreholes). The costs of pumping extra water to supply the plant initially, and then to run scavenger boreholes to recover the water that seeped away, is assumed to be more expensive than recovering water via decant directly back to the plant.	Lined
Technical suitability	As explained above, the geochemical test work undertaken do not show the need for a liner. Maximising the water returns are a technical advantage. If suitable soils are not available for the soil layer, and need to be imported from elsewhere, that could be a technical challenge.	Neutral
Environmental/social impacts	Lining the tailings dam rules out any risk of contaminating the groundwater in the area. However, this only applies if the liner remains undamaged, so high quality construction is important.	Lined (if constructed properly and not damaged)

Alternative selected: The Client has based all designs and cost estimates for the project based on a lined tailings disposal facility.

8.1.5 Location and layout

Location and layout alternatives include:

- Location of the processing plant in relation to the mining activities
- Location of accommodation
- Layout of the processing plant and waste dumps.

The design of the proposed mine has been based on geological and geotechnical investigations and engineering suitability. During the design of the mine layout various options have been considered. The design engineers employed by the Client have aimed to optimise the mining operation through design. During the optimisation process of the engineering design and layout of the mine, the following elements have been considered:

- Geotechnical stability
- Topography (e.g. flood risks)
- The proximity to the long-term mine blasting perimeter line
- The proximity of the process plant to the mine pit and minimising the haul road distance to the ROM pad
- Required capacity of the various components
- Proposed site access and haulage routes
- The boundaries of the existing farm properties
- Process plant infrastructure requirements
- Minimising the lengths of the conveyors in the plant area
- Minimising pumping distances, and use of gravity where possible
- Environmentally and socially related issues such as noise, dust creation, waste logistics, landscape and visual impacts and impacts on the surrounding.

The proposed layouts have undergone a number of revisions and updates during the engineering design to improve the site setup. Each revision of the design would result in a small number of changes and improvements based on the above elements.

Based on the location of the copper deposit (e.g. the mine pit location is depending on the physical location of the ore body, and alternatives cannot be considered) and the existing farm boundaries, two main options in terms of location/layout remained for the T3 mine:

- Option 1: Plant located on south-west of the pit and waste dumps and tailings located south-east of the pit
- Option 2: Plant located south-east of the pit, and waste dumps and tailings located south-west of the pit.

Locating the plant and dumps on the northern side of the pit was not considered as an option, as this would place them in much closer proximity of the Lemcke homestead. A comparison of the 2 layout options is shown in Table 8.5 below.

Table 8.5: Comparison of layout options

Aspect	Comparison	Preferred option
Capital cost	The geotechnical conditions are relatively similar across the site. The Capital cost for Option 2 would be an additional BWP 8 million.	Neutral
Operational (recurrent) cost	Having the waste dumps located on the south-eastern side slightly reduces the haulage distances for the waste rock. As the quantity of waste rock is larger than the quantity of ore (refer to strip ratios)	Option 1

	this reduces the operational cost. An added advantage is that this layout places the processing plant closer to the access road coming into the mine area, which avoids crossing of traffic flows	
Technical suitability	Option 1 places the processing plant closer to the access road coming into the mine area, which avoids crossing of traffic flows	Option 1
Environmental/social impacts	There is no clear difference from an environmental and social impact between the 2 options. The distance to the home-stead and related impacts is approximately the same for both options. The distance to the home-stead and related impacts is approximately the same for both options however, there would be increased safety risk with Option 2 due to the location of the HV powerline.	Neutral

Alternative selected: Plant located on south-west of the pit and waste dumps and tailings located south-east of the pit

8.1.6 Access road

For the access (from the A3 road) to the mine there are three options:

- Option 1: Continue the use of the current access road (through farms 110-NL and 111-NL)
- Option 2: Use a road along the northern boundaries of the farms
- Option 3: Use a road following the southern boundaries of the farms

The access road options are illustrated in Figure 8.1 below

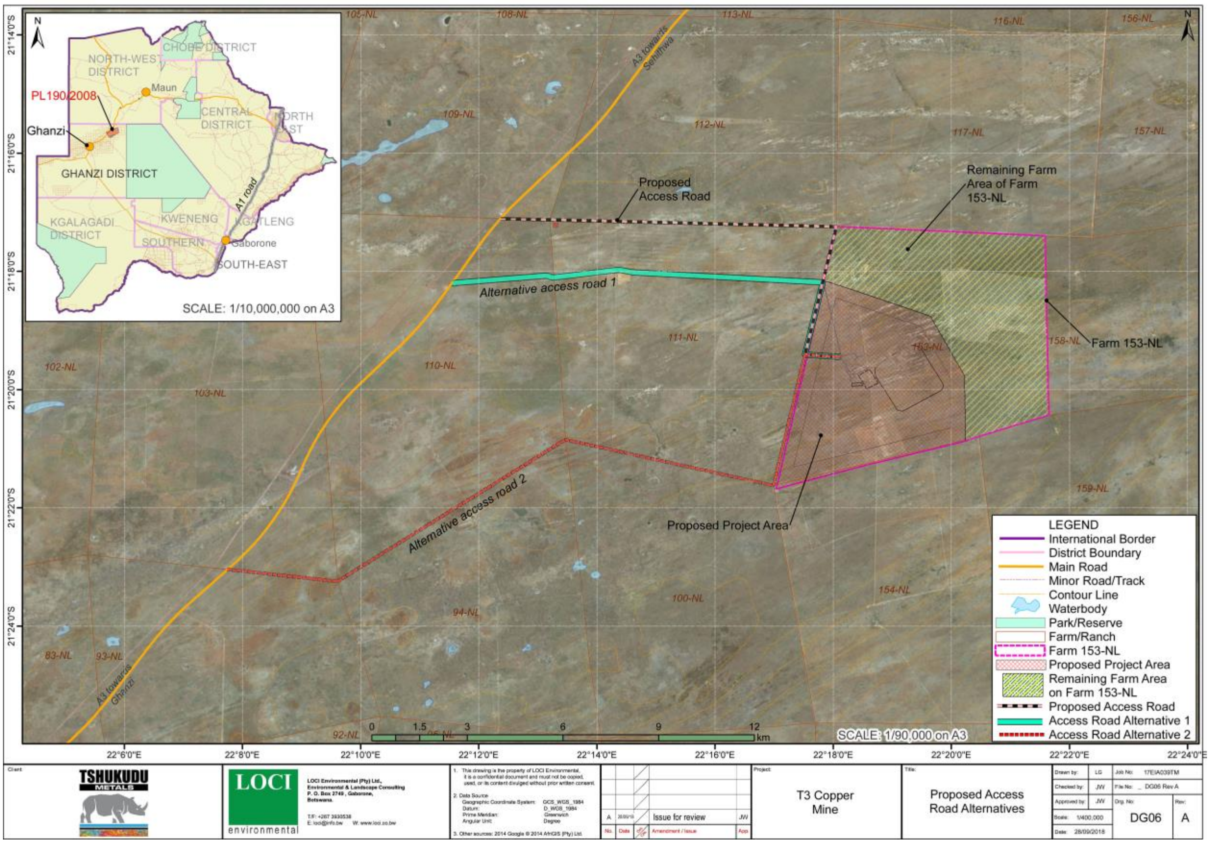


Figure 8.1: Access road/corridor options

The corridor will not only be the access road, but will also be used for the development of other infrastructure for the project such as the power line, fibre optic cable, possible water pipeline and telecommunications infrastructure. The primary activity on the corridor (after construction) is the movement of vehicles on the access road, with the main use being:

- Workers travelling to and from the mine
- Provision of supplies, equipment and fuel to the mine
- Transport of copper/silver concentrate from the mine
- Farmers using the road for access to farms and homestead
- Exploration drilling related traffic for drilling at other area.

Haulage of ore is not planned on the access corridor as part of the current project scope, and this would only take place if ore from other resources (such as T1) would be trucked to the T3 plant for processing. If this would take place, the suitability and impacts on the access corridor will be assessed in a separate assessment.

Table 8.6: Comparison of access corridor options

Aspect	Comparison	Preferred option
Capital cost	Option 1 is the shortest route, making this the cheapest to develop. Option 2 is longer than option one, but the difference is less than 1km. Option 3 is	Option 1

Aspect	Comparison	Preferred option
	by far the longest route. Option 2 estimated to incur a capital cost of an excess of BWP 10 million in comparison to Option 1.	
Operational (recurrent) cost	Length of the corridor has a direct impact on maintenance cost, making Option 1 the cheapest in terms of recurrent cost	Option 1
Technical suitability	All routes are technically suitable	Neutral
Environmental/social impacts	Option 1 cuts across farms 110-NL and 111-NL and does not follow farm fences. This creates disturbance to farm operations. Even more significant, Option 1 passes directly by the homestead of farm 111-NL, and if the route would be used as the main access route, the homestead and workers houses would require relocation. Option 2 and 3 both follow farm boundaries and avoid these impacts. With Option 2 already cleared and used, this is the clearly preferred route. Option 2 though more expensive reduces the impact on the farmers and lowers associated safety risks.	Option 2

Alternative selected: Use a road along the northern boundaries of the farms, to minimise impact on farm activities

8.1.7 Transport of concentrate (route)

As explained in Chapter 2, the mine will be producing a copper/silver concentrate for sale to smelters located elsewhere. This means the concentrate will need to be transported from the site to a smelter or port facility. There are limited options and alternatives available, due to the fact that:

- There is a lack of infrastructure such as railways, the only possible option for transport of the copper/silver concentrate is by road, using semi-trailer trucks. The ultimate route for the transport will depend on commercial negotiations with buyers of the concentrate and transport companies they will use, as the concentrate is usually collected by the buyer at the mine site and transported to the required port, for further transport by ship to a suitable smelter.
- The copper/silver concentrate is expected to be transported via Ghanzi to Walvis Bay (or South Africa), but transport companies may choose to use different routes, depending on optimal logistics. For example, if they can utilise the trucks on their way to the mine by carrying goods to Ghanzi or Maun and avoid trips without load, this will help improve efficiency.
- Much of the mine supplies are expected to come via Ghanzi and Maun.

Based on the above, it does not leave any alternatives for transport of concentrate to be assessed within the context of this ESIA, especially since the only access to site is via the A3 road. The traffic impacts related to this have been assessed as part of the ESIA study (refer to Appendix J).

8.1.8 Transport of concentrate (method)

For the method of concentrate transport, bulk transport (e.g. loose in bulk side tipping trucks or similar, as is common practice with coal) has been ruled out, as this presents complications in the port facilities. Copper concentrate is not a bulk commodity such as coal, and presents a much higher value product. As such, it must be kept contained and risk of mixing with other product streams must be avoided. It has therefore been assumed that the material will be loaded in batches for transport and handling downstream. For the batch loading of the concentrate there are 2 options considered for transport and further handling:

- Loading in containers
- Loading in bags, transported on flat-bed trucks.

These options have been compared in Table 8.7 below.

Table 8.7: Comparison of concentrate transport options

Aspect	Comparison	Preferred option
Capital cost	In terms of the loading facility to be constructed at the mine, the capital cost is expected to be similar when comparing a container loading facility with a bag loading facility. This has not taken into consideration the cost of the containers. However, when the cost of containers is considered there is an BWP 8 million increase in operating costs per annum, which equated to approximately BWP 80 million over the life of the mine.	Neutral
Operational (recurrent) cost	The handling costs of containers are estimated to be lower than bags (less handling). However, finding return freight for the containers when coming back to site empty is expected to be a challenge, where the possibility of return freight for flat-bed trucks is much more likely, reducing the transport cost	Bags
Technical suitability	The contained solution keeps the copper concentrate protected from any contamination, damage and spillage, and handling is easier	Containers
Environmental/social impacts	There is no clear direct difference in terms of impacts. However, if transport of bags enables the trucking company to secure return freight and avoid empty trucks, this reduces the overall carbon footprint of the operation	Bags

Alternative selected: Although the ultimate selection will be based on negotiations with transport companies and possibilities of return freight, bags is the most likely option

8.1.9 Staff accommodation

The proposed development will require a significant amount of staff housing. For the accommodation of personnel working at the mine during construction and operation, two alternatives have been considered:

- On-site accommodation (at the mine)
- Accommodation within existing villages, in a combination of rented and Client-owned properties.

Accommodation of staff within the existing villages requires the construction of housing units at the villages, as there is not enough and suitable capacity for rented accommodation. The nearest existing villages to the proposed mine areas are D'Kar and Kuke, which are both over 30km away. Both villages are very small (refer to Chapter 5), and do not offer basic facilities such as potable water, which could support an accommodation camp. The option of developing a camp near Ghanzi has therefore been compared with the possibility of accommodating all workers at the mine site. Table 8.8 below provides the comparison.

Table 8.8: Comparison of accommodation options

Aspect	Comparison	Preferred option
Capital cost	Excluding the cost of purchase of land, the development cost of the accommodation village at the mine or at Ghanzi village are expected to be similar	Neutral
Operational (recurrent) cost	Locating the accommodation at Ghanzi village will require the operation of daily staff transport services (bus) to transport the staff, which will be an additional cost. However, if the accommodation would be located at the mine, the Client would be operating transport to take people to Ghanzi at the start and end of their leave periods. The latter would require less busses and trips. The ~2 hr travel time each day per person adds ~ BWP 40 million per annum or BWP 400 million over the life of the mine.	At mine
Technical suitability	The accommodation facilities can be built at both locations without technical challenges. Should the Client discover other feasible resources, a facility at the village can support other projects easily, where at the mine this would be more complicated due to distances	At Ghanzi
Environmental/social impacts	There are both positive and negative impacts related to both options. Social impacts on Ghanzi are likely to be much bigger (both positive and negative) with the village being near Ghanzi. Traffic impacts and safety impacts are a negative for the Ghanzi village option, as it will add traffic and night driving. However, the accommodation near Ghanzi will minimise the impact and disturbance on the farm operation on the surrounding farms.	Neutral

It must be noted that the mine will operate on a shift schedule, with rotational schedules for all staff. Facilities such as kitchen, laundry and recreation are part of the mine setup, and will require support staff and management. By developing the accommodation facility near Ghanzi, this support can be provided by businesses and people from within Ghanzi, therefore reducing the need to accommodate the support staff, and creating local business opportunities. For accommodation at site this will be more challenging.

Alternative selected: Accommodation near Ghanzi, with some temporary accommodation during construction for peak staff numbers at site

8.1.10 Power supply

For the power supply, a number of configurations were considered:

- Grid power supply from the start of the project
- Diesel powered generators
- A combination of grid power and diesel.

Liaison with BPC (refer to Chapter 2) shows that a power transmission scheme is being developed to the North West and Ghanzi District. The transmission line from Toteng to Ghanzi runs along the A3 road, and will be located only approx. 12km distance from the project site, with permanent grid power expected to be available by end of 2019.

Table 8.9: Comparison of accommodation options

Aspect	Comparison	Preferred option
Capital cost	The on-site diesel generators will be procured and installed regardless of grid connection, as back-up power will be required. The cost of installation of the substation and connecting line will add capital cost to the project. HV grid connection has an increased capital cost of BWP 100 million relative to diesel generation in a BOOT style contract.	Grid power
Operational (recurrent) cost	Power generated from on-site diesel generators is significantly more expensive (double) compared to grid power. On-site power generation would add a huge amount to ongoing running costs of the project. Operating costs are reduced by BWP 160 million per annum or BWP 50 per tonne processed by selecting HV grid power.	Grid power
Technical suitability	Both grid power and on-site diesel generated power will be technically suitable to provide the required power to the project. Grid power supply reduces processing costs relative to diesel generator sets. Generator sets will be used for construction and emergency back-up only.	Neutral
Environmental/social impacts	On-site power generation from diesel gensets will add traffic (fuel transport), noise, emissions, quantities of diesel stored on site and related risks	Grid power

To get power to the project site, development of a substation at the transmission line and overhead powerline to site is required (as described in Chapter 2). It is therefore proposed the T3 mine plant will be developed with on-site power generation (for the construction period) and to be connected to the permanent grid power once it becomes available and the substation and connecting powerline have been developed.

Alternative selected: Grid power connection with on-site back-up (used during initial construction)

8.1.11 Water supply

An extensive water exploration programme was undertaken for the Project, as the supply of water for processing is critical to the feasibility of the Project. During the earlier feasibility stages external wellfields vs. water from boreholes within the project area were considered. During the feasibility study further work was done on understanding the water flows from de-watering the mining pit. Based on this work the following options for process water supply were identified:

- Water supply from de-watering (only)
- Water supply supplemented by production boreholes from within the project area
- Water supply supplemented by boreholes from an external wellfield.

The project water demand (make up water) does not only depend on the project capacity/scale but also on the water recoveries from the tailings facility. Different technologies can be selected (refer to Section 8.1.4), which will influence the water recovery rates and ultimately the water demand. The two main tailings dam design aspects that will impact the demand (and the capital cost):

- Lining of the tailings dam
- Installation of thickeners.

The Client has committed to HDPE lining of the tailings dam (as described in Chapter 2), considering the groundwater vulnerability as described in Chapter 5. This lining will avoid water loss into underlying surfaces and significantly increase water returns, and decrease water demand. Taking this into account, the water supply options are compared in the following table:

Table 8.10: Comparison of water supply options

Aspect	Comparison	Preferred option
Capital cost	The cost of high yield pumps and equipment for dewatering (if inflows are high) compared to cost of equipment to increase water recovery can be considered similar. Balancing this would make the need for supplementing water for back up only. An external wellfield would cause a significant increase in capital cost	Water supply from de-watering, with some production boreholes for back up
Operational (recurrent) cost	The operational cost of boreholes within the mine footprint will be similar for de-watering boreholes and production boreholes, and depend on the yields rather than location. Water supply from boreholes from an external wellfield will add operational cost	Water supply from de-watering, with some production boreholes for back up
Technical suitability	The extensive hydrogeological work has determined there is sufficient water within the mine area, and there is no requirement for an external wellfield	Water supply from de-watering, with some production boreholes for back up
Environmental/social impacts	Mine de-watering is a necessity for the mine operation, and as such impacts related to this are a “given” if the project proceeds. If additional water is supplied from an external wellfield, this would add an additional area of impact, which is not preferred	Water supply from de-watering, with some production boreholes for

		back up

Alternative selected: Water supply from de-watering, with some production boreholes for back up

8.1.12 Supply of gravel material for construction

The construction of the project components will require a significant amount of gravel, to construct the platform and foundations for the equipment. For the supply, two options are available:

- Supply/purchase from existing external borrow pits and within the mine area (overburden)
- Licensing of new borrow pits for the project.

A comparison of the options is provided in Table 8.11:

Table 8.11: Comparison of gravel supply alternatives

Aspect	Comparison	Preferred option
Capital cost	The capital cost comparison is mostly dependant on transport cost. The cost per ton of gravel from a commercial source is likely to be higher than from own borrow pits. However, if the existing borrow pit is already authorised and licensed, the material can be acquired right away (no time and cost required for permitting). As material quantities required are relatively small, this is expected to require less capital than opening a new borrow pit. In addition to this, the area is (refer to Chapter 5) rich in calcrete material and much of the overburden is calcrete. Utilising this material (which has to be removed anyway) will reduce the overall capital cost. It is estimated that there will be a potential increase in capital of 3M pula if aggregates sourced from an offsite quarry.	Overburden and supplemented from existing licensed source (if needed)
Operational (recurrent) cost	Gravel will only be required during construction, there is no difference during the operational phase of the project	Neutral
Technical suitability	The gravel (from either alternative) would need to meet the minimum technical specifications stipulated by the engineer	Neutral
Environmental/social impacts	Using an existing source avoids disturbance of a new area, and need for rehabilitation afterwards	Overburden and supplemented from existing licensed source (if needed)

Some material for site roads and earthworks will come from waste rock from the pit. Liaison with the Department of Mines has shown that there are borrow pits in the proposed project region. It has therefore been assumed that the contractor will procure his materials from these existing sources, rather than opening new borrow pits. The exact borrow pit the contractor will select for supply will depend on commercial negotiations between the owner of the borrow pit and the contractor.

Alternative selected: Overburden and supplemented from existing licensed source (if needed)

8.2 Planning alternatives

In addition to the technical alternatives, there are several planning related alternatives, which can especially impact the social related issues of the mine.

8.2.1 Equipment

A wide range of equipment will be used throughout the mining process. During the mining process large-sized plant such as haul trucks, loaders and excavators are required. The equipment purchases and maintenance is a very capital-intensive component of mining, and companies often outsource this to a specialised mining contractor. The alternatives considered are therefore:

- Owner-operated mining equipment
- Contract mining by outside contractor.

The benefit of owner-operated mining equipment is mainly related to being able to control the fleet, as well as long-term economics. Contract mining has the benefit of being less capital-intensive for the mining company. If an established contractor is hired for the Project, it is likely the contactor will be able to bring experienced operators, mechanics and support to the Project, and will have equipment available on standby or from other projects, should one of the machines fail.

Table 8.13: Comparison of equipment sourcing options

Aspect	Comparison	Preferred option
Capital cost	Contract mining will avoid the purchase of capital intensive equipment. Purchase of the mining equipment would be approximately BWP 850 Million.	Contract mining
Operational (recurrent) cost	If the Client can manage the equipment and engage a trained and experienced work force, the operational costs of owner-operated equipment is less compared to contractor operated. It is estimated that purchase of equipment would result in mine operating costs being 15% lower than if it was contracted.	Owner operated
Technical suitability	In terms of technical suitability both models work, but it is often found that contractors are better able to manage and utilise their fleet and their operators, as they have extensive experience	Contract mining
Environmental/social impacts	If the contractor engaged, will be controlled and comply to the environmental and social requirements and standards the same way the owner team would, there is no difference	Neutral

Alternative selected: Contract mining

The above alternatives do have significant environmental implications, as with contract mining the Client must ensure that all relevant ESIA and ESMP requirements are adhered to by the contractors involved. It is recommended that clauses related to this are included in the relevant contracts between Tshukudu Metals and the 3rd parties.

8.3 No-development

The inclusion of an appraisal of the "No Development" alternative is justified in the establishment of a standard or reference condition of the environment against which it is possible to assess the relative impacts to the environment that would occur because of the alternatives considered.

The "No development" alternative alludes to the possibility that the T3 copper mine would not be developed. The scale of disturbance on site would remain limited to the current exploration.

By not developing the proposed the T3 Copper Mine Project, none of the predicted impacts considered herein will occur, both positive and negative. The negative impacts related to air quality, noise, water and water resources, waste, ecology, archaeology and landscape would not become a reality, aside from those that currently exist due to the existing exploration. Local resettlement at the farms would not become an issue.

Positive impacts expected from the mine will also not be realised when considering the "no-development" alternative. The expected positive social impacts of job creation and additional economic opportunities for local businesses and improvement of facilities in surrounding villages would not be implemented, and creation of additional revenue for Botswana (nationally) related to the resource at the T3 project, would not materialise. As outlined in the economic section of this report, the nation has an opportunity to benefit from the proposed Project during the operational phase due to increase government income, which can be used for development of other areas and services.

8.4 Summary

The following table provides a summary of the alternatives considered for the Project.

Table 8.14: Summary of alternatives assessed and recommended

Alternatives	Recommended
Mining Method	Open pit mining
Processing method	Development of concentrator at T3
Mine and processing plant development(scale)	Development of a starter phase / base case and expand from there based on results from the further exploration (development of the plant with modular units to allow for increase of capacity)
Tailings dam design	The Client has based all designs and cost estimates for the project based on a lined tailings disposal facility
Location and layout	Plant located on south-west of the pit and waste dumps and tailings located south-east of the pit
Access road	Use a road along the northern boundaries of the farms, to minimise impact on farm activities
Transport of concentrate (route)	A3 road via Ghanzi or Maun
Transport of concentrate (method)	Although the ultimate selection will be based on negotiations with transport companies and possibilities of return freight, bags is the most likely option

Alternatives	Recommended
Staff accommodation	Accommodation near Ghanzi, with some temporary accommodation during construction for peak staff numbers at site
Power supply	Grid power connection with on-site back-up (used during initial construction)
Water supply	Water supply from de-watering, with some production boreholes for back up
Gravel material for construction	Overburden and supplemented from existing licensed source (if needed)
Equipment	Contract mining
"No Development" Alternative	Development of the Project

9 Mitigation measures

Mitigation is the development of practical measures to reduce adverse impacts on the environment, or to enhance beneficial aspects of a project. Mitigation measures were identified by the ESIA team to minimize or eliminate the predicted negative impacts and enhance or maximise positive impacts on people and the environment.

When describing the mitigation measures, it has been indicated for which phase of the project it is applicable. An assessment is also made of the predicted impact, after the proposed mitigation has been implemented. The proposed mitigation measures have then been incorporated in the environmental and social management plan presented in Chapter 10.

9.1 Biodiversity

The biodiversity impacts related to the construction phase and operational phase of the project are similar, and the mitigation measures are presented combined. Mitigation measures are presented for flora, fauna and avifauna separately.

9.1.1 Flora

A number of flora related impacts were identified in Chapter 7. The following mitigation measures are proposed.

9.1.1.1 Loss of vegetation and disturbance of plant communities

It is predicted that the disturbance that the floral community within the T3 site will experience during the construction and operation phases of the T3 mine will result a net loss of plant biodiversity. Therefore, rehabilitation of this area is of importance, particularly when considering its current agricultural land uses. The recommended means to limiting biodiversity attrition is to ensure that any non-utilised areas within the T3 footprint be left undisturbed. This includes areas outside of the local footprints but surrounding any of the planned structures (e.g. offices, storehouses and ponds), all areas adjacent to roadside reserves, and any areas within the T3 footprint that will not be cleared of vegetation. The untouched areas will for small corridors that provide refuge for fauna and allow them to traverse the area with a reduced likelihood of any contact or conflict with humans (Driver *et al.* 2003; Johnson, 2005). These areas will also preserve a selection of the native flora that can then be encouraged to spread following the closure phases of the project. This would significantly aid in the achievement of vegetation rehabilitation targets within the region. Furthermore, it would also provide a measure of natural resilience to the establishment of exotic species particularly those that tend to capitalise on areas that have been disturbed.

Though it can be argued that these small undisturbed patches will suffer from habitat fragmentation they will still preserve some biodiversity and will help mitigate the overall loss of vegetation within the whole T3 footprint. It is highly recommended that any areas to be left undisturbed be designated and demarcated. Furthermore, these areas should be monitored to ensure that they are not disturbed through the dumping of foreign materials, the stockpiling of excavation matter, the felling or removal of any flora, and the establishment of exotic species (Driver *et al.* 2003; Johnson, 2005).

Recommended mitigation measures to be deployed for loss of vegetation during the construction phase of the project are as follows:

- All areas to be cleared should be precisely demarcated. Bush clearing should only be carried out within the agreed upon areas only. It is recommended that clearing is also supervised and not permitted without an authorised disturbance permit signed of the by Environmental Manager and person responsible for overseeing the earth moving contractor
- Clearing strategies should retain vegetation links and habitat (large established and old trees with hollows) where possible. Trees need to be left where practicable and vegetation linkages between infrastructure should also be left in place where possible. This is not only responsible practice, but also helps with recruitment of species for rehabilitation. It also plays an essential role in dust management and aesthetics and maintaining ecological function in a sensitive environment.
- Any areas outside of the access corridor that are cleared or no longer in use should be rehabilitated when practicable to do so
- All areas (where possible) associated with the T3 footprint are to be rehabilitated and re-vegetated following closure phases.

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Loss of vegetation and disturbance of flora and vegetation	moderate	negative, permanent, direct			moderate

9.1.1.2 Increased risk of establishment of invasive or encroacher species

Recommended mitigation measures to be deployed for risk of establishment of invasive species during the construction and operation phase are:

- Hygiene Management and controls should be included across all operations
- Potential invasive flora species should be identified, and action must be taken to control and limit these species if they occur in or around areas designated for bush clearance to prevent establishment after clearing
- An invasive species control and management program should be integrated into routine maintenance.
- During the closure and rehabilitation phases, care must be taken to control these species, lest they inhibit re-vegetation efforts

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Increased risk of establishment of invasive or encroacher species	moderate	negative, permanent, indirect			negligible

9.1.1.3 Increased erosion risk

Through excavations and removal of top soil, soil erosion as a result of soil substrate disruption and reduced vegetation cover is a possibility at the proposed site. The following proposed mitigation measures should be adhered to:

- Implement a storm water management plan
- Revegetation of waste rock dumps
- Access roads and construction sites require suitable drainage systems
- Cleared areas no longer required for construction activities should be rehabilitated by reseeding with locally found grasses and shrubs to increase soil stability
- Heavy machinery and vehicles should remain on the access roads and not drive in the un-cleared bush unless work dictates them
- Regular maintenance checks and monitoring should be conducted, any areas showing signs of erosion should be repaired

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Increased erosion risk	moderate	negative, long term, direct			negligible

9.1.1.4 Risk of unintentional bushfires

There is a slight chance for unintentional bushfires due to negligence from project staff. Proposed mitigation measures should be adhered to:

- Construction and maintenance of not less than 6m x 6m firebreaks on both sides of the mine site perimeter fence as a legal requirement in the Herbage Preservation Act 37 of 1977.
- Fire safety to be included in site induction
- Fire safety to be part of the site induction and training package
- All staff to be aware of the site emergency response procedures on site
- Staff training in the use of firefighting equipment to be conducted

- Firefighting equipment such as fire extinguishers, fire water ring-main in the process plant, fire tender on site and water carts to assist
- Establishment of designated smoking areas

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Risk of unintentional bushfires	slight	negative, medium term, direct			negligible

9.1.1.5 Risk of pollution from spillage of fuel and chemicals

Fuels and hazardous chemicals that are used may pollute the area and impact on flora. Proposed mitigation measures include:

- All materials must be stored with spillage containment provision
- Care must be taken to avoid spillage when refuelling or refilling. Engineering designs and solutions as per Section 9.5 to be implemented
- Machinery must be well maintained to avoid leakages

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Risk of pollution from spillage of fuel and chemicals	slight to moderate	negative, medium term, direct			slight

9.1.2 Fauna

Several fauna related impacts were identified in Chapter 7. The following mitigation measures are proposed.

9.1.2.1 Disturbance, alteration and destruction of faunal habitats

Recommended mitigation measures to be deployed for alteration of faunal habitats during the construction phase of the project are as follows:

- A fauna management plan is to be developed prior to construction, providing information needed for a trans-location program for small and medium mammals, prior to clearing for construction

- Scouting the areas for clearing and recording of den locations, etc. If required, animal relocation to suitable site by qualified people
- Any fauna directly threatened by construction activities should then be relocated by officers from the Department of Wildlife and National Parks or appointed, qualified personnel
- Project staff require environmental education to limit additional disturbance and exploitation of fauna
- Bush clearing is to be carried out in demarcated areas
- The collection, harvesting or hunting of any plants or animals must be strictly prohibited
- All hazardous materials must be correctly stored to limit chances of contamination of the area

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Disturbance, alteration and destruction of faunal habits	slight	negative, medium term, direct			negligible

9.1.2.2 Excavations posing a threat to fauna

If the outlined stipulations below are followed, the impact on animals can be mitigated:

- Areas which have been excavated (during construction e.g. trenches) are to be temporarily demarcated and fenced off to bar access to animals
- Following the construction or excavation, trenches and excavated areas (not including mine pit and run-off ponds) need to be re-filled and rehabilitated.

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Excavations posing a threat to fauna	slight	negative, short term, direct			negligible

9.1.2.3 Displacement of territorial species because of mine fencing

Fencing is anticipated to be done during construction to secure the project area, this will displace fauna and further move them to a different location. Proposed mitigation measures include:

- It would be prudent to leave corridors (maintain corridors for movement of wildlife) in places where the fence completely cuts off access for animals (where possible)

- Utilise wildlife friendly fencing as per the DWNP guidelines (noting that new fencing will be within existing farm fence lines)

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Displacement of territorial species	slight	negative, long term, direct			negligible

9.1.2.4 Increase in ambient noise levels disturbing local fauna

The increase in ambient noise levels is expected to come from construction and operation machinery and increased traffic. Proposed mitigation measures include:

- Animals should be monitored to assess the effects of the noise on their behaviour (as part of Biodiversity Monitoring programme)
- Allow movement of animals during operations, so they can flee from noise disturbance

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Increase in ambient noise levels disturbing fauna	moderate	negative, medium term, direct			negligible

9.1.2.5 Lighting causing disorientation to fauna

The introduction of artificial lighting in the project site will affect fauna and avifauna. Mitigation measures proposed include:

- Use down lighting at the site where possible
- Utilize green/blue hue light bulbs as opposed to yellow/white where practicable

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Lighting causing disorientation to fauna	moderate	negative, long term, direct			negligible

9.1.2.6 Blasting negatively impacting fauna

Blasting will negatively affect avifauna. The following mitigations are proposed:

- Monitor wildlife before, during and after blasting (observation and report by staff on wildlife seen) to establish impacts on fauna
- “Sweep” for fauna in the area impacted by flyrock before blasting to minimise risk of injury to fauna

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Blasting negatively impacting fauna	moderate	negative, permanent, direct			Slight to moderate

9.1.2.7 Elephants migration to the south

Elephants are likely to migrate to the south in search of water from open sources. Proposed mitigation measures include:

- Fencing: Fences should be maintained regularly although this is an expensive measure
- Deterrent measures to be investigated with the Department of Wildlife. Develop working relationship with department of wildlife to understand tracking of elephant population
- Regular contact with local authority responsible for monitoring elephant migration

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Elephants migration to the south	slight	negative, long term, indirect			slight

9.1.2.8 Conflict between workers and fauna

Some of the mitigation measures may include:

- Workers must coordinate with relevant personnel who can resolve conflict situations
- Workers must be instructed on the correct courses of action when confronted in a situation with wild animals. Basic instructions to be provide in the site induction training

- A policy whereby the animals have "right of way" during construction would reduce incidents of conflict
- Any incidence of conflict between project staff and wildlife must be reported for monitoring purposes

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Conflict between workers and local fauna	slight	negative, medium term, direct			negligible

9.1.2.9 Risk of vehicle collisions with wildlife and livestock

Vehicle collisions with fauna is expected to occur during construction and operation phase. The proposed mitigations include:

- Drivers operating in the area are to be inducted and made aware of the danger the traffic poses to the local fauna
- Speed limits and all other road rules must be enforced and strictly adhered to
- All incidents of road kills should be reported and monitored to that hot spot areas can be identified and mitigated

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Risk of vehicle collisions with wildlife and livestock	moderate	negative, medium term, direct			slight

9.1.2.10 Risk of poaching and exploitation of fauna

As stated in chapter 6, fauna is anticipated to be at risk of poaching during construction of the T3 Copper mine. The proposed mitigation measures are:

- A 'no tolerance' policy is essential for all project staff guilty of poaching. This is a criminal offence under the Wildlife Conservation and National Parks Act (1992), and they must be immediately dismissed from their position and handed over to wildlife authorities
- Any sign or evidence of poaching must immediately be reported to the Department of Wildlife and National Parks
- All incidences of poaching or poaching related activities must be documented for monitoring purposes

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Risk of poaching and exploitation of fauna	moderate	negative, long term, indirect			negligible

9.1.3 Avifauna

A number of avifauna related impacts were identified in Chapter 7. The following mitigation measures are proposed.

9.1.3.1 Loss of foraging area

Avifauna around the project site will experience loss of foraging area to project development. Proposed mitigation measures include:

- The footprint is to be rehabilitated following closure of the mine based upon agreed closure plan

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Loss of foraging	moderate	negative, medium term, direct			slight

9.1.3.2 Vultures killed by people in the area

Avifauna faces risk of being killed by people (for various reasons) throughout all project phases. As described in Chapter 7, the nearest vulture nest at the time of assessment was approximately 7km from the mine pit, which limits the anticipated risk. The proposed mitigation measures include:

- Staff must be inducted and educated to alter perceptions towards vulture
- A “no tolerance” policy must be adopted with respect to project staff who are guilty of poaching or exploitation of avifauna. They must be immediately dismissed from their position and handed over to wildlife authorities
- Any sign or evidence of poaching must immediately be reported to the Department of Wildlife and National Parks
- All incidence of poaching or poaching related activities must be documented for monitoring purposes

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Human persecution	slight	negative, medium term, direct			negligible

9.1.3.3 Risk of electrocution of vultures

Vultures (and other avifauna) are at risk of electrocution by proposed powerlines. Mitigation measures proposed include:

- Tower designs for the power lines should take into consideration to have live and earth phases at least 1.8 meters apart from each other
- It is recommended that towers are designed such that nesting underneath the cables cannot take place

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Risk of electrocution of vultures and other avifauna species	moderate	negative, long term, direct			slight

9.1.3.4 Risk of vultures colliding with power lines

Vultures (and other avifauna) are at risk of colliding with powerline as they are not familiar with such. Mitigation measures proposed include;

- Anti-collision marking devices are recommended to be added along the entire length of the power line in the designated areas (as per BPC specifications on other lines in Botswana)
- Collision event must be monitored to isolate hot spot area, to inform future decisions

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Risk of vultures colliding with power lines	moderate	negative, long term, direct			slight

9.1.3.5 Decline in air quality affecting avifauna

Decline in air quality pose risk to health of avifauna. Mitigation measures should be implemented as per the recommendations of the air quality specialist (see Section 9.2).

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Decline in air quality affecting avifauna	slight	negative, medium term, direct			negligible

9.1.3.6 Increase in ambient noise levels affecting avifauna behaviour

Elevated noise levels disturb avifauna which may affect their breeding patterns. The proposed mitigation measures are as follows:

- Vultures nests in the areas within 10 kms surrounding the project must be monitored as part of biodiversity monitoring program to assess the effects of the noise on their behaviour
- Disturbance near to trees where vultures are nesting should be avoided where practicable.

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Noise disturbance to avifauna	slight	negative, medium term, direct			slight

9.1.3.7 Blast related disturbance to avifauna

Just as elevated noise levels, blasting will negatively affect avifauna. The following mitigations are proposed:

- Monitor vulture nests within a 10km radius after blasting to establish activity at the nests (compared to previous activity) to establish the impacts on the species
- Monitoring to be undertaken as part of overall project biodiversity monitoring program

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Blast related disturbance to avifauna	moderate	negative, medium term, direct			slight

9.1.3.8 Risk of vehicle collisions along roads

Just like fauna, avifauna face a risk of vehicle collision along roads during construction and operation phases of the project. Proposed mitigation measures include:

- Drivers operating in the area are to be inducted and made aware of the danger that traffic poses to the local avifauna

- Speed limits must be enforced and strictly adhered to
- All incidents of road kills should be reported and monitored to that hot spot areas can be identified and mitigated
- Road kill carcass must not be left on the road where they will attract vulture and increase risk of collision

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Risk of vehicle collisions along roads	moderate	negative, medium term, direct			slight

9.1.4 Biodiversity mitigation measures for decommissioning phase

There are a few specific mitigation measures related to biodiversity for the closure and decommissioning phase, which need to be incorporated into the mine closure plan.

9.1.4.1 Land contamination and mine reclamation

Decommissioning works may contaminate the land particularly through improper handling of waste. Proposed mitigation includes:

- Equipment and facilities are to be decommissioned and materials must be removed from the proposed footprint or surrounding areas
- Mine reclamation needs to be managed – soils that are to be used in rehabilitation require soil analysis in case they are contaminated

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Land contamination and mine reclamation	significant	negative, long term, indirect			slight

9.1.4.2 Increased poaching and exploitation of fauna

With mining activity having ceased there will be less control and increased possibility for poaching. Proposed mitigation for increased poaching and exploitation to fauna include:

- A "no tolerance" policy must be adopted with respect to project staff who are guilty of poaching or exploitation of fauna. They must be immediately dismissed from their position and handed over to wildlife authorities

- Any sign or evidence of poaching must immediately be reported to the Department of Wildlife and National Parks
- Liaison with authorities to increase monitoring
- All incidence of poaching or poaching related activities must be documented for monitoring purposes during the rehabilitation phase

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Increased poaching and exploitation of fauna	moderate	negative, long term, indirect			slight

9.1.4.3 Risk of fauna falling into the open mine pit

When the project ceases operation fauna face risk of falling into uncovered or unsealed pits. Proposed mitigation measures include:

- Areas which have been excavated have to be demarcated and fenced off to prevent access to animals
- Fences and berms must be checked and monitored by relevant authorities and post-closure land owner to maintain their integrity
- Liaison with farmers and authorities on most suitable and acceptable access control to the pit (e.g. for possible access to pumping of water)

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Risk of fauna falling into mine pit	slight	negative, long term, indirect			negligible

9.1.4.4 Increased risk of establishment and proliferation of alien flora and encroacher species

Increased risk of establishment of alien flora species is expected to occur at decommissioning and rehabilitation phase. Proposed mitigation includes:

- Potential invasive and encroacher flora species should be identified, and steps must be taken to manage any such species
- Equipment brought to site must be clean, hygiene procedures must be established to avoid bringing alien species to site

- During routine monitoring any invasive flora species should be removed. Cutting and poisoning of saplings is an effective control measure
- During the closure and rehabilitation phases, care must be taken to control these species, lest they inhibit re-vegetation efforts

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Increased risk of establishment of invasive or encroacher species	slight	negative, permanent, indirect			negligible

9.2 Air Quality

The air quality mitigation measures are mainly related to the construction and operational phases of the project and are outlined below.

9.2.1 Decline in air quality affecting the community

Proposed mitigation measures for construction phase to reduce air pollution are as follows:

- Increased dust management and mitigation during the windiest conditions (during the months of August, September and October)
- Wet suppression to control open dust sources at construction sites
- When working near (within 100m) a potential sensitive receptor, limit the number of simultaneous where practicable
- Designate a responsible person on site to handle complaint, and follow up should complaints arise, to reduce emissions

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Extent	Duration	Direct/ Indirect	
Decline in air quality affecting community	moderate	negative, local, short term, direct			slight

9.2.2 Air pollution during mining

Air pollution is expected to emanate from the following sources: stockpiles, conveyor belts, crushing plant and blasting activities. Proposed mitigation measures during the operational phase include:

- Dust suppression sprays should be considered when designing the crusher feed bin to help reduce dust during ore delivery to the crushing plant
- Consider dust suppression sprays at all transfer points in the crushing system to help control dust
- Develop procedure for dust management should excess wind create an issue
- Chemical dust suppression should be avoided where possible but may be considered around the coarse ore stockpile base. The type of chemical dust suppressants, if used will be non-hazardous and environmentally safe.
- Ensure roads are monitored for dust generation and frequent use of water cart to be applied
- Consider stockpile embankment angles to ensure stockpiles of top soil don't become airborne
- Adequate blasting management techniques should be employed. This includes informing nearby residents as to when blasting will occur on a certain day at a given time; and not blasting after day-time hours
- The Australian NPI recommends a number of ways in which emissions from materials handling and storage activities can be controlled. General control measures and efficiencies are given in the following table.

Emission reduction factors for materials handling and storage (NPI, 2008)

Control Method	Emission Reduction (%)
Wind breaks	30
Water sprays	50
Chemical suppression	80
Enclosure (2 or 3 walls)	90
Covered stockpiles	100

A detailed list of mitigation methods relating to each specific activity can be found in the air quality specialist report.

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Extent	Duration	Direct/ Indirect	
Decline in air quality from mining	moderate	negative, local, medium term, direct			slight to moderate

9.2.3 Decommissioning and rehabilitation

By restoring or rehabilitating areas to a suitable condition, the air quality impact can be mitigated. Several Project development areas were identified, and from an air quality point of view the following is recommended:

- The mine pit should be restored and used as:
  - Regional water reserve, and or
  - Conservation area
- The waste dumps and tailings should be restored and used as:
  - Habitat for fauna, and
  - Planting of suitable vegetation as per the closure and rehabilitation plan
- The processing plant and ROM areas should be restored and used as:
  - Natural habitat (if not a contaminated site)

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Extent	Duration	Direct/ Indirect	
Decline in air quality	moderate	negative, local, long term, direct			slight

9.3 Ambient noise levels

The mitigation measures for noise are presented separately for the construction phase and the operation phase of the project.

9.3.1 Construction phase

Proposed mitigation measures for construction phase to limit noise levels are as follows:

- Information regarding construction activities should also be provided to all farm residences within an agreed radius (suggested 5km)
- When working near (within 100m) a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as practicable
- Strict enforcement of speed limits will aid in limiting any additional noise along the access road
- Ensure equipment is well-maintained to avoid additional noise generation

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Extent	Duration	Direct/ Indirect	
Elevated noise levels from construction	moderate	negative, local, construction, indirect			slight

9.3.2 Operation phase

Recommended mitigation measures for elevated noise levels during operation phase are that:

- Inform nearby farm residents as to when blasting will occur on a certain day at a given time
- It is recommended that blasting activities be conducted during daylight hours

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Extent	Duration	Direct/ Indirect	
Elevated noise levels	moderate	negative, local, medium term, direct			Slight

9.4 Soil impacts

As described in Chapter 7, the impacts on soil are related to contamination risks and erosion risks. The mitigation measures are outlined below.

9.4.1 Soil contamination from hydrocarbon and chemical spills

Mitigation measures proposed for soil contamination from hydrocarbons include:

- All fuel and other hydrocarbon and chemical products are to be secured in correctly designed storage areas
- Bunds should be located on impermeable surfaces with controlled drainage away from natural water courses
- All fuel kept on site should be contained in suitable, clearly labelled, containers
- Refuelling should be done in designated areas. Care must be taken to avoid spillage, when refuelling machinery
- Run-off from plant areas and discard dumps must be collected in a water management system
- Vehicles should be regularly maintained to avoid oil leaks
- It is advisable to use biodegradable hydraulic oils, where practicable and acceptable by equipment suppliers

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Soil contamination from spills	slight to moderate	negative, medium term, direct			negligible

9.4.2 Erosion of topsoil

To reduce the risk of soil erosion the following measures should be implemented:

- It is imperative that proper drainage systems are constructed along the road and infrastructure and water runoff is monitored for suspended solids
- Rehabilitation of any areas cleared during construction that are no longer in will assist in combating erosion

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Increased risk of soil erosion	slight	negative, permanent, direct			negligible

9.5 Water resources

The mitigation measures applicable to the potential impacts from groundwater abstraction and pollution are described below.

9.5.1 Abstraction

The primary mitigation method to assess the effects of groundwater abstraction is a robust monitoring network and the regular monitoring of abstraction volumes, groundwater levels, water quality in line with the Groundwater Level Monitoring & Sampling Protocol.

It is also recommended that the groundwater flow model is updated annually, or as significant information becomes available, as part of the annual Groundwater Monitoring Reports (requirement) to WAB.

Groundwater level monitoring boreholes are required in the mine area and regionally to assess both the drawdown around the mine area and regionally and to monitor seasonal changes of water depth and quality. These regional boreholes will provide data on the expansion of the cone of depression caused by abstraction at the mine overtime. It is the regional boreholes that provide an early warning that other user’s boreholes may be affected by seasonal change, extraction for T3 or both.

In addition to monitoring bores, the water management plan will include measures to be taken should registered off-site bores be demonstrated to be impacted by water extraction for T3. Measures may include deepening bores where water recovery is reduced or the drilling of additional bores to replace water losses. This will require an audit of all private user boreholes prior to abstraction and monitoring of relevant registered boreholes. The following action plan is proposed in case private, registered boreholes are demonstrated to be affected by water extraction for T3:

- Step 1- Immediately provide water (from water treatment process on site) to any affected homestead and cattle watering post (and continue to supply water until disrupted water to the area is replaced).
- Step 2 - Deepen affected bores / Assist with upgrading pumps/mechanical pumping devices should supply be permanently disrupted
- Step 3 - Drill additional bores (providing pumping and piping) if affected bores are not recoverable.

In terms of monitoring, the following recommendations are made:

- Water level monitoring:
  - Carried out monthly on all boreholes and reported monthly and annually
- Abstraction volume monitoring:
  - Individual (registered and active boreholes) borehole flow totalizer readings carried out weekly and reported weekly monthly and annually
- Water quality monitoring:
  - Carried out quarterly on production boreholes, environmental boreholes and selected observation boreholes
  - Analyses as specified in the water sampling protocol
  - Analysis result reported quarterly and annually
  - Indications of potential contamination should be immediately investigated and if required clean-up remedial measures undertaken using appropriate technology relevant to the nature of the contamination
- Pit Lake:
  - It is anticipated that a pit lake will form once mining ceases. The water from which could be utilised for other uses such as (irrigation, watering livestock). However, it will be deep and thus requires adequate protection (fencing, warning signs, lifebelt) to prevent unauthorised entry as it may be a danger to the public.
  - Water quality monitoring of the pit lake must be allowed for as part of the closure planning, using the BOS 93:2012 standards and parameters (effluent discharge) as the basis for the monitoring. It would also be advised to conform to the ISO Standard 13.030.20 for Liquid Wastes.
  - Work in consultation with WAB to develop strategies for how to manage the pit lake (detailed closure planning)

The impacts after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Declining yields	significant	negative, medium term, direct			moderate
Declining water levels	moderate	negative, medium term, direct			moderate
Decline in water quality	slight	negative, medium term, direct			negligible
Pit lake	slight	Positive, long term, direct			slight

9.5.2 Pollution

All potential pollution source locations will require environmental monitoring boreholes to be drilled around them to detect any leakage and thus groundwater contamination, even if the facility has design control measures to prevent any leakage. These boreholes should have their water levels recorded monthly and be chemically sampled quarterly. All monitoring to be reported monthly, quarterly and annually.

The locations of monitoring boreholes should be as presented in "Appendix 1 *Hydrogeological Aspects of Waste Disposal by Landfill*, of the Botswana Guidelines for the Disposal of Waste by Landfill (Government of Botswana 1997)" that is one up-gradient and three downgradient. The exact locations are to be determined by the hydrogeological model and the hydrogeologists (refer to Appendix C).

An effective system of management is a good technique for ensuring that all appropriate pollution prevention and control techniques are delivered reliably and on an integrated basis.

Effective operational and maintenance systems should be employed on all aspects of the process whose failure could impact on the environment, there should be:

- Documented procedures to control operations that may have an adverse impact on the environment
- A defined procedure for identifying, reviewing and prioritising items of plant for which a preventative maintenance regime is appropriate
- Documented procedures for monitoring emissions or impacts
- A preventative maintenance programme covering all plant, whose failure could lead to impact on the environment, including regular inspection of major 'non-productive' items such as tanks, pipework, retaining walls, bunds ducts and filters
- The maintenance system should include auditing of performance against requirements arising from the above (quarterly) and reporting the result of audits to top management for signing of acceptance and to instigate remedial measures through detailed contamination clean-up plans

Specific mitigation measures for each of the project components are outlined below:

- Process plant:
  - The primary risk is the leakage of chemicals and subsequent contamination of the groundwater. This can be managed and minimised by the plant being concrete lined

with bunds around it and water collection drains, which would feed to a collector and subsequent delivery by pipeline to the sediment pond.

- Waste rock dumps and stockpiles:
  - There is the possibility of water run-off from the WRD which could lead to an uncontrolled release of contaminated water to the surrounding area. There is a sand layer, which will prevent pooling (or ponding).
  - Monitoring boreholes should be drilled to monitor any impacts and align with the water management plan.
  - Acid rock drainage studies should be periodically carried out throughout the life of mine.
  - Any stockpiles of material containing high levels of lead should have an engineered liner to prevent heavy metal mobility.
  - Favourable geochemical characteristics significantly reduce the risk of ARD.
- Tailings storage facility:
  - The TSF will be lined with a geosynthetic high-density polyethylene (HDPE) membrane. The facility will incorporate an underdrainage system to reduce the pressure head acting on the basin liner, reduce seepage, increase tailings densities, and improve the geotechnical stability of the embankments
  - The facility will require monitoring boreholes around it to allow assessment of any leakage and the chemical nature of the leachate.
- Sewage:
  - A self-contained modular sewage treatment plant will be utilised with the resultant effluent being disposed of at the TSF and the solids/wastewater treatment sludge will be stored in a tank for periodic emptying and disposal off site. This facility should be placed in a concrete bunded area to capture any leakage from it
  - Regular bore monitoring (as part of the water management plan) is to include bacteriological and pathogenic analyses
  - The water quality of the treated water should be monitored monthly (BOD, COD, bacteriological and pathogenic analyses) to ensure the facility is working properly and that no contaminants are disposed of at the TSF. Results will be included in the annual groundwater monitoring report and will be shared with relevant stakeholders.
  - The treated effluent will be discharged to the TSF.
- Waste material storage:
  - The waste storage/handling facility should be constructed in such a way that leakage cannot occur and have drains for collection of rainfall water for transmission to the contaminated water dam. There should be an oil separator/inceptor placed in the drain
- Fuel storage
  - Fuels are to be well managed both during the construction phase and the life span of the mine

- The fuel storage and refuelling point would be in a bunded facility to minimise the risk of hydrocarbon contamination of the soil and groundwater (however refuelling remote generators or mining equipment will occur using mobile fuelling trucks). At the refuelling point there should be a spillage collection drain, waste oil collector and oil / water separators, which should be emptied on a regular basis, especially during the rainy season to prevent overflow, and the oil transported off site and disposed of at a proper waste oil disposal facility
- All pipework should be routed within bunded areas where possible (or double contained) with no penetration of contained surfaces
- Bunds must be designed to catch leaks from tanks or fittings, have a capacity greater than 110 percent of the largest tank or 25 percent of the total tankage and any contents pumped out or otherwise removed under manual control after checking for contamination
- The following works are required to enable detection of any hydrocarbon leaks:
    - Install monitoring wells around the main storage tanks to provide early warning of any losses and hydrocarbon movement away from the tanks
    - Sample the boreholes quarterly and analyse the samples for benzene, toluene, ethylbenzene and xylene (BTEX), speciated diesel and gasoline range organics
    - Records of all deliveries and usage of fuel on a monthly (recommended) basis are to be kept and reported
    - Regular inspections of the facility
    - An accident procedure relating to fuel spillage should be put in place and appropriate clean-up actions taken should an incident occur. The procedure should be reviewed and updated following any incident
- All drains and fuel stores etc. are to be fully decommissioned and rehabilitated at the end of the life span of the mine and any soils below or around the facilities contaminated by materials stored must be removed and disposed of at an appropriate licensed facility:

- Explosives store:
    - The primary risk from explosives is from nitrate and ammonia contamination of the groundwater, being via contamination from stored explosives and or directly because of blasting
- Workshops:
    - The maintenance workshops are a potential low volume point source risk due to the nature of the work undertaken (vehicle repair and servicing) and the hydrocarbon-based chemicals used – engine oil, hydraulic oil, cleaning solvents etc.
    - There should be an oil separator/inceptor placed in the drain
    - All waste oil should be collected, removed and disposed of to the proper waste oil disposal facility
    - Leakage from vehicles need to be considered. Inspections should take place on a regular basis with the information forwarded to senior management of potential problems. Where these are found, short term pollution prevention should be applied

– i.e. placing of oil absorbent socks in key drainage outlets until the problem (leak) has been rectified

- Where possible all cleaning, painting, repairs and maintenance should take place in an area which has self-contained drainage. Any oils or grease in the wash water should be removed by oil separator before discharge into the main dirty water drain system. Solid accumulations of oil/grease etc. should be collected and taken off site for disposal
- A hydrocarbon spill management plan should be developed with appropriate training. Not, withstanding all drainage off site should be channelled through oil separators/inceptors as a matter of routine

A summary of the potential pollutants associated with maintenance workshops is presented in Table 9.1

Table 9.1: Potential contamination problems and proposed mitigation

Potential problem	Source	Frequency of check	Mitigation action
Fuels, general petroleum products	Leaking fluids from vehicles as they await maintenance or being serviced. All fuel/chemical storage areas	Inspect all vehicles for leaks weekly	If spills/leaks observed absorbent oil socks to be placed on drainage/ storm system outlets Drip trays to be placed under any detected leaks to collect fluid Leaks should be repaired.
Hydraulic oil/fluids	As above	As above	As above
Brake fluids	As above	As above	As above
Coolants	As above	As above	As above
Oils/grease recovered from cleaning	Cleaning and Repair Areas	Checks to be carried out when cleaning/maintenance occurring	To take place in all workshops - to go through oil separator Remove any accumulated oily sludge and solvent and transport the material off-site
Wastewater recovered from cleaning	As above	As above	To go to dirty water drain system
Degreasing Solvents	As above	Checks to be carried out when this work is being carried out	Solvent cleaning to be performed in two self-contained bunded areas Remove any accumulated oily sludge and solvent and transport the material off-site

Potential problem	Source	Frequency of check	Mitigation action
Paint	As above	Routine Quarterly check of storage	Storage in bunded area - drip trays to be used when painting work being carried out
Lubrication	As above	As above	As above

The impacts after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Process Plant – groundwater contamination from the chemicals used from inadequate control of spillage and leakage from chemical storage	moderate	negative, medium term, direct			slight
Waste Rock Dump – mineral leaching and downward leakage into the groundwater and laterally from run-off	moderate	negative, medium term, direct			slight
Tailings storage Facility – leakage of minerals and hydrocarbon bi-products from the chemicals used	moderate	negative, medium term, direct			slight
Water storage – groundwater contamination due to leakage of recycled process water and from pollution control dams.	moderate	negative, medium term, direct			slight
Sewage – chemical, biological and pathogenic contamination	moderate	negative, medium/long term, direct			slight
Waste material	moderate	negative, short term, direct			slight
Fuel Storage – hydrocarbon contamination of soil and groundwater	significant	negative, long term, direct			slight
Explosives contamination of groundwater by nitrate and hydrocarbon	slight	negative, short term, direct			negligible
Workshop – oil, lubricant and solvent contamination of groundwater from spillage	slight	Negative, medium to long term, direct			slight
Geochemical impacts from pit lake	Slight	Negative, long term, direct			slight

9.6 Landscape and visual amenity

The mitigation measures related to the landscape and visual impacts are outlined below.

9.6.1 Alteration of land morphology: addition of large-scale dumps on landscape

The alteration of land morphology will be done during the construction and operation of the project by creating large waste rock dumps and tailings dumps on surface. The visual impact of these dumps will remain. Proposed mitigation includes:

- Design Phase: design dumps contours to ensure level elevations, not exceeding heights of 50m maximum
- Progressively revegetate starter embankments of waste rock and tailings storage facility.
- Sides to be covered with a blend of competent rock and topsoil and planted with local provenance species based on results of the biodiversity surveys
- Ensure effective runoff from rehabilitated areas to prevent water infiltration and impact on surrounding screening vegetation
- Ensure that lighting design for the tallest structure of the mine (dumps), residential accommodation, security, and offices make use of directional and baffled lighting to minimise urban sky glow and light trespass into the surrounding rural environment

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Alteration of land morphology	significant	negative, permanent, direct			significant

9.6.2 Unearthing of underground material previously not exposed

Construction and operation works include unearthing of underground material which had not been previously exposed. Recommended mitigation includes:

- The Client should re-vegetate where practicable as per closure and rehabilitation plan
- Topsoil must be preserved and used for rehabilitation

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Unearthing of underground material previously not exposed	slight	negative, long term, direct			slight

9.6.3 Clearance of existing vegetation

Clearance of vegetation will be carried out during construction and operation phases. Proposed mitigation measures include:

- Ensure that vegetation clearance is minimal and only as required. Any areas outside the mine footprint and access corridor that are no longer in use should be rehabilitated
- Implement mitigation measures as outlined in Section 9.1

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Clearance of existing vegetation	significant	negative, long term, direct			moderate

9.6.4 Addition of industrial mining elements into rural landscape

The addition of industrial mining elements into the rural (non-industrial) landscape causes substantial change in landscape character. During the development and operation of the mine this impact is a given, and possibilities for mitigation are limited. The following is proposed:

- Minimise vegetation clearance to provide screening
- Ensure that all elements are removed at decommissioning of the mine (except for infrastructure handed over as part of the sale of the property (power line, roads, etc.)), after closure

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Addition of industrial mining elements into rural landscape	significant	negative, long term, direct			moderate

9.7 Waste management

The mitigation measures related to waste management have been presented separately for non-hazardous and hazardous waste in the sections below. The mining waste (dumps) and mitigation measures have already been described in the Landscape and Visual section.

9.7.1 General (non-hazardous) waste

The mitigation measures discussed below are a summary for impacts from non-hazardous waste management at the project area and associated facilities, both during the construction and operation phases of the project.

9.7.1.1 Land pollution and litter

A variety of recyclable materials will be generated at the administration areas, and construction or management camp. Food waste from leftovers at the catering facilities, cigarette buds, improper disposal of litter from packaging goods and other materials such as paper, glass, plastic, cardboard and cans, ferrous and non-ferrous metal can cause an unhealthy environment and the area will be left unappealing. Tyres are likely to be generated in the workshops or mechanical garage, whilst the maintenance / engineering department will be responsible for replacement of conveyor belts. After the initial construction of the mining infrastructure, building rubble will be generated wherever construction or renovations are undertaken. All these will contribute to the disturbance of aesthetic view. Recommended mitigation measures, alternative uses, or sound disposal are as follows:

- Source separation
- Composting
- Recovery and recycling where possible
- Re-use cleared trees as fencepost or rehabilitation where possible

The impact has been summarised as follows after mitigation:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Land pollution and litter	moderate	negative, medium-term, direct			slight

9.7.1.2 Reduction in landfill capacity at Ghanzi

General non-hazardous waste will be disposed of at Ghanzi landfill which might burden the landfill as quantities of waste will increase. The listed mitigation measures below are recommended:

- Source separation
- Recycling

Agreement must be reached between the Client and the Ghanzi District Council prior to start of construction in relation to waste disposal. It is recommended that the rates for waste disposal will be based on cost-recovery basis for the Council. The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Reduce in landfill capacity	slight	negative, medium-term, direct			slight

9.7.1.3 Risk of poor human health

Throughout the construction and operation of the T3 Mine, workers are at risk of incurring health risks through exposure to hazardous (infectious or toxic) waste, exposure to pathogens and exposure to fumes and powder when packaging is damaged. The following mitigation measures are recommended:

- Supply of appropriate HCRW containers
- Provide HCRW management training
- Appropriate segregation and containerisation of HCRW
- Transport to legally compliant and environmentally sound incinerator for destruction

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Risk of poor human health	moderate	negative, short-term, direct			slight

9.7.1.4 Fine tailings

Fine tailings are the fine particles washed from the coarse residue after the milling process. There is no after use for this material that is to be contained in a tailings dam. Recommended mitigation measures are as follows:

- Tailings to be encapsulated in a correctly designed tailings management facility
- Remove topsoil from area and store for mining rehabilitation
- Sides and cover at closure to be covered with a blend of competent rock and topsoil and planted with local provenance species based on results of the biodiversity surveys

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Disturbance of fine tailings	moderate	negative, long-term, direct			slight

9.7.2 Hazardous waste

The mitigation measures discussed below are a summary for impacts from hazardous waste management at the project area and associated facilities, both during the construction and operation phases of the project.

9.7.2.1 Risk of soil and water contamination

Oil/grease containers, oil filters, contaminated rags and packaging are likely to be generated at the workshops and at the plant. Oil and fuel leaks, grease, oil filters, lead acid from batteries at the plant and during vehicle servicing have potential to contaminate water with hydrocarbons and acid (as outlined in Section 9.5). Sewerage sludge will also be generated at the sewerage treatment plants and may overflow if uncontrolled. Recommended mitigation measures are as follows:

- Recycling or disposal to legally compliant and environmentally sound landfills
- Consider using bacterial sewage / bio-reactor treatment plant to eliminate solids waste. Treated effluent will be disposed of in the TSF and from there will be pumped back to the plant as process water. Alternatively, if treated wastewater meets the required specification it may be used elsewhere, such as dust suppression to supplement mine water supply.
- Treatment plant to be designed and operated to ensure discharged water is in compliance with BOBS standards for effluent discharge (BOS 93-2012 2nd edition). It would also be advisable to conform to ISO standard 13.030.30 Sewage Water Disposal and Treatment.
- Consider hydrocarbon bioremediation trial
- Disposal to legally compliant oil disposal facilities by licensed companies

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Water and soil contamination risk from workshop waste	moderate	negative, short-term, direct			slight

9.7.2.2 Florescent tubes and e-waste

Non-hazardous waste, florescent tubes and energy saving globes will require disposal at a designated landfill during construction and operation phases. E-waste and fluorescent tubes may pose risk to human health. This waste is harmful to employees as they can be exposed to toxic emissions when damaged and there may be pollution by heavy metals. Recommended mitigation measures are as follows:

- Recycling if within viable transport distance from recycling plants
- Disposal at legally compliant and environmentally sound landfills

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Florescent tubes and e-waste	moderate	negative, long-term, direct			Slight

9.8 Health impacts

The mitigation measures related to the health impacts are outlined in the following sections.

9.8.1 Increased HIV and AIDS and STIs prevalence rates

Already high HIV/AIDS prevalence and STI incidence could be exacerbated by population influx. The mitigation measures proposed are as follows:

- Project to develop and implement an HIV/AIDS, STI and TB policy as part of an overall Health Management Plan. This should be guided by the Botswana policies and programs and take particular cognisance of local District Health Management Team (DHMT) programs. Project efforts in this regard would include; Information, Education, and Communication (IEC), condom distribution, STI treatment at Project health facilities, counselling and testing and other efforts in conjunction with the DHMT
- Develop and implement robust IEC programs
- Develop a partnership with District Health Medical Team
- Implement robust information, education and communication (IEC) programmes at employee and contractor induction and regularly at toolbox talks. Organize IEC campaigns for HIV/AIDS, and STI;
- Development and implementation of these IEC programmes should be in partnership with District Health Medical Team to ensure alignment with Ministry of Health programmes. Special attention to vulnerable groups in the community.
- Support the local health authorities in extending Voluntary Counselling and Testing (VCT) care and HIV treatment programs in the area;
- Support workplace accommodation camp and community-based condom distribution centres;
- Support community-based peer educator programs in both the workplace and community. Use locally acceptable tools;
- Support equal employment opportunities for women and livelihood programs, to reduce the risk of opportunistic sexual encounters.
- Support NGO groups active in area on HIV/AIDS and STI;
- Ensure that contractors have similar access to occupational health, basic primary health care and HIV/AIDS programmes as do employees.

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Increased HIV and AIDS and STIs prevalence rates	significant	negative, permanent, indirect			moderate

9.8.2 Increased tuberculosis occurrence

High TB incidence could be exacerbated by population influx. The following mitigation measures are proposed

- Develop and implement an HIV/AIDS, STI & TB Policy as part of an overall Health Management Plan
- TB should always be considered together with HIV/AIDs
- Develop and implement robust IEC programs
- Implement Occupational Medical Surveillance (compliant with relevant legislation)
- Develop a partnership with District Health Medical Team
- Implement robust information, education and communication (IEC) programmes at employee and contractor induction and regularly at toolbox talks. Organize IEC campaigns for TB;
- Development and implementation of these IEC programmes should be in partnership with District Health Medical Team to ensure alignment with Ministry of Health programmes. Special attention to vulnerable groups in the community.
- Support community-based peer educator programs in both the workplace and community. Use locally acceptable tools;
- Establish an active TB case finding program at Project health facilities, including chest x-ray on initial examination, annual chest x-ray and implement mandatory TB questionnaire at each health visit. Do this for all employees and contractors;
- Support NGO groups active in area on TB;
- Ensure that contractors have similar access to occupational health, basic primary health care and TB programmes as do employees and
- Ensure that employee and contractor housing is adequately ventilated and that rooms are not crowded.

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
TB occurrence	significant	negative, permanent, indirect			moderate

9.8.3 Increased road traffic accidents

There will be high risk of accidents during transport to and from site and accommodation camp thus the following mitigation measures should be adhered to:

- Road traffic accident risk assessment and management plan required
- Provide transport to and from site to reduce traffic and risk of driver fatigue

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Road traffic accidents	significant	negative, short-term, direct			moderate

9.8.4 Fatigue

Daily transport from accommodation to camp will increase risk of staff fatigue. Proposed mitigation will consist of the development of a Fatigue risk assessment and management plan, which will then inform controls such as work shift cycles. Transport to and from site should be provided to help reduce fatigue. Shift rosters should be developed taking into consideration camp location, national standards, etc.

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Fatigue	significant	negative, short-term, direct			moderate

9.8.5 Lack of Medical Emergency Response

Relatively low level of medical emergency response is available in the area. Proposed mitigation measures include:

- The risk presented by road traffic and mine accident requires a specific medical emergency response plan (MERP) to be developed and implemented, and should consider provision of ambulances with advance life support capability. The MERP would be developed in conjunction with Ghanzi Primary Hospital management and emergency response providers, such as MRI Botswana
- Procurement of an emergency services vehicle for the project

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Lack of Medical emergency response	significant	negative, short-term, direct			moderate

9.8.6 Lack of capacity of the emergency room at Ghanzi Primary Hospital

There is currently no facility for multiple causalities at Ghanzi Primary hospital. The following mitigation measures have been recommended:

- Engage with Ghanzi Primary Hospital management and Government service providers to facilitate expansion of the current facility to attend multiple casualties

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Emergency room at Ghanzi Primary Hospital	significant	negative, short-term, direct			moderate

9.8.7 Malaria risk

Malaria risk persists to the north of the project (Maun/Okavango). Recommended mitigation measures include:

- Development of a Health Management Plan which will include Malaria as a risk. The plan will be developed to include actions such as:
  - IEC on malaria risk at induction and tool box talks to be implemented, with a special emphasis on employees and contractors who travel through Maun/Okavango
  - Project health facility staff should be aware of the possibility of malaria and be able to test and initiate treatment

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Malaria	moderate	negative, short-term, indirect			slight

9.8.8 Occupational Health Risks

A comprehensive OHRA is required to determine work-related health risks. Such OHRA will provide information on which controls may be based. OHRA risks on a project such as this might be expected to include; dust exposure (including silica), noise exposure, thermal (hot and cold) exposure, vibration, ergonomic and certain chemical risks depending on concentrator metallurgical processes.

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Occupational Health Risks	significant	negative, medium-term, indirect			slight

9.8.9 Increased Occupational Medical Surveillance

There is a requirement for risk based occupational medical surveillance. The recommended mitigation measure is to implement an occupational medical surveillance program and it is recommended that this be undertaken at the Ghanzi accommodation camp medical facility. All employees and contractors, even short term, should have occupational medical surveillance (ensure this follows relevant legislation).

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Nature	Duration	Direct/ Indirect	
Occupational medical surveillance	significant	negative, medium-term, indirect			slight

9.8.10 Provision of primary health care

There is a need/requirement for provision of first aid on site. Development of a Health Management Plan will address occupational medical surveillance and primary healthcare. Liaison with District medical authorities and services will guide actions in the Plan.

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of Impact	Significance (pre-mitigation)	Scale of Change			Significance after Mitigation
		Direction	Duration	Direct/ Indirect	
Primary health care	significant	neutral, medium-term, direct			slight

9.9 Social impacts

The following section outlined the Mitigation and enhancement measures for construction and operation phases in relation to the social impacts identified for the project. Because the significance for the social impact is different between the two phases, and mitigation measures are the same, the impact after mitigation is shown separately for each of the social impact for the construction and operational phase.

9.9.1 Creation of employment

Employment opportunities will arise during the construction period of the project. To enhance the positive impact, the following is recommended:

- Roles will be advertised locally to ensure local residents will have an opportunity to apply
- A monitoring system is to be established to measure subcontractor's local employment efforts
- If required, the local resident status of applicants should be verified in consultation with community representatives
- No hiring at the site. Regional or national recruitment centres are to be established to reduce influx of people moving to Ghanzi to seek employment
- The local Tshukudu office is to ensure appropriate and constant communication with the community regarding employment opportunities

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Project stage	Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after enhancement
			Nature	Duration	Direct/Indirect	
Construction	Creation of employment	moderate	positive	short term	direct and indirect	significant
Operation	Creation of employment	significant	positive	long term	direct and indirect	significant

9.9.1.1 Regional economic development

The regional economic development will boost the economy during construction and operation phases. The recommended enhancement measures are:

- When appointing subcontractors, correct advertising protocols need to be followed to give opportunities to local contractors to bid on available works where suitable skills/trades are available
- The Client should utilise the existing local business database to identify local SMMEs and businesses
- The Client should establish linkages and liaison with other key stakeholders in the area involved in skills and SME development, to enhance the need to create suitable service providers within the local area

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Project stage	Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after enhancement
			Nature	Duration	Direct/Indirect	
Construction	Regional economic development	slight to moderate	positive	short term	direct	moderate

Project stage	Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after enhancement
			Nature	Duration	Direct/Indirect	
Operation	Regional economic development	significant	positive	long term	direct	significant

9.9.1.2 Skills transfer and development

During construction and operation there will skills transfer and development. The recommended enhancement measures are as follows:

- Liaison with Vocational Training Centres (VTCs) and schools to promote skills development
- Promote in-house (work) related training for engaged locals
- LED and CSR programmes should (where still possible) be designed in consultation with community representatives to ensure that the actual needs of communities are met

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Project stage	Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after enhancement
			Nature	Duration	Direct/Indirect	
Construction	Skills transfer and development	moderate	positive	short term	direct	moderate
Operation	Skills transfer and development	significant	positive	long term	direct	significant

9.9.1.3 Loss of agricultural land for the directly affected freehold farmers

Farmers around the site (Farms 153-NL, 110-NL and 111-NL) will experience loss of agricultural land directly. The proposed mitigation measure includes purchase of the land from affected farmers prior to project development for the affected land. Voluntary agreement in relation to this is already in place.

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Farm affected	Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
			Nature	Duration	Direct/Indirect	
Farm 153-NL	Compensation of affected farmers	slight	negative	long term	direct	slight
Farms 110-NL and 111-NL	Compensation of affected farmers	slight	negative	long term	direct	slight

9.9.1.4 Community relations and social disruption

For the project works to minimise social disruption amongst communities the proposed mitigation measures include:

- Where possible ensure that access farms are uninterrupted by providing alternative access routes and/or temporary access points during construction activities
- Detailed road pavement inspection and regular maintenance (in consultation with Ghanzi District Council roads division, and Botswana Roads Department (BRD) is necessary to ensure the road is fit to carry additional heavy vehicles generated by the life of the mine. A Road Maintenance Plan should be developed
- Consider a request to the government or local council to reduce speed either side of the mine turn off as large trucks and buses will be turning/pulling out on a regular basis
- Upgrade of the intersection to allow through traffic to bypass turning mine vehicles should be considered
- Mine trucks should be serviced/maintained regularly to reduce possibility of excessive noise from truck engines

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Project stage	Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
			Nature	Duration	Direct/Indirect	
Construction	Social disruption	moderate to significant	negative	short term	direct	slight
Operation	Social disruption	significant	negative	long term	direct	slight

9.9.1.5 Conflict or competition between jobs/opportunity seekers and locals

Competition for employment between jobs/opportunity due to marginalisation of minority group is highly probable between seekers (outsiders) and locals for all project phases. Proposed mitigation includes:

- Clearly communicate the intention to be employing people with the right skills to make the project a success, to discourage an influx of job-seekers from other areas
- Involve local community structures (e.g. Ward Councillors and/or Ward Committees) in identifying the local labour pool
- Liaison structures are to be established with local police to monitor social changes in crime patterns. Liaison should also be established with existing crime control organisations, such as local Community Policing Forums and other crime prevention organisations

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Project stage	Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
			Nature	Duration	Direct/Indirect	

Project stage	Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
			Nature	Duration	Direct/Indirect	
Construction	Competition for jobs	moderate	negative	permanent	direct	slight
Operation	Competition for jobs	moderate	negative	permanent	direct	moderate

9.9.1.6 Increased pressure on local services and infrastructure

Increased pressure on services and infrastructure is relevant to the construction and operation of the Project. It is recommended that Tshukudu Metals should liaise with the District planning officials to ensure that expected population influx is considered in infrastructure development planning.

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Project stage	Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
			Nature	Duration	Direct/Indirect	
Construction	Pressure on infrastructure	moderate	negative	permanent	direct	slight
Operation	Pressure on infrastructure	moderate	negative	permanent	direct	moderate

9.9.1.7 Establishment and growth of informal settlements

The sprouting and growth of informal settlement is anticipated for construction and operation phases of the Project. Proposed mitigation measures include:

- Development of a Migration Plan which will incorporate settlement controls such as:
  - Land Board must discourage low rates of land transaction, particularly affecting the Basarwa
  - Discourage squatting near the project development areas, in collaboration with the District leadership
  - Continual liaison with the District authorities to avoid overcrowding of accommodation in local villages (Kuke and D'Kar) and Ghanzi, especially in the case of contractors, sub-contractors and those seeking work
  - Sufficient acceptable camp accommodation for all project staff – employees, contractors and sub-contractors

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Project stage	Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
			Nature	Duration	Direct/Indirect	
Construction	Informal settlements	moderate	negative	short term	direct	slight

Project stage	Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
			Nature	Duration	Direct/Indirect	
Operation	Informal settlements	moderate	negative	long term	direct	slight

9.9.1.8 Opposition to the mine development due to perceived negative impacts

Locals may oppose the proposed project because of perceived negative impacts. The following mitigation measures are proposed:

- Tshukudu Metals must attempt to honour the commitments made to the community
- Tshukudu Metals should be transparent regarding employment practices and LED initiatives, and these should be communicated to the local communities
- The findings of the various specialist studies conducted as part of the ESIA should be summarised and presented to the surrounding land owners and communities in a simple and clear manner, to illustrate that Tshukudu Metals has taken their concerns into account, to explain how these concerns will be addressed or mitigated, as well as to illustrate the significance of the resultant impacts after mitigation
- Regular community briefings

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Project stage	Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
			Nature	Duration	Direct/Indirect	
Construction	Opposition due to negative perception	slight	negative	short term	direct	slight
Operation	Opposition due to negative perception	slight/ moderate	negative	long term	direct	slight

9.9.2 Social mitigation during decommissioning phase

There are several social mitigation measures specifically for the closure and decommissioning phase of the project, as outlined below.

9.9.2.1 Loss of employment

During decommissioning stage employees will lose their jobs. Mitigation measures include:

- Localise employment opportunities from decommissioning and rehabilitation activities
- Consider setting up of pension scheme for workers (in accordance with local legislation)
- Consider supporting re-skilling in collaboration with local Government services as part of closure program

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
		Nature	Duration	Direct/Indirect	
Loss of employment	significant	negative	permanent	direct	moderate

9.9.2.2 Loss of business opportunities

Loss of business opportunities is anticipated for the decommissioning phase. A social economic assessment to inform the potential opportunities for enhancement of sustainable communities after closure should be considered, including opportunities such as engagement of local nurseries for provision of plants species (preferably indigenous species) to be used for rehabilitation.

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
		Nature	Duration	Direct/Indirect	
Loss of business opportunities	significant	negative	permanent	direct	moderate

9.9.2.3 Dependency on mine for sustaining local economy

The dependency on mine to sustain the local economy is mainly applicable on decommissioning phase. Proposed mitigation measures are as follows:

- Consider set up of programmes to support turnaround or redeployment strategies
- Liaise with Government to initiate economic diversification through development of alternative markets

Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
		Nature	Duration	Direct/Indirect	
Dependency on mine to sustain economy	significant	negative	long term	direct	moderate

9.9.2.4 Labour migration

Labour migration (away from the area) is anticipated to occur during closure of the copper mine. Proposed mitigation measures include:

- Provision of adequate retrenchment packages, that as a minimum meet relevant Botswana Labour legislation

- Training opportunities likely to be provided by Tshukudu Metals consider other economic activities at the study area

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
		Nature	Duration	Direct/Indirect	
Labour migration	moderate	negative	long term	direct	slight

9.9.2.5 Loss of community cohesion and structures

There will be loss of community cohesion and structures once the mine ceases operation. Proposed mitigation measures include:

- Provision of adequate retrenchment packages, that as a minimum meet relevant Botswana Labour legislation

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
		Nature	Duration	Direct/Indirect	
Loss of community cohesion	moderate	negative	long term	direct	slight

9.9.2.6 Loss of revenue for the Government and effects on social services

Government will experience loss of revenue when the project cease operation. The mitigation measures include minimisation of the social, environmental and economic liabilities to be addressed during closure planning. The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
		Nature	Duration	Direct/Indirect	
Loss of revenue	moderate to significant	negative	permanent	direct	moderate

9.9.2.7 Safety risks associated with improper mine site rehabilitation

Improper mine site rehabilitation can pose a risk to employees and locals. The mitigation involves effective closure planning and implementation to ensure site is made safe, stable and non-polluting. The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
		Nature	Duration	Direct/Indirect	

Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
		Nature	Duration	Direct/Indirect	
Safety risks during rehabilitation	significant	negative	long term	direct	moderate

9.10 Archaeological and cultural heritage impacts

According to the archaeological specialist report, from the heritage perspective, there is no need to consider any mitigation measures once the development is fully operational, unless further development is required.

The risk of discovering an archaeological artifact or site during the construction or mining is low although cannot be entirely ruled out. Refer to (Archaeological report, Appendix L, Chapter 7) for protocols proposed in case of chance finds.

9.10.1 Risk of damage or loss of archaeological artefacts

Also listed below are the mitigation measures in case of chance finds:

- A supervisor is made accountable for heritage matters
- In the case of a possible find or feature being exposed, the supervisor should be contacted so the correct authority can be notified
- Should more possible archaeological or cultural objects (e.g. stone tools, bone) be found, excavation should stop, and a qualified archaeologist called in to advise
- Development of an Archaeological Induction Procedure for the project
- Development of a procedure dealing with human remains and graves for the project

The impact after mitigation (compared to pre-mitigation) is summarised as follows:

Project stage	Description of impact	Significance (pre-mitigation)	Scale of Change			Significance after mitigation
			Nature	Duration	Direct/Indirect	
Construction	Archaeological	slight	negative	permanent	direct	negligible
Operation	Cultural heritage	slight	negative	permanent	direct	negligible

9.11 Risk assessment

Following the establishment baselines and the potential impacts of the proposed T3 Copper Mine Project on the environmental and social conditions, a risk ranking was applied pre and post mitigation. The aim of the impact assessment is to provide tangible identification of the risks involved in with various activities associated with the construction, operation and closure of the T3 mine and the corresponding access corridor.

A “traffic light” risk matrix was employed to assess the predicted impacts in a semi-quantitative manner. This system derives an environmental impact level based on the extent, duration, potential intensity and probability of the impact occurrence to determine the significance of the impact in question (see Table 9.2, 9.3 and 9.4). The impact evaluation, relevant mitigation measures and effectiveness of the mitigations measure are predicted using these scales, based on the results from the specialist presented in Chapter 7 and 9.

Table 9.2: Risk assessment parameters - Extent

Extent description	Definitions	Rating
Site	The impact footprint remains within the cadastral boundary of the site.	1
Local	The impact footprint extends beyond the cadastral boundary of the site, to include the immediately adjacent and surrounding areas.	2
Regional	The impact footprint includes the greater surrounding area within which the site is located.	3
National	The scale / extent of the impact is applicable to Botswana.	4
Global	The extent / scale of the impact is global.	5

Table 9.2: Risk assessment parameters – Duration

Duration Descriptors	Definitions	Rating
Temporary	The impact is only for one year or less, and applicable to the construction period. This implies the impact is fully reversible.	1
Short Term	The impact continues to manifest for a period of between 1 – 9 years. The impact is reversible.	2
Medium Term	The impact continues to manifest for a period of 10 – 19 years. The impact is reversible with relevant and applicable mitigation and management actions.	3
Long Term	The impact continues to manifest for a period of 20 – 60 years	4
Permanent	The impact will continue indefinitely and is irreversible.	5

Table 9.3: Risk assessment parameters – potential intensity

Rating	Descriptors: Potential Negative Consequence	Score
Profound	Impact affects 100% of receptors, with no mitigation measures applicable. An environmental parameter may be completely obscured, made void or invalid, or destroyed completely, due to profound adverse effects.	16
Significant	Potential change in the daily experiences of all receptors due to the impact caused by the development. The impact would require a significant change in management practices with associated costs.	8
Moderate	Development causes a degree of impact that will cause a noticeable change in the environment by a majority of receptors affected.	4

Slight	Environmental parameter minorly affected (nuisance) by the positive or adverse impact, to a point whereby the impact may or may not be noticed by the receptors affected.	2
Insignificant/ negligible	Environmental parameter will remain largely unaffected by positive or adverse impact. Impact unnoticeable in general	1

Table 9.4: Risk assessment parameters – probability

Likelihood / Probability Descriptors	Definitions	Rating
Improbable	The possibility of the impact occurring is negligible and only under exceptional circumstances	0.1
Unlikely	The possibility of the impact occurring is low with less than 10% chance of occurring. The impact has not occurred before	0.2
Probable	The impact has a 10 – 40% chance of occurring. Only likely to happen once every three or more years	0.5
Highly Probable	It is most likely that the impact will occur. A 41 – 75% chance of occurring	0.75
Definite	More than 75% chance of occurring. The impact occurs regularly	1

The significance of the impacts is then calculated using the following equation:

(Extent + Duration + Potential Intensity) x Probability = Significance

The significance level of the risks, as weighted by the above equation, identifies the risk rating that each impact triggers and the associated authorisation implications as outlined in Table 9.5.

Table 9.5: Impact assessment parameters – significance

Descriptors	Definitions	Rating
None	The project can be authorised.	<3
Low	The project can be authorised with a low risk of environmental degradation.	3 – 4
Medium	The project can be authorised but with conditions and routine inspections.	5 – 8
High	The project can be authorised but with strict conditions and high levels of compliance and enforcement in respect of the impact in question.	9 – 15
Fatally flawed	The project cannot be authorised.	>15

Table 9.6: Assessment and rating of risks associated with the construction and operation of the proposed development

Description	Without Mitigation						With Mitigation					
	Extent	Duration	Potential Intensity	Probability	Significance	Risk Level	Extent	Duration	Potential Intensity	Probability	Significance	Risk Level
Loss of vegetation and disturbance of floral communities because of bush clearing (approx.. 400 - 600 ha)	1	5	8	1	14	High	1	5	2	1	7	Medium
Increased risk of establishment of invasive or encroacher species	2	4	4	0.75	7.5	Medium	2	4	1	0.5	3.5	Low
Increased erosion risk	1	4	4	0.75	6.75	Medium	1	4	1	0.5	3	Low
Risk of unintentional bushfires	2	3	2	0.5	3.5	Low	2	3	1	0.2	1.2	None
Risk of pollution damaging local flora	1	3	4	0.5	4	Low	1	3	2	0.2	1.2	None
Disturbance, alteration and destruction of faunal habitat	1	3	2	1	6	Medium	1	3	1	1	5	Medium
Excavations posing a threat to fauna	2	2	2	0.75	4.5	Low to Medium	2	2	1	0.50	2.5	Low
Displacement of territorial species because of mine fencing	2	4	2	0.75	6	Medium	2	4	1	0.75	5.25	Medium
Increase in ambient noise levels disturbing fauna	2	3	4	0.75	6.75	Medium	2	3	1	0.5	3	Low
Lighting causing disorientation of fauna	2	4	4	0.75	7.5	Medium	2	4	1	0.5	3.5	Low
Blasting negatively impacting fauna	2	5	4	0.75	8.25	Medium to High	2	5	1	0.5	4	Low
Elephants migrating south causing disturbance on farms	3	4	2	0.5	4.5	Low to Medium	3	4	2	0.5	4.5	Low to Medium
Conflict between workers and fauna	2	3	2	0.75	5.25	Medium	2	3	1	0.75	4.5	Medium
Risk of vehicle collision with wildlife and livestock	2	3	4	0.75	6.75	Medium	2	3	2	0.75	4.5	Medium
Risk of increased poaching	2	4	4	0.75	7.5	Medium	2	4	1	0.5	3.5	Low
Loss of foraging area for avifauna	2	4	4	1	9	High	2	4	2	1	8	Medium
Human persecution of avifauna	2	4	2	0.75	6	Medium	2	4	1	0.5	3.5	Low
Risk of electrocution of avifauna	2	4	4	0.75	6	Medium	2	4	2	0.5	3.5	Low
Risk of collision of avifauna with powerlines	2	4	4	0.75	6	Medium	2	4	2	0.5	4	Low

Declining air quality affecting avifauna	2	4	2	0.5	4	Low	2	4	1	0.2	1.4	None
Increased noise levels affecting avifauna behaviour	2	4	2	0.75	6	Medium	2	4	2	0.5	4	Low
Blasting related disturbance to avifauna	2	4	4	0.75	7.5	Medium	2	4	2	0.5	4	Low
Risk of vehicle collisions with avifauna	2	4	4	0.75	7.5	Medium	2	4	2	0.75	6	Medium
Construction phase impacts of air quality on sensitive receptors	2	1	4	0.75	5.25	Medium	2	1	4	0.5	3.5	Low
Operational phase impacts of air quality on sensitive receptors	2	3	4	0.75	6.75	Medium	2	3	4	0.5	4.5	Low to medium
Construction phase impacts of noise on sensitive receptors	2	1	2	1	5	Medium	2	1	2	0.75	3.75	Low
Operational phase impacts of noise on sensitive receptors	2	3	2	0.75	5.25	Medium	2	3	1	0.5	3	Low
Soil contamination from spills	1	4	4	0.75	6.75	Medium	1	4	1	0.5	3	Low
Increased soil erosion	1	5	2	0.75	6	Medium	1	5	1	0.5	3.5	Low
Declining yields in existing boreholes	2	3	4	1	9	High	2	3	4	1	9	High
Declining water levels	2	3	4	1	9	High	2	3	4	1	9	High
Decline in water quality	2	4	2	0.75	6	Medium	2	4	1	0.5	3.5	Low
Groundwater contamination from chemicals used	2	3	4	0.75	6.75	Medium	2	3	2	0.5	3.5	Low
Mineral leaching from rock dumps and downward leakage into groundwater	2	3	4	0.75	6.75	Medium	2	3	2	0.75	6.75	Medium
Leakage and contamination of groundwater from TSF	2	3	4	0.75	6.75	Medium	2	3	2	0.5	3.5	Low
Leakage and contamination of groundwater from pollution control dams	2	3	4	0.75	6.75	Medium	2	3	2	0.5	3.5	Low
Sewerage – chemical, biological and pathogenic contamination	2	4	4	0.75	7.50	Medium	2	4	2	0.5	4	Low
Contamination from inappropriate storage of waste	2	2	4	0.75	6	Medium	2	2	2	0.5	3	Low
Groundwater contamination from hydrocarbon spillage	2	4	8	0.75	10.5	High	2	4	2	0.5	4	Low
Groundwater contamination from nitrates in explosives	2	2	2	0.75	4.5	Low to Medium	2	2	1	0.75	3.75	Low
Hydrocarbon spillage and contamination from workshops	2	4	2	0.75	6	Medium	2	4	2	0.5	4	Low
Alteration of land morphology	2	5	8	1	15	High	2	5	8	1	15	High
Unearthing of underground material previously not exposed	2	4	2	1	8	Medium	2	4	2	1	8	Medium
Vegetation clearance changing landscape character	2	4	8	1	14	High	2	4	4	1	10	High

Addition of industrial mining elements into rural landscape	2	4	8	1	14	High	2	4	4	1	10	High
Land pollution and litter	2	3	4	0.75	5.25	Medium	2	3	2	0.5	3.5	Low
Reduced landfill capacity in Ghanzi	3	3	2	1	6	Medium	3	3	2	0.75	6	Medium
Risk of waste causing health impacts	2	2	4	0.75	6	Medium	2	2	2	0.5	3	Low
Increased HIV and AIDS and STIs prevalence rates	3	5	8	0.75	12	High	3	5	8	0.5	12	Medium
Increased TB occurrence	3	5	8	0.75	12	High	3	5	8	0.5	8	Medium
Increased road traffic accidents	3	2	8	0.75	9.75	High	3	2	4	0.5	4.5	Medium
Fatigue	3	2	4	0.75	6.75	Medium	3	2	2	0.5	3.5	Low
Capacity challenges for medical emergency response	3	2	8	0.75	9.75	High	3	2	4	0.75	6.75	Medium
Capacity challenges at Ghanzi hospital	3	2	8	0.75	9.75	High	3	2	4	0.75	6.75	Medium
Malaria	3	2	4	0.75	6.75	Medium	3	2	2	0.5	3.5	Low
Occupational health and safety risks	2	4	8	0.75	10.5	High	2	4	2	0.75	6	Medium
Loss of agricultural land	1	3	1	1	5	Medium	1	3	2	1	5	Medium
Social disruption	3	4	8	0.75	11.25	High	3	4	2	0.75	6.75	Medium
Conflicts between job seekers and locals	3	4	4	1	11	High	3	4	4	0.5	5.5	Medium
Increased pressure on local services and infrastructure	3	5	4	1	12	High	3	5	4	0.75	9	High
Establishment and growth of informal settlements	3	4	4	0.75	8.25	Medium to High	3	4	2	0.75	6.75	Medium
Negative public opinion and perception about the mine	3	4	2	0.75	6.75	Medium	3	4	2	0.5	4.5	Low to Medium
Damage of loss of archaeological sites	1	5	2	0.75	6	Medium	1	5	1	0.5	3.5	Low

10 Environmental and Social Management Plan

This Chapter serves as the Environmental and Social Management Plan (ESMP) for the proposed T3 Copper mine project, in Ghanzi District of Botswana. This Chapter and the monitoring plan may be used as a separate standalone document to summarise the overall commitments and requirements within the Environmental and Social Impact Assessment (ESIA) for the project.

An Environmental and Social Management Plan is a document aimed at providing a framework for mitigating environmental impacts associated with the project and its activities.

This ESMP provides information pertaining to the:

- Implementation of the proposed Project
- Regulation of the implementation of the proposed Project
- Methods and means through which mitigation measures will be implemented
- Ways in which environmental restoration will be achieved

The ESMP must be included in any contract documentation for contractors undertaking work on the proposed project, to ensure they are aware of the legally binding environmental requirements. Regular (e.g. annual) Independent Environmental Auditor services are recommended to be commissioned by Tshukudu Metals management to monitor the progress of the ESMP and ensure that specific items are adequately put into place and managed.

The subsequent sections describe and explain the categories of information used within the ESMP table (in Table 10.1).

10.1 Project stage

The project stage describes the stage of the overall project in which the impacts are expected. A project typically follows four clear stages throughout its lifetime:

- Pre-construction phase
- Construction phase
- Operational phase
- Closure and decommissioning phase

Every stage of the project has a unique set of impacts, as predicted by the ESIA that was undertaken for the project. Related mitigation measures have been formulated for the proposed project, as detailed in the ESMP.

10.2 Subject

The subject describes the field or category in which the impacts are expected. The subjects are generally organised as per the specialist studies undertaken for this project, although a number of more general subjects are also included to ensure all areas are covered, and a full comprehensive ESMP is presented.

10.3 Management objective

The management objective describes the goal to be achieved. Some goals are crucial for the success of the project and have very clear thresholds. Non-compliance with the objective will result in technical difficulties for the operations or non-compliance with the laws and guidelines of Botswana.

Other objectives have thresholds that are less clearly defined. In practice these objectives are sometimes perceived as less important. It is crucial to the success of the implementation of the ESMP that all parties involved in the project fully understand that these objectives are equally as important as objectives with clear thresholds, for successful implementation of the project.

10.4 Mitigation measures recommended

The mitigation measures recommended aim to minimise the expected negative impacts, and maximise the expected positive impacts. For a single management objective there is usually a set of recommended mitigation measures. The maximum result from the mitigation measures will be achieved when the full set or combination are implemented.

It is therefore important that mitigation measures will be implemented in totality (unless otherwise proven to not to be beneficial and alternatives are developed) and with similar levels of propriety, to ensure minimum effect of the negative impacts and maximum effect of the positive impacts.

10.5 Implementation agency

The implementing agency is responsible for full implementation of the mitigation measures. As some of the positions and contracts for the project have not been finalised and awarded yet, the general role description of the implementing person or organisation has been used for this ESMP.

It is crucial for the success of the ESMP that regular monitoring is implemented to ensure that mitigation measures are being adhered to. The monitoring is also important to evaluate measures and processes, and implementation of improvements as the project develops. Along with the recommended monitoring/governmental agencies that are recommended within the ESMP table that follows, an Independent Environmental Auditor can also be utilised or commissioned by Tshukudu Metals to monitor the progress and implementation of the specific actions recommended. This is not, however, included in all items of the ESMP table.

The following Section will present a full-scale monitoring plan for the implementation of the proposed Project and will further establish roles and responsibilities. In the following table the agency ultimately responsible for monitoring compliance has been stated. For some management objectives it is possible that more than one monitoring agency is applicable, and in these cases careful and regular communication between the agencies is recommended.

10.6 Estimated costs

Based on the estimated costs in the Table presented in the following pages, the Client has made the following (total) allowances for implementation of the environmental and social plan:

- Pre-construction (post ESIA): P 2 million
- Construction phase: P 3 million
- Operational phase: P1 million annually
- Closure and decommissioning phase: 7% of total closure cost

The above total costs have been included in the Clients feasibility study budgets for the project, and as such will form part of the overall finance package for the project.

10.7 Environmental and social mitigation plan

Table 10.1: Environmental and social mitigation plan

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
Pre-construction	BIODIVERSITY - Flora	Loss of vegetation and disturbance of plant communities	Project design and areas earmarked for clearance	*To avoid unnecessary loss of vegetation, conserve and manage vegetation, revegetate*	▪ Development of a vegetation clearance plan/ Planning of vegetation clearance	Qualified biodiversity specialist	Approximately P4,000 per day (part of project design cost)	ESIA Team, Mine Engineers
	GROUND AND SURFACE WATER	Draw down and access by other users to water resources during operations	Project design and groundwater exploration	*To conserve water resources and avoid impacts by mining on farming*	▪ Detailed groundwater studies, drilling and test pumping to understand local hydrogeology and develop sustainable water supply ▪ Maximise water returns in project design where practicable	Test pump rigs and hydrogeologist supervision	Approximately P500,000.00 (Part of detailed feasibility studies/ESIA costs)	ESIA Team, Mine Engineers
		Contamination via leakage of hazardous chemicals & minerals	Construction of mining infrastructure & operation of the mine	*To conserve and maintain water quality*	▪ All potential facilities designed with contaminant prevention measures as outlined in Section 9.5.2 ▪ Groundwater exploration boreholes must be capped to DWS standards	Civil engineer, drilling supervision	Part of detailed feasibility studies/ESIA cost	ESIA Team, Mine Engineers
	LANDSCAPE AND VISUAL AMENITY	Change of landscape character	Planning of mine, layout, site lighting and waste dumps	*To minimise landscape/visual impacts due to site lighting, mining infrastructure and waste dumps*	▪ Maximum waste dump height of 50m as per Landscape and visual study ▪ Progressive rehabilitation where practicable ▪ Ensure that lighting design for mine site and contractor's camp, security, and offices make use of directional and baffled lighting (where practicable to do so)	Mine closure plan for rehabilitation plans Detailed mine design/ electrical engineer for lighting	Part of detailed feasibility studies/ESIA cost	ESIA Team, Mine Engineers
		Change of landscape character	Planning of mine, layout, site lighting and waste dumps	*To minimise landscape/ visual impacts due to site lighting, mining infrastructure and waste dumps*	▪ Design dumps' contours to ensure level elevation ▪ Progressive rehabilitation where practicable	Mine closure plan Detailed mine design/ electrical engineer for lighting	Part of detailed feasibility studies/ESIA costs	ESIA Team, Mine Engineers

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
	TRAFFIC	Increased traffic volumes	Planning of access to the mine site and staff/material transportation	*To avoid impacts on other road users*	■ Develop a Traffic and Vehicle Management Plan for the construction period	Traffic engineer	Approximately P100,000 (Part of detailed feasibility studies/ESIA costs)	ESIA Team, Mine Engineers
	WASTE MANAGEMENT	Increased waste quantities	Planning of waste management and disposal	*To minimise waste streams and impacts from the Project*	■ Allow for waste separation, holding and collection areas on site.	Waste stream plan	Part of detailed feasibility studies/ESIA costs	ESIA Team, Mine Engineers
Pre-construction (continued)	OCCUPATIONAL HEALTH AND SAFETY	Occupational Safety Risks	Safety planning	*To grow and develop the SHE culture*	■ A SHE Management system to be developed and put in place to improve the SHE culture among employees and to protect their health and safety as well as to protect the environment	Development of SHE management system/ SHE Policy	Part of detailed feasibility studies/ESIA costs	Project Manager (PM), ESIA Team, Mine Engineers
		Risk of accidents and emergencies	Construction and operation planning	*To ensure all emergency procedures are in place before the start of construction*	■ Develop an emergency response plan (including emergency response team) and a site health and safety plan before starting the construction works.	Qualified OHS specialist	Approximately P4,000 per day (Part of detailed feasibility studies/ESIA costs)	PM, ESIA Team, Mine Engineers
	COMPLIANCE TO LEGAL AND REGULATORY REQUIREMENTS	Risk of constructing the mine without having obtained all relevant licensing	*Mine construction*	*To ensure that licenses have been obtained prior to commencement of the project*	■ Obtaining of all relevant licences and approvals before the start of the project, including ESIA approval, mining licence and surface rights ■ Licencing for materials borrow pits and water rights must have been obtained before use of such sources	Mine FS specialist team	Part of detailed feasibility studies/ESIA costs	PM, Mine Engineers
			Infrastructure/service planning	*To ensure that infrastructural services for the project have been planned and allowed for and approved before construction starts*	■ Timely planning and design of the access road, power lines and other required services to the mine site	Mine FS specialist team	Part of detailed feasibility studies/ESIA costs	PM, Mine Engineers

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
	SOCIAL	Disruption of current activities	Design and planning of the mine	*To ensure that the planned layout of the mine causes the least amount of negative impacts*	■ Thorough review of the designed layout, with input from ESIA specialists	Environmental/ social manager and ESIA consultant/ specialist	Specialist approximately P4,000 per day (Part of detailed feasibility studies/ESIA costs)	PM, ESIA specialist, Mine Engineers
			Design and planning of the mine	*To ensure that the affected communities and property owners are aware of the planned activities and had input in the decisions made about the proposal*	■ Consultation with surrounding communities and affected parties	Community liaison officer and ESIA consultant/ specialist	Specialist approximately P4,000 per day (Part of detailed feasibility studies/ESIA costs)	ESIA specialist
		Loss of agricultural land for the directly affected freehold farmers	Acquisition of surface rights for mine and associated infrastructure development	*To ensure that all land issues and rights have been resolved before construction of the mine*	■ Landowner agreements to be completed with directly affected parties before start of the project	Funds for purchasing the land	Funds for purchasing the land at agreed compensation rate	PM
Construction	BIODIVERSITY - FLORA	Loss of vegetation and disturbance of plant communities	Vegetation clearance within the mine site, access corridor and temporary accommodation camp site	*To avoid unnecessary vegetation clearance*	■ Bush clearing should only be carried out within demarcated areas ■ Any areas outside of the access corridor that are cleared or no longer in use should be rehabilitated (unless needed for future expansion) as soon as practicable ■ All areas associated with the T3 footprint to be rehabilitated and re-vegetated following agreed closure plans	Seed mix and seedlings (where required) and graders Vegetation clearance plan	Approximately P10,000 for seed mix and seedlings	Environmental Officer (EO), PM

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
Construction (continued)	BIODIVERSITY - FLORA	Loss of floristic diversity through invasion by alien taxa or encroachment by encroacher species	Introduction machinery and equipment to the project sites	*To ensure alien plant species are not introduced to the proposed development sites*	■ Potential invasive and encroacher flora species should be identified, and steps taken to manage any such species. ■ During routine maintenance any invasive flora species should be removed. ■ Prevent by implementing hygiene measures ■ During the closure and rehabilitation phases care must be taken to control invasive species lest they inhibit re-vegetation efforts.	Annual botanical monitoring by a suitably qualified specialist	Allow for P60,000 annually	EO, PM
	BIODIVERSITY – FAUNA	Displacement of territorial species because of mine fencing	Construction of mine site fencing	*To minimise displacement of territorial species due to mine site fencing*	■ Leave corridors in places where the fence completely cuts off access for animals ■ Utilise wildlife friendly fencing as per DWNP guidelines	Fencing layout plan. Wildlife friendly fencing material	Cost of fencing and maintenance (part of construction and maintenance costs)	EO, PM
		Disturbance, alteration and destruction of faunal habitats	Bush clearance within all construction sites	*To minimise vegetation loss and fauna habitat disturbance*	■ Bush clearing is only to be carried out in demarcated areas. ■ The collection, harvesting or hunting of any plants or animals must be strictly prohibited. ■ Implementation of Fauna Management Plan ■ Relocation of sensitive species in liaison with DWNP ■ Outdoor fires are not to be permitted ■ All hazardous materials should be correctly stored to limit chances of contamination of the area.	Fauna Management Plan Camera Trapping survey	Approximately P50,000 for camera trapping survey	EO, PM

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
		Excavation posing a risk to fauna	Excavated areas (unsecured)	*To prevent animals from being trapped in excavated areas*	■ Areas which have been excavated have to be temporarily demarcated and fenced off to bar access by animals ■ Following the excavation activities, any open trenches or excavated areas need to be re-filled and rehabilitated (this does not include the mine pit).	Temporary fencing	Allow P100,000	EO, PM
		Reduced air quality affecting avifauna	Construction works	*To avoid/minimise air quality impacts on avifauna*	■ Begin re-vegetation on areas no longer in use to stop wind erosion. ■ Monitor avifauna and specifically vulture nesting in the project area as part of biodiversity monitoring	Assistance from avifauna specialist	Allow P25,000 annually	HSO, EO, PM
Construction (continued)	BIODIVERSITY – FAUNA	Risk of vehicle collisions with wildlife	Transportation of construction staff and material, movement of construction equipment	*To prevent disturbance or casualties of wildlife*	■ Drivers operating in the area must be well briefed and must be aware of the danger that traffic poses to the local fauna. ■ Speed limits must be enforced and strictly adhered to. ■ All incidents of road kills should be reported and monitored so that hot spot areas can be identified and mitigated.	Induction and staff training materials	Allowed for in construction budget	EO, PM
		Noise disturbance to local fauna	All construction sites, including material haulage routes	*To avoid/minimise disturbance of wildlife due to increased noise levels*	■ Allow movement of animals during operations, so they can flee from noise disturbance. ■ Animals should be monitored (as part of the environmental management plan) to assess the effects of the noise on behaviour ■ Haul traffic to adhere to predetermined route	Assistance from biodiversity specialist	Allow P45,000 annually	EO, PM, Contractor

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
		Lighting causing disorientation to fauna	All construction sites	*To avoid/minimise disturbance of wildlife due to construction sites lighting*	■ Animals should be monitored to assess the effects of the light on their behaviour (see earlier) ■ Use downlighting and green/blue light bulbs where practicable ■ Liaison with DWNP	Assistance from biodiversity specialist	Part of above	EO, PM, Contractor
	BIODIVERSITY – FAUNA	Disturbance of wildlife from blasting activities	Blasting activities	*To avoid/minimise disturbance of animals in the project area*	■ Monitor wildlife as part of biodiversity monitoring plan ■ Development and implementation of fauna management plan	Fauna Management Plan Camera Trapping survey	Approximately P50,000 for camera trapping survey	EO, PM, Contractor
Construction (continued)		Human-wildlife conflict	Presence of construction workers within wildlife areas or use of construction activities.	*To avoid/minimise conflict between wildlife and construction staff*	■ Workers to coordinate with the relevant personnel to resolve wildlife-human conflict situations. ■ Workers to be instructed on the correct courses of action when confronted in a situation with wild animal (basic instructions to be provide in the site induction training). ■ A policy whereby the animals have "right of way" during construction would reduce incidents of conflict. ■ All incidences between project personal and local fauna must be reported for monitoring purposes.	Induction and staff training materials	Allowed for in construction budget	EO, PM, Contractor

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
		Increased poaching and exploitation of wildlife	Presence of construction workers within wildlife areas or use of construction activities.	*To avoid poaching and exploitation of wildlife*	■ A 'no tolerance' policy must be adopted with respect to project staff who are guilty of poaching or exploitation of fauna. They must be immediately dismissed from their position and handed over to Wildlife authorities. ■ Any sign or evidence of poaching must immediately be reported to the Department of Wildlife. ■ All incidence of poaching or poaching related activities must be documented for monitoring purposes.	Development of strict policies and enforcement through inductions and monitoring	Allowed for in construction costs	EO, PM, Contractor
Construction (continued)	AIR QUALITY	Decline in air quality	Excavation of areas, material haulage on gravel roads and construction of components	*To reduce dust emissions and other pollutants during the construction phase*	■ When working near (within 100m) a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible ■ Wet suppression to be implemented to control open dust sources at construction sites ■ Extra management and suppression during the windiest conditions (during the months of August, September and October) ■ Dust fall-out monitoring plan must be developed and implemented to identify key areas where dust suppression is required	Water bowsers for dust suppression. Dust collection / sampling points and laboratory analysis	Allow P80,000 annually	EO, PM, Contractor

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
	NOISE	Increased noise levels	Entire construction activities, transportation of material and staff and power generation	*To reduce noise levels to be generated by construction activities*	■ Information regarding construction activities should also be provided to all farm residences within an agreed radius (suggested 5km) ■ Strict enforcement of speed limits will aid in limiting any additional noise along the access road ■ Ensure equipment is well-maintained to avoid additional noise generation.	Community liaison office to engage all farm residents. Vehicle maintenance program. Signage for speed limits	Part of construction cost (includes salary for community liaisons officer, vehicle maintenance and signage)	PM, EO
	SOIL	Risk of soil erosion and loss of topsoil	Vegetation clearance and use of heavy machinery at all construction sites	*To avoid/minimise loss of top soil due erosion*	■ Implement a storm water management plan ■ Access roads and construction sites require suitable drainage systems. ■ Cleared areas no longer required for construction activities should be rehabilitated ■ Regular checks and monitoring should be conducted, any areas showing signs of erosion should be immediately repaired.	Development of stormwater management plan. Rehabilitation may require seed mix and seedlings (where required) and graders	Allow approximately P10,000 for seed mix and seedlings	EO, PM, Contractor

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
Construction (continued)	SOIL	Risk of hydrocarbon pollution from spillage from construction vehicles	Removal of soil to facilitate construction of mine infrastructure, areas where vehicles and machinery are parked and/or operate. Fuel storage and refuelling sites.	*To avoid/minimise spillage and hydrocarbon pollution*	■ Fuel and other hydrocarbon products storage should be secured in a bund. ■ Bunds should be located on impermeable surfaces with controlled drainage away from natural water courses. ■ Refuelling should be done in designated areas (although fuel trucks will be used for field generators and large mining equipment) ■ Vehicles should be regularly serviced to avoid oil leaks. ■ Drip trays to be used when oil/fuel leakages are identified on vehicles and machinery ■ Contaminated soil removed to a designated area for remediation	Drip trays and oil spill kits. Contaminated soil storage areas/ containers (prior to being treated)	Approximately P7000 for drip trays and spill kits. P10,000 for treating soil.	EO, PM, Contractor
	GROUND WATER	Lowering of water levels	*Abstraction*	*To reduce the impact on ground water levels and groundwater users*	■ Drilling of on-site monitoring boreholes as part of water management and monitoring plan ■ Conducting Hydrocensus to ascertain the groundwater resource	Hydrogeologist and technicians	Boreholes drilling at cost of approx. P120,000 each Cost of Hydrogeologist as above	EO or appointed consultant
		Groundwater contamination from hydrocarbons and other chemicals	*Chemical storage, vehicle and machinery servicing, storage and use of fuel, oils and other lubricants*	*To minimise groundwater contamination*	■ Pollution control measures built suitable for the potential pollutants associated with each facility ■ Lining of TSF ■ Drilling of monitoring boreholes ■ Water management plan to be developed that outlines regular water monitoring program	Pollution preventing designs, monitoring boreholes	Part of above	EO or appointed consultant

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
Construction (continued)	LANDSCAPE AND VISUAL AMENITY	Alteration of land morphology: addition of large-scale dumps on landscape	Development of mine dumps and open pit	*To minimise alteration of land morphology*	▪ (Re-)designing of dumps' contours to ensure level elevations where required ▪ Progressive rehabilitation where practible	Mine plan and management	Part of design and construction costs	EO, PM
		Unearthing of underground material previously not exposed	Site clearance and excavation works	*To avoid/minimise impacts associated with exposing materials previously not exposed*	▪ Re-vegetate areas where practicable to preserve topsoil	Mine plan and management Seed mix and seedling (where applicable)	Part of construction costs Seed mix and seedlings approximately P10,000	EO, PM
		Clearance of existing vegetation	Site clearance	*To avoid/minimise unnecessary vegetation clearance*	▪ Minimise clearance where practicable ▪ Re-vegetate all areas upon decommissioning	Seed mix and seedling (where applicable)	Part of construction costs Seed mix and seedlings approximately P10,000	EO, PM
		Addition of industrial mining elements into rural landscape	Construction of mine and associated developments	*To minimise change in landscape and visual character*	▪ Maximum waste dump height of 50m ▪ Design dumps' contours to ensure level elevations	Mine plan and management	Part of construction costs	EO, PM
	WASTE (HAZARDOUS)	Increased hazardous waste amounts	Equipment maintenance (e.g. used oils)	*To sustainably dispose of hazardous waste (Oil / grease / oil filters / oil rags / contaminated packaging)*	▪ Disposal at legally compliant and environmentally sound facilities ▪ Store at appropriate storage facility ▪ Source separation ▪ Recycling where possible	Waste management plan	Part of construction costs	EO, PM, contractor
		Pollution by heavy metals from e-waste	Use, storage and disposal of e-waste	*To avoid/minimise contamination of air, soil and water from e-waste*	▪ Recycling ▪ Environmentally sound disposal of residues.	Waste management plan	Part of construction costs	EO, PM, contractor

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
		Generation of toxic Hg emissions and Pollution by heavy metals.	Storage and disposal of damaged florescent tubes	*To sustainably manage and dispose of damaged florescent tubes*	■ Recycling if within viable transport distance from recycling plants. ■ Crushing and transport for disposal at legally compliant and environmentally sound landfills.	Tube crusher	Allow approximately P100,000	EO, PM, contractor
Construction (continued)		Health and safety risks due to management of medical/clinical waste	Storage and disposal of medical/clinical waste	*To sustainably manage and dispose of medical/clinical waste*	■ Appropriate segregation and containerisation of HCRW ■ Transport to legally compliant and environmentally sound incinerator for destruction/disposal	HCRW storage and transport	Part of construction costs (allow approximately P30,000 per annum)	EO, PM, Ghanzi District Council (Public Health Officer)
		Health and safety risks due to management of sewage sludge	On-site management of sewage sludge and disposal (off-site)	*To sustainably manage and dispose of sewage waste*	■ Set up sewage treatment plant on site as early as possible	STP set up	Blending as part of rehabilitation costs (see Chapter 12)	EO, PM, Ghanzi District Council
	NON-HAZARDOUS WASTE	Pollution of soil and water due to littering, reduction of landfill airspace.	Littering or inappropriate management of waste	*To sustainably manage and dispose of non-hazardous waste*	■ Source separation ■ Recycling of general waste ■ Recycling of old rubber tyres and conveyor belts	Waste management plan and waste holding facility	Approx. P250,000	EO, PM, Contractor
	ARCHAEOLOGY	Risk of destruction and loss of archaeological artefacts and cultural heritage sites	Construction works with all development areas	*To avoid disturbance or destruction of archaeological artefacts and cultural heritage sites*	■ Construction personnel should be inducted on exercising caution for archaeological materials ■ A procedure dealing with human remains and graves should be developed for the project. ■ The spoil heap should also be regularly inspected lest any object be missed ■ All chance finds must be reported	Grave management procedure, development of induction	Approximately P100,000	EO, PM, independent Archaeologist

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
Construction (continued)	OCCUPATIONAL HEALTH AND SAFETY	Increase in HIV and AIDS prevalence and incidence, including STI incidence Increase in TB incidence	Influx of people at the study area	*To minimise the spread of HIV and AIDS* *To minimise the spread of TB*	▪ Development and implementation of the infectious diseases HIV/AIDS, STI and TB Policy ▪ Develop and implement robust IEC programs ▪ Partnership with DMHT ▪ Develop and implement an Occupational Medical Surveillance (voluntary - in accordance with relevant legislation)	Developing of HIV and AIDS, STI and TB Policy and IEC materials	Allow P150,000	EO, PM, Contractor
		Increased prevalence of Malaria	Construction employees traveling to and from areas (North West District)	*To avoid/minimise spread of malaria*	▪ Development and implementation of a medical emergency response plan (MERP) in conjunction with Ghanzi Primary Hospital management and emergency response providers	MERP	Allow P50,000	EO, PM, Ghanzi Hospital Matron
		Fatigue related incidents	Daily transportation of construction personnel from accommodation camp	*To avoid/minimise any safety incidents related to fatigue*	▪ Undertaking of a fatigue risk assessment ▪ Transport supplied to and from site to help reduce fatigue	Undertaking of assessment Company provided transport	Allow P50,000	EO, PM, Contractor
	TRAFFIC	Risk of road traffic accident	Daily transportation of construction personnel from accommodation camp near Ghanzi to mine/construction sites	*To avoid/minimise any road traffic accidents*	▪ Undertaking of road traffic accident risk assessment and development of a plan ▪ In liaison with Roads Department, consider (1) reduced speed zones around turn-offs to site and camp dust suppression on gravel road (2) development of turning lane for T3 site and turning lane and/or pick-up and drop-off point for camp ▪ Discourage use of private vehicles to travel to the mine ▪ Liaison with Botswana police and DRTS ▪ Zero-tolerance for drink-driving	Cost of undertaking road traffic risk assessment	Part of Traffic Assessment Cost (above)	Contractor, EO, PM
Co nst ruc	SOCIO-ECONOMIC	Creation of employment	Employment process	*To ensure the local community benefit from*	▪ Roles should be advertised locally to ensure local residents will have an	Human Resource- Local	Part of construction	EO, PM, HR Department

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
				available jobs	opportunity to apply ■ A monitoring system should be established to ensure that the subcontractors honour the specified local employment policy ■ The local Tshukudu office should ensure appropriate and constant communication with the community regarding employment opportunities. ■ No hiring on site, hiring to be done at regional or national recruitment centres	Employment Policy Local advertisements	cost. Cost of advertisement (Approximately P400 per advert)	Contractor, Ghanzi Regional Labour Office
		Regional economic development	Procurement of construction goods and services	*To promote localisation of entrepreneurship opportunities where possible*	■ Maintain and utilise local business database to identify local SMMEs	Business database	Part Corporate Social Responsibility/ training programs	Procurement Officer, PM, Contractor
		Community relations and social disruption	Construction activities at mine site and transport of construction materials and equipment	*To minimise disturbance of neighbouring farms activities*	■ Access to neighbouring farms should not be interrupted through provision of alternative temporary access points ■ In liaison with Roads Department, upgrade of the intersection to allow through traffic to bypass turning mine vehicles should be considered ■ Maintenance of construction equipment	Public liaison officer	Community Liaison Officer salary approximately P15,000 per month	EO, PM, Contractor
		Conflict or competition between jobs seekers and the locals	Hiring process and influx of job seekers	*To avoid/minimise conflicts between locals and job seekers*	■ Establishment of regional/national recruitment centre to avoid influx of job seekers in area ■ Employment of locally based people where qualified and practicable	Community Liaison Officer HR Employment Policy	Community Liaison Officer salary approximately P15,000 per month	PM, HR Department, Contractor

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
	PUBLIC SAFETY	Risk of injury or death to members of the public	Construction sites (along access roads)	*To eliminate/minimise any negative safety impacts on the public*	▪ Appropriate signage will be provided on site during construction and must be provided wherever necessary. ▪ Access to site is to be restricted ▪ All dangerous areas must be fenced	Signage and fencing and security personal	(Included in construction cost) Cost of signage approximately P10,000 Allow approximately P4,000 per person per month	EO, PM, Contractor
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Operation	BIODIVERSITY - FLORA	Loss of vegetation	Further bush clearing	*To avoid unnecessary vegetation clearing*	▪ All areas to be cleared should be clearly demarcated ▪ Re-vegetate when practicable areas that were cleared and are no longer in use ▪ Progressive rehabilitation of dumps and TSF	Seedlings for re-vegetation	See Chapter 12 (allow approximately P10,000)	EO, Mine Manager (MM)
		Loss of floristic diversity through invasion by alien taxa or encroacher species	Introduction of mining machinery and equipment to site	*To avoid introducing alien plants to all project areas*	▪ Potential invasive and encroacher flora species should be identified, and steps must be taken to manage any such species ▪ During routine maintenance any invasive flora species should be removed	Assistance from flora specialist	Allow for P60,000 annually	EO, MM

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
Operation (continued)	BIODIVERSITY - FAUNA	Fauna habitat destruction and alteration	Clearing of additional land for other works	*To avoid unnecessary vegetation clearing*	■ Any fauna directly threatened by operation activities should be relocated in accordance with Fauna Management Plan and in liaison with DWNP ■ Project staff require environmental education raise awareness ■ The collection, harvesting or hunting of any plants or animals must be strictly prohibited ■ Bush clearing to be only carried out in demarcated areas ■ Progressive rehabilitation	Training programmes	Rehabilitation cost is outlined in Chapter 12 (costs as above)	EO, MM, Department of Wildlife and National Parks (DWNP)
		Conflict between project staff and fauna	Project operational activities	*To avoid/minimise human/wildlife conflict*	■ Workers to be instructed on the correct courses of action when confronted in a situation with wild animals (basic instructions to be provide in the site induction training). ■ All incidences between project personal and local fauna must be reported for monitoring purposes	Training programmes carried out by SHE officers	Part of operational costs (allow approximately P15,000 per month per SHE officer)	HSO, EO, MM
	BIODIVERSITY - FAUNA	Noise disturbance to local fauna	Entire operation	*To avoid/minimise disturbance of animals in the project area*	■ Allow movement of animals during operations, so they can flee from noise disturbance ■ Monitor fauna to assess the effects of the noise on their behaviour (as part of biodiversity monitoring plan) ■ Haul traffic to adhere to predetermined routes	Assistance from biodiversity specialist	Allow P45,000 annually	EO, MM

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
Operation (continued)		Lighting resulting in the disorientation of fauna	Entire operation	*To avoid/minimise disturbance of animals in the project area*	▪ Animals must be monitored to assess the effects of the light on their behaviour (see earlier) ▪ Use downlighting and green/blue light bulbs where practicable ▪ Liaison with DWNP	Assistance from biodiversity specialist	Allow P45,000 annually	EO, MM
		Risk of vehicle collisions with wildlife and livestock	Mine haulage operations	*To prevent animals from being hit by vehicles*	▪ Drivers be aware of the danger that traffic poses to the local fauna ▪ Speed limits must be enforced and strictly adhered to ▪ All incidents of road kills should be reported and monitored to that hot spot areas can be identified and mitigated	Traffic management plan. Induction by SHE officers	Part of operational costs (costs for SHE Officer above)	EO, MM
		Blasting disturbing fauna and potentially increasing mortality	Mining in open pit	*To avoid/minimise disturbance and mortality of animals in the project area*	▪ Prior to blasting ensure no fauna are within the blast radius ▪ Align blasting timelines with documented fauna movements ▪ Development and implementation of fauna management plan	Assistance from biodiversity specialist	Same cost as above	EO, MM
		Risk of poaching and exploitation of fauna	Entire operation	*To avoid poaching and exploitation of fauna*	▪ A 'no tolerance' policy must be adopted with respect to project staff who are guilty of poaching or exploitation of fauna ▪ Any sign or evidence of poaching must immediately be reported to the Department of Wildlife. ▪ All incidence of poaching or poaching related activities must be documented for monitoring purposes.	Assistance from DWNP	Part of operational costs (no additional cost)	EO, MM, DWNP

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
Operation (continued)	BIODIVERSITY - FAUNA	Excavation posing a risk to fauna	Excavation of pit	*To avoid trapping of animals in excavations*	■ Temporary excavated such as trenches and foundations to be temporarily demarcated and fenced ■ Following the excavation activities, temporary excavated areas need to be re-filled and rehabilitated (does not apply to mine pit).	Fencing and signage	Same costs as above	EO, MM
		Elephants migration to the south	Mining site (tailings dam and open water sources)	*To avoid/minimise presence/attraction of elephants to the mine site*	■ Deterrent measures to be investigated with the department of wildlife. ■ Develop working relationship with department of wildlife to understand tracking of elephant population.	Monitoring and liaison with DWNP	Part of operational costs (no additional cost expected)	EO, MM
	BIODIVERSITY – AVIFAUNA	Risk of disturbance of vultures	Mining activities	*To avoid/minimise impact on vultures*	■ Monitor vulture activity and nesting as part of biodiversity monitoring programme ■ Liaison with DWNP and Raptors Botswana	Assistance from avifauna specialist	Allow P45,000 annually	EO, MM
		Risk of vultures and other avifauna electrocution or collision with power lines	Operation of electrical infrastructure	*To avoid/minimise electrocution of vultures and other avifauna species*	■ Live and earth phases should at least 1.8 meters apart from each other ■ Towers should be maintained such that nesting underneath the cables cannot take place. ■ Anti-collision marking devices are to be added along the entire length of the power line in the designated areas	Assistance from avifauna specialist	Part of operational/ maintenance cost Allow for avifauna specialist cost (as above)	EO, MM, Biodiversity specialist

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
Operation (continued)	AIR QUALITY	Decline in air quality	Stockpiles, Conveyor belts, Crushing	*To reduce dust emissions during the mining phase*	▪ Dust suppression sprays should be considered at crusher feed , transfer points, coarse ore stockpile to help reduce dust. ▪ Develop procedure for dust management should excess wind create issue ▪ Consider chemical dust suppression around coarse ore stockpile base ▪ Ensure roads are monitored for dust generation and frequent use of water cart to be applied ▪ Consider stockpile embankment angles to ensure stockpiles of top soil don't become airborne.	Spray equipment (water bowsers) and water	Allow for P500,000 per water bowser	EO, MM
	AIR QUALITY	Decline in air quality	Blasting	*To reduce dust emissions during the mining phase*	▪ Use reduced charges (where possible) to reduce dust production.	Planning of blasts	Part of operational cost	EO, MM
		Decline in air quality	Transport on gravel roads	*To reduce dust emissions during the construction phase*	▪ Dust suppression and speed reduction on roads ▪ Dust fall-out monitoring plan must be developed and implemented	Spray equipment (water bowsers) and water	Same as above	EO, PM, Contractor
	NOISE	Increased noise levels	Entire operation	*To minimise overall noise produced by the operation*	▪ Not blasting after day light hours ▪ Regularly service vehicles and equipment	Planning of blasts Vehicle maintenance	Vehicle maintenance costs (approximately P10,000 per vehicle)	EO, MM

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
Operation (continued)	SOIL	Soil contamination	Entire operation (vehicle and machinery storage, operational and parking areas, fuel and chemical/ lubricant storage area, and refuelling sites)	*To minimise soil contamination from hydrocarbons*	■ All chemicals, fuel and other hydrocarbon products must be secured in a bund ■ Refuelling should be done in designated areas. Care must be taken to avoid spillage, when refuelling machinery ■ Vehicles must be regularly maintained as to not leak oil ■ Contaminated soils to be isolated and treated in designated area	Maintenance and monitoring of storage equipment	Vehicle maintenance costs (approximately P10,000 per vehicle)	EO, MM
		Soil erosion	Land clearance and soil stockpiling	*To minimise soil erosion*	■ Drainage systems to be maintained along infrastructure ■ Rehabilitation of areas where practicable ■ Minimise heights and slopes of soil stockpiles to reduce chances of erosion, establish vegetation	Topsoil planning and management	Cost of planting ground cover, approximately P10,000 for seed mix and seedlings	EO, MM
	GROUND WATER	Lowering of water table	Water Abstraction from boreholes	*To minimise lowering of the water table by having a monitoring protocol outlining monitoring requirements and adhering to it to allow effective management of the effects*	■ Monitoring of abstraction volumes ■ Monthly water level measurements ■ Annual update of the numerical groundwater flow model ■ Liaison with borehole owners (2 - based on studies) to maintain water supply	Hydrogeologist and technicians	Approx. P200,000 annually	EO, MM
		Decreasing borehole yields in private registered boreholes near the mine	Water Abstraction from boreholes	*To ensure water supply for other users is not interrupted due to abstraction at the mine*	■ Immediately provide water (from water treatment process on site) to any affected homestead ■ Deepen affected bores / Assist with upgrading pumps/ mechanical pumping devices should supply be permanently disrupted ■ Drill additional bores (providing pumping and piping) if affected bores are not recoverable.	Drilling equipment, piping and pumps	Approx. P3 million	MM

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
Operation (continued)	GROUND WATER	Decline in water quality, Contamination by hazardous substances	Operation of Processing plant, Sewage works, waste rock & tailings storage facility, Workshops & vehicles, Explosives store and Waste storage area	*To minimise or eliminate any groundwater contamination*	▪ Pollution control measures built suitable for the potential pollutants associated with each facility to be maintained ▪ Quarterly water sampling of groundwater ▪ Geochemical sampling and testing ▪ Reporting of monitoring results ▪ Operational management procedures and clean-up protocols in case of accidental spillage/leakage	Hydrogeologist and technicians and mine staff associated with running the facilities	Approx. P200,000 annually for Hydrologist and technicians	EO, MM
	LANDSCAPE AND VISUAL AMENITY	Addition of large-scale dumps on landscape	Mining site	*To avoid/minimise dumps on landscape*	▪ Maintain dump contours as per designs to ensure level elevations	Mine plan and management	Allowed for in the operational budget (no extra cost)	EO, MM
		Unearthing of underground material previously not exposed	Mining site	*To avoid/minimise exposure of materials not previously exposed*	▪ Re-vegetate areas where practicable to preserve topsoil	Mine plan and management Seed mix and seedlings	Allowed for in the operational budge (no extra cost) Seed mix and seedlings approximately P10,000	EO, MM
		Addition of industrial mining elements into rural landscape, causing substantial change in landscape character	Entire operation	*To avoid/minimise addition of industrial mining elements into rural landscape*	▪ Minimise clearance where practicable ▪ Maintain maximum waste dump height of 50m ▪ Create dumps' contours to ensure level elevations	Mine plan and management	Part of operational costs	EO, MM

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
Operation (continued)	WASTE (HAZARDOUS)	Increased hazardous waste amounts	Equipment maintenance (e.g. used oils) and chemical waste	*To sustainably dispose of hazardous waste* such as *oil / grease / oil filters / oil rags / contaminated packaging*	■ Recycling if within viable transport distance from recycling plants ■ Transport for disposal at legally compliant facilities ■ Separate waste at source ■ Disposal of battery acid at legally compliant facilities	Waste management plan	Part of operational costs, exact cost unknown	EO, MM
		Pollution by heavy metals from e-waste	Use, storage and disposal of e-waste	*To avoid/minimise contamination of air, soil and water from e-waste*	■ Recycling of e-waste (where feasible) ■ Environmentally sound disposal of residues	Waste management plan	Part of operational costs, exact cost unknown	EO, PM
	WASTE (HAZARDOUS	Generation of toxic Hg emissions and pollution by heavy metals	Storage and disposal of damaged florescent tubes	*To sustainably manage and dispose of damaged florescent tubes*	■ Recycling if within viable transport distance from recycling plants ■ Transport for disposal at legally compliant and environmentally sound landfills	Tube crusher	Part of operational costs, tube crusher cost estimated at P100,000	EO, MM
		Health and safety risks due to management of medical/clinical waste	Storage and disposal of medical/clinical waste	*To sustainably manage and dispose of medical/clinical waste*	■ Appropriate segregation and containerisation of HCRW ■ Transport to legally compliant incinerator for destruction/disposal	HCRW storage and transport	Part of operational costs, exact cost unknown	EO, MM, Ghanzi District Council
	NON-HAZARDOUS WASTE	Pollution of soil and water due to littering	Littering or inappropriate management of waste	*To sustainably manage and dispose of packaging materials*	■ Source separation ■ Recycling of waste ■ Recycling of old rubber tyres and conveyor belts	Waste management plan and waste holding facility	Part of operational costs, exact cost unknown	EO, MM
	NON-HAZARDOUS WASTE	Food waste causing health risks and attracting wildlife	Food preparation, equipment maintenance	*To manage food waste and minimise quantities disposed at the landfill*	■ Source separation ■ Composting	Waste management plan and waste holding facility	Part of operational costs, exact cost unknown	EO, MM

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
	OCCUPATIONAL HEALTH AND SAFETY	Increase in HIV and AIDS prevalence and incidence, including STI incidence Increase in TB incidence	Influx of people at the study area	*To minimise the spread of HIV and AIDS* *To minimise the spread of TB*	▪ Development and implementation of the HIV/AIDS, STI and TB Policy ▪ Develop and implement robust IEC programs ▪ Partnership with DMHT ▪ Develop and implement an Occupational Medical Surveillance (voluntary - in accordance with relevant legislation)	Developing HIV and AIDS, STI and TB Policy and IEC materials. SHE Officer	Covered during construction, Allow for at least P15,000 per SHE officer monthly.	EO, MM
		Increased prevalence of Malaria	Construction employees traveling to and from areas (North West District)	*To avoid/minimise spread of malaria*	▪ Development and implementation of a medical emergency response plan (MERP) in conjunction with Ghanzi Primary Hospital management and emergency response providers, such as MRI Botswana.	MERP	Covered during construction	EO, MM, Ghanzi Hospital Matron
Operation (continued)	OCCUPATIONAL HEALTH AND SAFETY	Fatigue related incidents	Daily transportation of construction personnel from accommodation camp	*To avoid/minimise any safety incidents related to fatigue*	▪ Undertaking of a fatigue risk assessment ▪ Provide transport between mine site and camp	Undertaking of assessment	Covered during construction	EO, MM
	TRAFFIC	Risk of road traffic accident	Daily transportation of construction personnel from accommodation camp near Ghanzi to mine/construction sites	*To avoid/minimise any road traffic accidents*	▪ Undertaking of road traffic accident risk assessment and development of a plan ▪ Maintain speed restrictions ▪ Dust suppression on gravel roads ▪ Undertake road safety awareness campaigns ▪ Discourage use of private vehicles to travel to the mine ▪ Liaison with Botswana police and DRTS ▪ Zero-tolerance for drink-driving	Traffic risk assessment	Covered during construction	EO, MM

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
	SOCIO-ECONOMIC	Creation of employment	Employment process	*To ensure the local community benefit from available jobs*	▪ Roles will be advertised locally to ensure local residents will have an opportunity to apply ▪ If required, the local resident status of applicants should be verified in consultation with community representatives ▪ No hiring at the site. Regional or national recruitment centres should be established ▪ The local Tshukudu office should ensure appropriate and constant communication with the affected community regarding employment opportunities.	HR Employment Policy Local Advertising	Part of operational cost (including cost of advertising estimated at P400 per advert)	MM, HR Department, Ghanzi Regional Labour Office
Operation (continued)	SOCIO-ECONOMIC	Regional economic development	Procurement of construction goods and services	*To promote localisation of entrepreneurship opportunities where possible*	▪ The Client should utilise the existing local business database to identify local SMMEs and businesses ▪ Tshukudu Metals should establish linkages with other key stakeholders in the area involved in skills and SMME development, to enhance the effort to create suitable service providers within the local area.	Database of businesses	Part Corporate Social Responsibility/ training programs costs	Procurement Officer, MM
		Skills transfer and development	Hiring of construction employees	*To promote participation of locals in the project construction employment*	▪ Liaison with Vocational Training Centres (VTCs) and schools to promote skills development ▪ Promote in-house (work) related training ▪ LED and CSR programmes should (where still possible) be designed in consultation with community representatives to ensure that the actual needs of communities are met.	Training plans for locals	Part Corporate Social Responsibility/ training programs costs	MM, HR Department

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
		Community relations and social disruption	Operational activities	*To minimise disturbance of neighbouring farms activities*	■ Access to neighbouring farms must not be interrupted ■ Liaison with roads department to enable them to undertake preventative maintenance	Public liaison officer	Part of operational cost (allow approximately P15,000 per month per Officer)	MM, EO
	SOCIO-ECONOMIC	Conflict or competition between jobs/opportunity seekers and locals	Hiring process and influx of job seekers	*To avoid/minimise conflicts between locals and job seekers*	■ Ensure that the intention to be employing people with the right skills to make the project a success is clearly communicated ■ Involve local community structures to assist in communicating job opportunities, and to assist in identifying the local labour pool ■ Liaison structures are to be established with local police to monitor social changes in crime patterns.	Public liaison officer	Community Liaison Officer salary approximately P15,000 per month	MM, HR Department, MM
	ARCHAEOLOGY	Risk of destruction and loss of archaeological artefacts and cultural heritage sites	All mining areas	*To avoid disturbance or destruction of archaeological artefacts and cultural heritage sites*	■ Relevant mining personnel must be inducted on exercising caution for archaeological materials during the mining operation ■ Archaeological Induction Procedure must be developed and implemented for the project ■ The spoil heaps should also be regularly inspected for artefacts ■ All chance finds must be reported to the Department of National Museum and Monuments as soon as possible	Grave management procedure, induction material Archaeologist	Already developed. Were archaeological specialist input is required allow for P4,000 per day	EO, MM, independent Archaeologist
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Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
Closure and de-commissioning	ECOLOGY - FLORA	Loss of vegetation	*Re-vegetation of cleared areas during rehabilitation*	*Ensure successful re-vegetation of native vegetation, erosion control, and establishment of grasses to prepare the land for end use.*	■ Re-vegetation using indigenous flora, which resembles the adjacent areas not affected by the proposed development ■ Re-vegetation must seek to protect the continuous erosion of soil from the disturbed areas ■ Development of detailed closure and rehabilitation plan	Development of detailed closure and rehabilitation plan	Refer to Chapter 12	ESIA specialist, MM, EO, Mine Closure specialist
	LANDSCAPE AND VISUAL AMENITY	Change of topography	*Closure and rehabilitation of waste dumps*	*Minimise the visual impact of the dumps*	■ Final shape of dumps to take other topographical landscape features into account ■ Development of detailed closure and rehabilitation plan ■ Implement progressive rehabilitation	Development of detailed closure and rehabilitation plan	Refer to Chapter 12	ESIA specialist, MM, EO, Mine Closure specialist
	GROUND WATER	Rebound of water levels and creation of a pit lake	*Cessation of abstraction*	*Minimise the risk of fatality due to inadequate protection* *Allow water usage after mine closure*	■ Consider possibilities of utilising the water collected in the pit ■ Monitor the water quality of the lake to ensure it can be utilised for closure period ■ Continue monitoring water levels and their reporting for closure period	Hydrogeologist and technicians	Refer to Chapter 12	ESIA specialist, MM, EO, Mine Closure specialist
Closure and de-commissioning (continued)	GROUND WATER	Continued contamination from facilities not removed	*Waste rock dumps*	*Minimise or eliminate any groundwater contamination*	■ Removal of mine infrastructure which can be removed or would not be used after mine closure ■ Continue monitoring of water locally and their reporting, hand over monitoring to new land owner after satisfactory closure and rehabilitation	Hydrogeologist and technicians	Refer to Chapter 12	ESIA specialist, MM, EO, Mine Closure specialist
	SOCIO-ECONOMIC	Loss of employment, loss of community cohesion and structures, labour migration	*Mine closure*	*Minimise the impact of employment loss on the local community*	■ Consider support of re-skilling, re-employment, transition of workforce ■ At start of employment, consider establishment of pension plans	Training	Unknown at this stage	ESIA specialist, MM, EO, Mine Closure specialist

Project phase	Environmental category	Impact	Activity or process where impact is expected	Mitigation objective	Mitigation measure or recommendation to be implemented	Required resources	Estimated cost	Implementing agency
		Loss of business opportunities and revenue for the Government and effects on social services	*Mine closure*	*Minimise the impact of mine closure on the regional economy*	■ Engagement of local nurseries for provision of plants species to be used for rehabilitation	Development of detailed closure and rehabilitation plan	Unknown at this stage	ESIA specialist, MM, EO, Mine Closure specialist
		Loss of community cohesion and structures	*Mine closure*	*Minimise impacts of mine closure on the services provided at the study area*	■ Social services: Evaluate activities, hand over lessons learned and best practices recommendations report to relevant authorities. ■ Provision of adequate retrenchment packages, that as a minimum meet relevant Botswana Labour legislation.	Development of detailed closure and rehabilitation plan	Unknown at this stage	ESIA specialist, MM, EO, Mine Closure specialist
	ENVIRONMENTAL MANAGEMENT	Risk of unacceptable condition of site after closure	*Closure planning*	*Ensure that closure is undertaken in accordance with requirements and expectations of relevant authorities*	■ Development of a detailed closure and re-vegetation plan prior to closure, to be submitted to DOM and DEA for comment and approval	Development of detailed closure and rehabilitation plan	Part of rehabilitation costs	ESIA specialist, MM, EO, Mine Closure specialist

11 Environmental and Social Monitoring Plan

Environmental monitoring is a process that assists in assessing compliance with the mitigation measures drawn up in the ESMP. There are several parties that are involved in carrying out this environmental monitoring, as stated in the responsibility matrix and reporting structure below.

11.1 Responsibility matrix

The responsibilities of the involved parties are summarised in Table 11.1, the responsibility matrix. This matrix should be updated with contact details of all parties involved, once appointments and contracts have been completed, and should be distributed amongst the project team.

Table 11.1: Responsibility matrix

Function	Description	Responsibility
Project Manager (PM)	Client's Technical Director or Mine Manager	Overall management of Project and ESMP implementation
Site supervisor/ Construction Manager (CM)	Construction Manager	Oversees site works, liaison with Contractors, PM and ECO
Environmental Control/ Compliance Officer (ECO)	Qualified Environmental scientist employed by Proponent	Implementation of EMP, overseeing of monitoring and liaison between management, contractors and labourers; work in conjunction with SHE management
Contractor (C)	To be appointed, specialist subcontractors	Implementation and compliance with recommendations and conditions of the ESMP, appoints dedicated person (CECO) to work with ECO
Contractor Environmental Control Officer (CECO) (where applicable)	Subcontractor's dedicated officer in charge of any relevant ESMP related issues or actions to be taken	Implementation of ESMP, environmental control of site actions, remediation and rehabilitation work, answers to ECO
Environmental Advisor/Auditor	Independent Environmental Consultant to be appointed by the Client	Environmental advice and auditing
Mine Manager (MM)	Appointed by Tshukudu Metals in accordance with Mines, Quarries, Works, and Machinery Regulations.	Implementation of ESMP for the mine operations, overseeing of monitoring and liaison between management, contractors and labourers; work in conjunction with SHE management

11.2 Reporting structure

The success of an ESMP depends on the level of cooperation and collaboration between the parties in the Project. It is of great importance that every party is aware of their specific roles and the success of an EMP depends on the level of cooperation and collaboration between the parties in the Project. It is of great importance that every party is aware of their specific roles and requirements within the ESMP. An environmental reporting structure should be put in place, following the general guideline as illustrated in Figure 11.1.

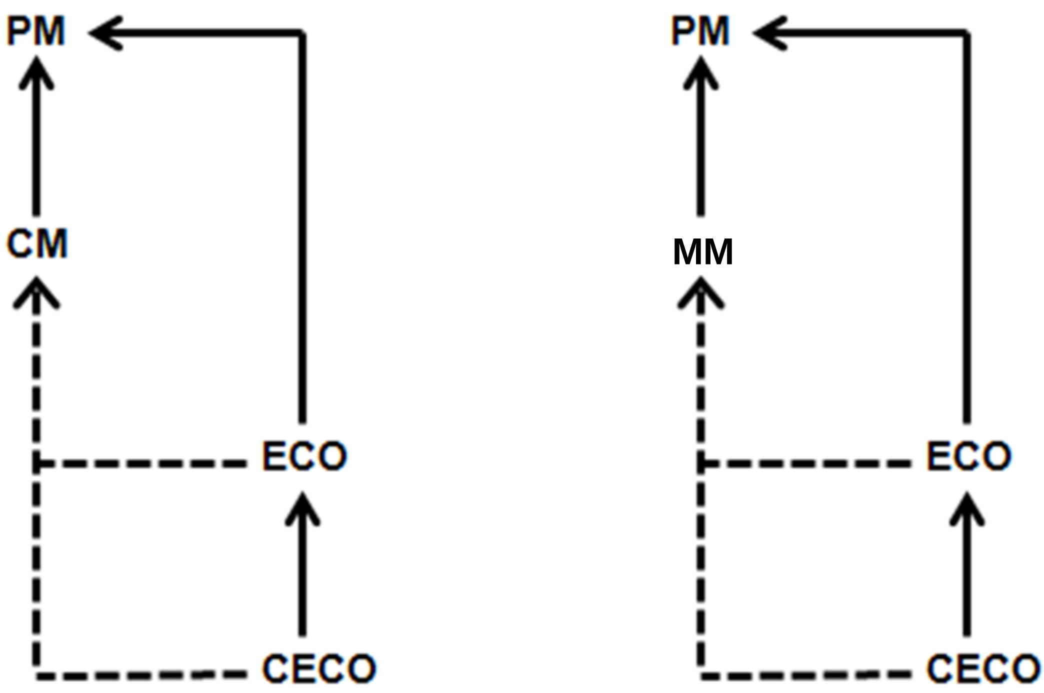

Figure 11.1 Environmental management reporting structure (A- Construction, B-Operation)

ECO:	Environmental Control Officer (appointed by the Client – an ECO occupies the same organisational level, but not the same position, as the SHE manager, who focuses on issues of Safety and Health).
CM:	Construction Manager
MM:	Mine Manager
CECO:	Contractor's Environmental Control Officer (appointed by any Contractors on site)
PM:	Project Manager or Project Director

It is of great importance that communication between the Project developer and members of the community will be maintained during the construction period. This provides a platform for members of the community to raise their concerns, fears and comments. The Client must appoint a dedicated person for this communication (e.g. “Public Liaison Officer”). The Client, through this appointed person, should respond to all questions and queries and records of all comments and queries must be logged and kept. These records should include names, dates and contact details, as well as the issue raised, and how the issue was resolved. The records must be made available at any time to environmental monitoring agencies.

The ESMP should become an item raised during construction team meetings, operation meetings and management review meetings. The Project manager must ensure that continuous reporting through monitoring takes place.

11.3 Monitoring plan

All aspects of environmental monitoring during the design, construction, operation and closure period are summarised in Table 11.2, 11.3 and 11.4.

In the event of non-compliance or exceeding set thresholds, corrective action by the responsible personnel is required immediately. The corrective action can include:

- Immediate implementation of the suggested mitigation measure.
- Review of the set mitigation measures and thresholds with ESIA consultant or relevant Botswana Authority.
- Inform DEA, Department of Mines, Department of Water Affairs or another relevant regulator.

All expected impacts and mitigation measures have been established based on designs, models and site data before the proposed Project can take place. It can therefore be expected that certain circumstances change during the implementation and development of the Project. A constant review of the set guidelines and measures is required to ensure that the EMP is developing alongside with any new developments on the Project.

Table 11.2: Pre-construction phase monitoring plan

Environmental Category	Impact	Parameter monitored	Location	Key performance indicator	Responsible agent for monitoring	Monitoring frequency	Monitoring method	Reporting mechanism	Threshold/ Standard	Recommended Action when threshold exceeded
BIODIVERSITY - FLORA	Loss of vegetation	Total site footprint earmarked for clearance (m^2)	Project designs and specifications at engineer's office	Designs allowing for minimum vegetation clearance (only where required)	Environmental Consultant	After completion of preliminary designs and once following final designs	Review of documents and plans	Once-off Pre-construction report compiled by the Environmental Consultant to the Client	Designs allowing for minimum vegetation clearance (only where required)	Engineering designs to be revised to incorporate recommendations from biodiversity study
GROUND AND SURFACE WATER	Pollution of ground and surface water quality	Inclusion of pollution control measures in the project designs	Project designs and specifications at engineer's office	Inclusion of storm water channels and runoff, catchment dams in the project designs	Environmental Consultant, PM	Once, after completion of designs	Review of designs	Once-off Pre-construction report compiled by the Environmental Consultant to the Client	No (suitable) water resources and contaminants management plan	Revise plant and mine designs to allow for (possible) contaminant control where required
GROUND AND SURFACE WATER	Over-exploitation of groundwater resources	Inclusion of monitoring boreholes in project designs	Project designs and specifications at engineer's office	Designs including establishment of monitoring boreholes	Water Consultant, PM	Once, after completion of designs	Review of designs and alignment with water management plan	Once-off Pre-construction report compiled by the Water Consultant or PM to the Client	Insufficient allowance for monitoring boreholes	Include ground water monitoring in project design scope, consider additional pump testing
TRAFFIC	Increased traffic volumes	Development of a traffic management plan for the project	Project designs and specifications at engineer's office	Availability of Traffic management plan for the project	PM	Once, after completion of designs	Review of designs	Once-off Pre-construction report compiled by the PM to the Client	Availability of Traffic management plan for the project	Develop a traffic Management Plan prior to construction
WASTE MANAGEMENT	Increased waste quantities	Development of a waste management plan for the project	Project designs and specifications at engineer's office	Availability of a waste management plan for the project	Environmental Consultant, PM	Once, after completion of designs	Review of designs	Once-off Pre-construction report compiled by the Environmental Consultant to the Client	No plans to minimise waste, recycle where possible	Review sourcing of materials and equipment, Develop a waste Management Plan
OCCUPATIONAL HEALTH AND SAFETY	Occupational Safety Risks	Development of a SHE management system	Project designs and specifications at engineer's office	Availability of a SHE management system	PM, Consultants	Once following development of the SHE management system	Review and approve plan	Once-off Pre-construction report compiled by the Environmental Consultant to the Client	Lack of SHE planning	Develop SHE management system prior to construction

Environmental Category	Impact	Parameter monitored	Location	Key performance indicator	Responsible agent for monitoring	Monitoring frequency	Monitoring method	Reporting mechanism	Threshold/ Standard	Recommended Action when threshold exceeded
OCCUPATIONAL HEALTH AND SAFETY	Risk of accidents and emergencies	Development of emergency procedures before the start of construction	Project designs and specifications at engineer's office	Availability of an emergency procedures before the start of construction	PM, Consultants	Once following development of the emergency procedures	Review and approve plan	Once-off Pre-construction report compiled by the Consultant or PM to the Client	Lack of emergency planning before the start of construction	Develop ERP procedures prior to construction
COMPLIANCE TO LEGAL AND REGULATORY REQUIREMENTS	Risk of constructing the mine without having obtained all relevant licensing	Compliance with Botswana Acts and guidelines by acquiring correct approvals and licensing	Engineer's office	ESIA clearance and acquisition of all planning approvals	Environmental Consultant, PM	Once, after completion of designs	Review of documents and plans	Once-off Pre-construction report compiled by the Environmental Consultant or PM to the Client	Missing approvals from relevant authorities	Halt or delay on commencement of Project until approvals have been acquired
SOCIAL	Disruption of current activities	Registration and resolution of complaints	Tshukudu Community Office	Registration and resolution of complaints	Environmental Consultant, Land Authorisation Authority	Once, after completion of designs	Review of documents and plans	Once-off pre-construction report compiled by the Environmental Consultant to the Client	Reports of complaints lodged without action or feedback	Establish a complaint register prior to construction
SOCIAL	Loss of land for the directly affected freehold farmers	Resolution of land related issues for Farms 153-NL, 110-NL, 111-NL and 112-NL	Tshukudu Head Office	Resolution of land related issues	Environmental Consultant, Land Authorisation Authority	Once, after completion of designs	Review of documents and plans	Once-off pre-construction report compiled by the Tshukudu Community Office to the Client	Land / footprint surface rights not secured	Resolve land issues and payment for affected areas

Table 11.3: Construction/operational phase monitoring plan

Environmental Category	Impact	Parameter monitored	Location	Key performance indicator	Responsible agent for monitoring	Monitoring frequency	Monitoring method	Reporting mechanism	Threshold/ Standard	Recommended action when threshold exceeded
BIODIVERSITY - FLORA	Loss of vegetation and disturbance of plant communities	Area of Vegetation cover	Construction/ operational areas of the mine	Clearance of vegetation only within demarcated areas, preservation of vegetation within the site footprint where applicable	ECO	Monthly	Estimation of area cleared of vegetating through visual observation of clearance zones	Monthly internal Environmental Monitoring Report to Client and incorporated into quarterly report to DEA	Clearance as per the project vegetation clearance plan and approved site vegetation disturbance permit (internal permit)	Rehabilitation of areas outside agreed clearance zones and cleared areas no longer required. Clear demarcation of work areas, induction of staff to minimise over clearing
	Loss of floristic diversity through invasion by alien taxa or encroachment by encroacher species	Establishment of invasive species/ increase in encroacher species densities	All affected areas within the mine footprint	Pre-development vegetation condition	ECO	Annually	Vegetation surveys along permanent transects. Survey of re-vegetation success	Incorporated in the monthly (only in month of monitoring) internal Environmental monitoring report to the Client and incorporated into quarterly report to DEA	No significant change in species diversity	Determine cause of establishment of alien taxa or encroacher species, and implement necessary mitigation
BIODIVERSITY - FAUNA	Displacement of territorial species because of mine fencing	All fauna and avifauna species density and movement	Construction/ operational areas within the mine footprint	No records of fauna and avifauna trapped within fenced site	ECO	Weekly	Visual inspection and recording any fauna and ani-fauna presence and sightings	In weekly tabulated internal summary to the EO and incorporated into the monthly internal Environmental monitoring report to the Client and incorporated into quarterly report to DEA	Record incidents of animals trapped within fenced site	Investigate cause of the change, and implement necessary mitigation

Environmental Category	Impact	Parameter monitored	Location	Key performance indicator	Responsible agent for monitoring	Monitoring frequency	Monitoring method	Reporting mechanism	Threshold/ Standard	Recommended action when threshold exceeded
BIODIVERSITY - FAUNA	Disturbance, alteration and destruction of faunal habitats	Presence of rewidening fauna (denning or nesting) species	Vegetation clearance zones (due to be removed) in construction/ operational areas of the mine site	No fauna deaths due to clearing, no impacts on young in breeding season	ECO	Monthly (as required for construction)	Visual inspection and recording of any dens or nests encountered	Monthly internal environmental monitoring report to the Client and incorporated into quarterly report to DEA	Adherence to fauna management plan	Determine the cause of fauna death or disturbance of young during vegetation clearance. Implement lessons learnt into induction of staff program
	Excavation posing a risk to fauna	Number of fauna causalities/injuries due to excavations	All excavated areas on mine site	No records of casualties due to excavations	ECO	Weekly	Visual inspection and keeping record fauna deaths (fauna death register) and trapped fauna	In weekly tabulated summary to the EO and incorporated into the internal monthly Environmental monitoring report to the Client and incorporated into quarterly report to DEA	Adherence to fauna management plan	Investigate the means fauna of access to excavated area. Correct through implementation of mitigation measures
	Risk of vehicle collisions with wildlife	Number of fauna and avifauna causalities/injuries due to collision with vehicle	All construction areas and material/ staff transportation routes	No records of casualties	ECO	Weekly	Fauna deaths register	In weekly tabulated summary to the EO and incorporated into the monthly Environmental monitoring report to the Client and DEA	Record casualties	Investigate cause of the change, and implement necessary mitigation

Environmental Category	Impact	Parameter monitored	Location	Key performance indicator	Responsible agent for monitoring	Monitoring frequency	Monitoring method	Reporting mechanism	Threshold/ Standard	Recommended action when threshold exceeded
BIODIVERSITY - FAUNA	Lighting causing disorientation to fauna	Light intensities outside of work areas (Lux)	Construction/ operational areas of the mine site	No light intensities outside of work areas (Lux)	ECO, PM	Annually	Light level measurement	Incorporated in the monthly (only in month of monitoring) internal Environmental monitoring report to the Client and incorporated into quarterly report DEA	Site lighting focused on the construction and mining areas only/use of directional and low-level lighting where safe to do so	Review installed lighting
	Disturbance of wildlife from blasting activities	Number of fauna and avifauna causalities due to blasting activities	Construction/ operational areas earmarked for blasting Activities	No records of casualties from blasting activities	ECO	Weekly	Fauna deaths register	In weekly tabulated summary to the EO and incorporated into the monthly internal Environmental monitoring report to the Client and incorporated into quarterly report to DEA	Adherence to fauna management plan	Investigate cause of the change, and implement necessary mitigation
	Human-wildlife conflict	Records of Human/wildli fe encounters and causalities	Construction/ operational areas of the mine site and access roads	No causalities from human/wildlife encounters	ECO	Weekly	Fauna deaths register	In weekly tabulated summary to the EO and incorporated into the monthly internal Environmental monitoring report to the Client and incorporated into quarterly report to DEA	Adhere to SHE and fauna management plan	Investigate cause of the change, and implement necessary mitigation

Environmental Category	Impact	Parameter monitored	Location	Key performance indicator	Responsible agent for monitoring	Monitoring frequency	Monitoring method	Reporting mechanism	Threshold/ Standard	Recommended action when threshold exceeded
BIODIVERSITY - FAUNA	Increased poaching and exploitation of wildlife	Incidences of poaching	All Construction/ operational areas and site engineer's office	No records of poaching	ECO	Weekly	Record any poaching activities, reported cases of poaching to relevant authorities	In weekly tabulated summary to the EO and incorporated into the monthly internal Environmental monitoring report to the Client and incorporated into quarterly report to DEA	NO incidences of poaching recorded	Investigate cause of the change, and implement necessary mitigation
BIODIVERSITY - AVIFAUNA	Risk of electrocution of vultures and collision with powerlines	Incidences of vulture causalities along the powerline	Along powerline servitude	No signs/records of casualties along the powerline	ECO	As required (when vulture casualties are observed)	Record any vulture causalities	Monthly internal environmental monitoring report to the Client and incorporated into quarterly report to DEA	No signs/records of casualties along the powerline	Investigate cause of the change, and implement necessary mitigation
AIR QUALITY	Decline in air quality	Environmental dust fallout	All mine site areas (where dust monitoring station are present)	Dust particulates within the BOS 498:2012 (ISO13.040.40) permissible levels	CECO, CM	Annually	Dust monitoring and lab analysis	Monthly internal environmental monitoring report to the Client and incorporated into quarterly report to DEA	Dust particulates within the BOS 498:2012 (ISO13.040.40) permissible levels	Dust suppression (watering) or change working methods during dry conditions

Environmental Category	Impact	Parameter monitored	Location	Key performance indicator	Responsible agent for monitoring	Monitoring frequency	Monitoring method	Reporting mechanism	Threshold/ Standard	Recommended action when threshold exceeded
	Decline in air quality	Gasses (including Sulphur dioxide, Carbon monoxide, Nitrogen dioxide and ozone), Total suspended particulates, Particulate matter (both 10µm and 2.5 µm)	Turnkey Optical Particle Analysis System (TOPAS) station on mine site	Gasses, total suspended particulate and PM_{10} and $PM_{2.5}$ levels within the BOS 498:2012 (ISO13.040.40) permissible levels	CECO, CM	Weekly	Data collection and analysis from the TOPAS system	In weekly tabulated summary to the EO and incorporated into the monthly internal Environmental monitoring report to the Client and incorporated into quarterly report to DEA	Air quality standards within the BO 498:2012 (ISO13.040.40) permissible levels	Identify source of air pollution resulting in quality decline and implement necessary mitigation measures
NOISE	Increased noise levels	Noise level (dB)	Construction/ operational areas and access roads in mine site	Noise levels below BOS: 575:2013 limits (70C (dBA)) (ISO11204:2010)	CECO, CM, ECO	Annually	Measurement of noise levels using a noise meter	Incorporated in the monthly (only in month of monitoring) internal Environmental monitoring report to the Client and incorporated into quarterly report DEA	Noise levels below BOS: 575:2013 limits (70C (dBA)) (ISO11204:2010)	Review sound damping options
			Near access roads to mine site	Noise levels below BOS: 575:2013 limits (70C (dBA)) (ISO11204:2010)	ECO, PM	Annually	Measurement of noise levels using a noise meter	Incorporated in the monthly (only in month of monitoring) internal Environmental monitoring report to the Client and incorporated into quarterly report DEA	Noise levels below BOS: 575:2013 limits (70C (dBA)) (ISO11204:2010)	Road maintenance and vehicle maintenance

Environmental Category	Impact	Parameter monitored	Location	Key performance indicator	Responsible agent for monitoring	Monitoring frequency	Monitoring method	Reporting mechanism	Threshold/ Standard	Recommended action when threshold exceeded
SOIL	Risk of soil erosion and loss of topsoil	Sign of erosion, sheet flow, presence of solids in stream water	All mine site (cleared) areas	No signs of erosion and re-vegetation of previously affected areas	ECO	After rainfall events	Visible inspection. Collection of stream water samples and lab analysis	Incorporated in the monthly (only in month of monitoring) internal Environmental monitoring report to the Client and incorporated into quarterly report DEA	Retention and management of topsoil, surface water management plan	Review erosion control measures developed, revegetation of potentially affected areas
	Risk of soil contamination	Presence of hydrocarbon s on soil	Construction/ operational areas, workshops	No presence of hydrocarbons on soil from the site	CECO, ECO	Weekly Visual inspection	Visual inspection and where required collection and testing of soil samples	Verbal report of oil spills to supervisor and SHE manager. Incorporated into monthly internal Environmental monitoring reports to the Client and incorporated into the quarterly report to DEA	No presence of hydrocarbons on soil from the site	Isolate and treat contaminated soil, repair source of contamination
GROUND WATER	Groundwater abstraction, groundwater drawdown and groundwater pollution	Abstraction volumes from boreholes	Water abstraction records from the site office	Water use within permissible limit (as per the abstraction rights)	EO, PM	Weekly & monthly	Manual flow meter readings	Reported as part of water monitoring program to the Client	Water abstraction within permissible limit (as per the allocated water rights)	Reduce volumes or operational hours for specific bores

Environmental Category	Impact	Parameter monitored	Location	Key performance indicator	Responsible agent for monitoring	Monitoring frequency	Monitoring method	Reporting mechanism	Threshold/ Standard	Recommended action when threshold exceeded
		Groundwater drawdown	All monitoring boreholes at mine site	Abiding by sampling protocols and submitting reports to appropriate authorities	EO, PM	Monthly	Manual dipping with piezometer	Reported as part of water monitoring program and water quality reports to the Client	No drawdown in monitoring boreholes and other nearby boreholes	Reduce volumes or operational hours for specific bores, update hydrogeological model
		Groundwater pollution - pH, hydrocarbon content, coliform bacteria, nitrates, heavy metals	All monitoring boreholes at mine site	Concentration of pollutants below threshold limits in the BOS 93:2012 (ISO 13.030.30 & 13.030.20)	EO, PM	Quarterly	Follow procedures in water monitoring program	Reports, tables and graphs in quarterly and annual water quality monitoring reports to the Client and incorporated into quarterly report to DEA	Concentration of pollutants below threshold limits in the BOS 93:2012 (ISO 13.030.30 & 13.030.20)	Investigate contamination cause, mitigate and manage, provision of an alternative water source
LANDSCAPE AND VISUAL AMENITY	Degraded visual amenity	Shape of dumps, revegetation of areas as recommended (refer to Landscape and Visual assessment specialist report – Appendix H)	Waste dumps areas on mine site	Height and shape comply with recommendations of Landscape and Visual assessment specialist report, revegetation of areas (where required)	ECO, PM	Annually	Visual inspection	Incorporated in the monthly (only in month of monitoring) internal Environmental monitoring report to the Client and incorporated into quarterly report DEA	Height and shape comply with recommendations of Landscape and Visual assessment specialist report, revegetation of areas (where required)	Improve design and prepare waste handling options

Environmental Category	Impact	Parameter monitored	Location	Key performance indicator	Responsible agent for monitoring	Monitoring frequency	Monitoring method	Reporting mechanism	Threshold/ Standard	Recommended action when threshold exceeded
WASTE MANAGEMENT	Waste management	Management of waste as per the Waste Management Act of Botswana	All mine site areas	Management of waste as per the Waste Management Act of Botswana	CECO, CM, ECO	Monthly	Visual inspection	Monthly internal environmental monitoring report to the Client and incorporated into quarterly report to DEA	Management of waste as per the Waste Management Act of Botswana	Waste Management Plan developed before construction
TRAFFIC	Traffic delays and deteriorating road condition on A3 road Risk of road traffic accident	Traffic volumes and road condition	A3 road on section from Ghanzi to T3 turn	Level of Service (see traffic specialist report - Appendix J)	EO, PM	Annually	Traffic count (by Roads Department)	Incorporated in the monthly (only in month of monitoring) internal Environmental monitoring report to the Client and incorporated into quarterly report DEA	Lower Level of Service	Identifying road maintenance with Roads Department, road improvements such as turning lanes by Roads Department
		Number of traffic incidents	Construction/ operational areas, access road, material haulage routes (main road from Ghanzi to Maun)	Traffic incidents and accidents	HSO, EO, PM	Monthly	Visual inspection of signage conditions at junction, review of safety statistics	In monthly internal environmental reports to the Client	Signage damaged or removed, recorded accidents	Replacement of signage, enforcement of all road rules and included in site induction
SOCIO-ECONOMIC	Creation of employment	Number (percentage) of local employees	Human Resource office	Engagement of local employees	EO, PM	Quarterly	Inspection of staff records	In monthly site report to the Client	Recruitment from local communities	Change hiring policy if required
	Community relations and social disruption	Level of engagement of local communities	Community Liaison office	Undertaking of community meetings and keeping of complaints records	EO, PM	Quarterly	Inspection of community engagement records	In monthly HR report to the Client	Undertaking of community meetings and keeping of complaints records	Review and revise communication and complaints procedures

Environmental Category	Impact	Parameter monitored	Location	Key performance indicator	Responsible agent for monitoring	Monitoring frequency	Monitoring method	Reporting mechanism	Threshold/ Standard	Recommended action when threshold exceeded
SOCIO-ECONOMIC	Conflict or competition between jobs/opportunity seekers and the locals due to marginalisation of minority group	Public opinion	Surrounding communities	Good relationship between the community members, and the project	ECO	Bi-Annually (2 times per year)	Review of feedback from public meetings	Incorporated in the monthly (only in month of monitoring) internal Environmental monitoring report to the Client and incorporated into quarterly report DEA	Good relationship between the community members, and the project	Organisation of public meetings, review of recruitment process
PUBLIC SAFETY	Risk of injury or death to members of the public	Number of safety incidents affecting the public	All project areas	No incidents and accident records	HSO, EO, PM	Monthly	Visual inspection and records	In monthly internal safety reports to the Client and incorporated into quarterly report to DEA	No incidents and accident records	Change security and safety measures implemented, No public access into the mine site, review transport management and SHE plan
ARCHAEOLOGY	Risk of destruction and loss of archaeological artefacts and cultural heritage sites	Archaeological artefacts discovery and losses	All clearance areas	Induction of construction staff on clearance works, implementation of chance find procedure	ECO	During site clearance works (daily)	Visual inspection (by qualified person if required)	In monthly internal Environmental monitoring reports to the client and when required a report to DNMM	Knowledge about archaeology by project staff, inductions, protection of sites, chance find procedure to be utilised	Engagement of qualified archaeologist, to train site staff. Review chance find procedure

Table 11.4: Decommissioning phase monitoring plan

Environmental Category	Impact	Parameter monitored	Location	Key performance indicator	Responsible agent for monitoring	Monitoring frequency	Monitoring method	Reporting method	Threshold/ Standard	Mitigation when threshold exceeded
BIODIVERSITY - FLORA	Loss of vegetation	Vegetation coverage after rehabilitation	Complete site	Revegetation of affected areas	Department of Mines, DEA	Every second year (10 year period)	Visual inspection	Closure update to DoM	Site revegetated to acceptable standard (as per the rehabilitation plan)	Planting, erosion mitigation
LANDSCAPE AND VISUAL AMENITY	Change of topography	Shape of waste dumps	Complete site	Contours and elevations complying with the recommendation of the closure plan	Department of Mines, DEA	Every second year (10 year period)	Visual inspection, topographic survey	Closure update to DoM	No action	Re-shaping of contours as per closure plan
SOCIO-ECONOMIC	Loss of employment, loss of community cohesion and structures, labour migration	Statistics of unemployment in the study area after mine closure	Construction/ operational areas	Re-engagement of locals as per the mine closure plan	HR, PM	Annually pre and post closure until relinquishment	Review of statistics and employment records	Closure update	Re-engagement of locals as per the mine closure plan	Prepare transition to closure program
REHABILITATION	Risk of unacceptable condition of site after closure	Presence of closure and rehabilitation plans	All project areas	Condition of the site comply with the rehabilitation programme	EO, MM, Department of Environmental Affairs, Department of Mines	Annually pre and post closure until relinquishment	Review of proposed process	Rehabilitation report	Acceptable condition of site after closure	Ensure funding provision for closure and integration closure planning and implementation

At the start of mining, a full comprehensive and site-specific rehabilitation, re-vegetation, and closure plan will be developed and submitted to relevant authorities. It is of crucial importance that this closure plan also includes an updated monitoring plan for environmental monitoring during site closure. A financial provision for the closure and decommissioning costs must be made throughout the operational phase of the project, and Tshukudu Metals, together with the Department of Mines must regularly review this provision in relation to sufficiency.

11.4 Environmental audit

The monitoring plan presented in this Section is designed for monitoring and regulation of environmental impacts of the project by the on-site HSEC team and appointed consultants. The management structure at the proposed Mine must ensure that those appointed have the means and authority to fully implement the mitigation measures and rectify any issues that arise.

In addition to the appointed qualified (internal) personnel monitoring for compliance, Tshukudu Metals is required to have an annual audit carried out by an independent environmental auditor/consultant. During the environmental audit, the following general items must be included in the investigation:

- Review of the implementation of ESMP and monitoring plans on site
- Review of responsible personnel on site
- Review of any developments and changes required to the ESMP
- Discussion of any problems encountered during the implementation of the ESMP
- A comparison of the impacts expected during the ESIA phase vs. the impacts experienced during the project implementation
- Review of environmental record keeping on site.

A full environmental audit checklist must be developed and agreed upon between the independent environmental auditing company and Tshukudu Metals. Both Tshukudu Metals and the environmental auditing company must keep records of the audit reports for a period of at least 5 years.

It can also be anticipated that the Department of Environmental Affairs and/or Department of Labour will carry out an audit of the project at any time(s) during construction and operation, to check implementation of the ESMP and ensure that all mitigation measures are adhered to. The DEA also reserve the right to check participation of all monitoring authorities listed in the management plan.

11.5 Policy, organisation and training

It should be a requirement that all staff as well as management staff of subcontractors on site (construction or otherwise), are familiar with the content of the ESMP and monitoring plan. The site manager should ensure that any contractor commissioned to carry out activities on site, has an Environmental Policy, which their suppliers, subcontractors and agents and are covered by and follow vigilantly.

Appointed personnel must have authority and management support to rectify any problems occurring on site. It is important that responsibilities concerning environmental management and monitoring are clear to everyone involved.

During regular on-site training of all personnel employed on the site, environmental awareness should be a re-occurring topic. By ensuring awareness and responsibility of environmental issues at all levels of the organisation, successful implementation will be accomplished.

12 Closure and decommissioning programme

This Chapter provides information for the closure process for the proposed T3 Copper Mine. This information has been prepared and compiled based on the guidelines for mine closure prescribed by the World Bank and the International Finance Corporation. It is not a comprehensive "Closure Plan", a detailed conceptual mine closure plan has been attached to this as Appendix N. However, advice and guidance on decommissioning process and strategy is provided herein.

The impacts (both social and environmental) that are associated with the mining sector have acquired a negative connotation; this can be attributed, in part, to the absence (over time) of comprehensive mining closure and decommissioning plans and arrangements. The lack of adequate reclamation and rehabilitation by mining companies of areas that have been mined leads to the responsibilities and adverse effects of mining being shifted to the shoulders of other stakeholders or Interested and Affected Parties (IAPs). This may include governments and the public. The presence of an appropriate plan for closure and decommissioning commits the developers of mining projects to performing activities that are aimed at reducing or removing altogether the residual impacts that may be felt following the implementation of mitigation measures during the operational phase of a mining development.

Decommissioning activities provide the Tshukudu Metals with the opportunity to rehabilitate the area mined to a state that is as close to the pre-mined state as is possible, or acceptable to the relevant stakeholders. Formulation of a comprehensive closure and decommissioning plan should ideally take place early in the design phase of a mining development. This allows for ample preparation to ensure that the objectives of the decommissioning activities can be fulfilled. Early commencement of planning for decommissioning allows for sufficient budget provision as well as allocation of responsibilities and adequate notification of responsible parties. Decommissioning and rehabilitation planning should be proactive as opposed to reactive, and this has cost implications. The overriding aims of this proposed closure guidance are to ensure that the decommissioned mine site meets socially and environmentally acceptable standards, and that the site may be utilised for continued productivity, whether that be ecological, tourism based, economic, recreational (for example a pit lake for leisure purposes) etc., in the future. However, it is imperative that a fully detailed, final closure plan be developed at the time of decommissioning to reflect the changes to the original design and operational strategy that may have occurred over the life of the mine.

The Botswana legislation requires for the Director of Mines to be notified of the intention to discontinue mining operations, not less than three months prior to cessation or termination.

Requirements and activities relating to closure/cessation must be undertaken according to the Mines, Quarries, Works and Machinery Act and Regulations (Act No. 20 of 1973 (as amended)) and the Mines and Minerals Act (Act No. 17 of 1999). This includes fencing and earth berm requirements and any other requirements outlined by the Director after notification of the proposed closure.

12.1 Goals to be included within the final closure plan

Closure Plans for mines have become an important component of the planning and design phases of mining development. The reasons for this are evidenced in the comparison between sites which have been decommissioned following a closure and rehabilitation plan, and those that have been closed without the interjection of such a plan. This Closure Guidance has been prepared to assist the Client in fulfilling the following general rehabilitation requirements and aims, each of which will be elaborated on within this section:

- Defining the acceptable or goal state of the site
- Revegetation
- Treatment of contaminated soils
- Dismantling of buildings and surface structures
- Rehabilitating open pit works areas
- Safety and security
- Restoration of dewatering ponds
- Stabilisation of waste rock piles and tailings dams
- Management of mining effluents
- Removal of sanitary installations
- Rehabilitation of petroleum product storage sites
- Appropriate management and disposal of hazardous wastes
- Appropriate management and disposal of solid waste
- Dealing with closure social impacts.

12.1.1 Defining the acceptable state of the site

The aim of rehabilitation is to restore the area affected by the mine to a satisfactory state. A significant component of this is identifying and defining the characteristics of the goal or acceptable state of the site. The satisfactory state of a site is dependent on the specific nature of the site, including the type of mining activities that were undertaken during the operational phase of the mine project. To be considered acceptable, the site will be required to meet a few criteria, including those pertaining to the natural and socio-economic environment.

12.1.2 Revegetation

All areas affected by the mine (where practicable, not including pit, roads, powerline) and related infrastructure must be re-vegetated to a state that is as close to the naturally occurring vegetation as is possible.

12.1.3 Treatment of contaminated soils

Any soils that are contaminated must be removed from the site and treated accordingly. The lost soil must then be replaced appropriately.

12.1.4 Dismantling of buildings and surface structures

If continued use of any of the surface structures introduced to the area by the advent of the mine is not foreseen; all infrastructure must be dismantled and disposed of appropriately. The removal of infrastructure should be completed with the socio-economic environment of the area in mind, to avoid the removal of any infrastructure that may have continued usefulness (e.g. roads).

12.1.5 Rehabilitating pit

The rehabilitation of mine pit (including borrow pits etc.) is essential to ensure that the general shape of the landscape is restored. Pits also pose a health and safety risk if they are not dealt with accordingly upon closure.

As the pit for the T3 Mining Project is located in a farming area, it is recommended that liaison with the farmers in relation to rehabilitation of the pit will commence years prior to closure. During this liaison the Client and relevant stakeholders must agree on the shape of the pit, fencing, earth berms and access in relation to possible use by farmers and nearby communities. Backfilling of the pit is not economically feasible and will not be undertaken.

12.1.6 Safety and security

This relates to many other aspects to be rehabilitated following mine closure. All unsafe features of the site must be restored to a state that is safe and secure for the general public. This may involve addressing a range of impacts brought about by the mine, for example, remediating soil or water contamination and backfilling excavations. Security fences must be provided if any areas of the site are considered unsafe; appropriate signage and contact numbers must be provided.

12.1.7 Restoration of dewatering ponds

Mine dewatering ponds must be completely restored except in cases where the Client can prove that such ponds provide some sort of positive environmental affect and no adverse public health and safety impacts.

12.1.8 Stabilisation of waste (rock) piles and tailings dams

It is essential that waste rock piles be stabilised to avoid erosion and collapse, which can lead to a number of other problems, while simultaneously threatening health and safety. Aesthetics must also be considered when rehabilitating waste rock piles. The same factors hold true for tailings dams. Acid Mine Drainage could arise because of poor rehabilitation and management of waste rock piles. This is caused by chemical reactions that occur within the waste rock piles, the soluble resultant substances are then leached or drained when they come into contact with water, and are then distributed.

12.1.9 Management of mining effluents

Mining effluents typically have the potential to contain contaminants that can diminish water quality, and poison biota. They can also act as a detriment to the environment by means of impeding ecosystem function.

12.1.10 Removal of sanitary installations

All types of sanitary installations must be removed or emptied and backfilled.

12.1.11 Rehabilitation of hydrocarbon storage sites

This includes storage structures for substances such as lubricants, diesel, gasoline and fossil fuels. All structures used for the purpose of storing petroleum products are to be decommissioned appropriately by qualified and experienced personnel. All contaminated sites must be appropriately remediated according to Government Regulations and international best practice standards that apply.

12.1.12 Appropriate management and disposal of hazardous wastes

All hazardous wastes are to be disposed of in an environmentally and socially appropriate manner. As of yet, there are no appropriate facilities for the disposal of hazardous wastes within Botswana, thus the correct and lawful procedures must be adhered to for the export of hazardous wastes to suitable waste facilities elsewhere.

12.1.13 Appropriate management and disposal of solid waste

Upon closure, all solid wastes must be removed and disposed of in an acceptable fashion to licensed landfills. The removal of solid waste produced by mining and associated activities must be managed timeously and efficiently.

12.2 Objectives of the closure plan

Tshukudu Metals have developed a conceptual closure plan in accordance with legislative requirements under the various acts in Botswana. The closure goals are defined in Chapter 5 of the closure plan (Appendix N) and encapsulate the list mentioned above.

The closure vision has been summarised as:

- To leave behind an enduring and positive legacy after mining where closure planning has been adequately resourced and integrated ensuring effective transition to the final agreed land use (Rescology, 2017).

The closure goals for the T3 Project will involve decommissioning and rehabilitation of areas disturbed by mining leading to a site that is:

- Safe for people and wildlife (risk to people, animals and livestock is acceptable to all stakeholders)
- Stable (rates of change for geochemical, geotechnical and geomorphic [erosion and deposition] processes are acceptable)
- Non-polluting (long-term performance meets Tshukudu's commitments to protect environmental values)
- Able to sustain the agreed post mining land use
- Socially acceptable
- Adequately provisioned with financial resources for closure
- Possible to relinquish back to the state or landowner/s after mining (Rescology, 2017).

Site-specific objectives have been proposed and will be further developed in the closure planning phase (Table 12.1). These objectives provide a basis for development of early completion criteria.

Table 12.1: Conceptual closure objectives (Source: Rescology, 2017)

Factor (goal from which the objectives are derived)	Rehabilitation objectives
Safe for people and wildlife (risk to people, animals and livestock is acceptable to all stakeholders)	The post mining landscape will be safe to humans, wildlife and livestock: ■ Safe and secure for short term (0 to 100 years) ■ Safe for the long term (100 to 100 years). Any boreholes, costeans, ventilation shafts or similar below ground excavations should be made safe, filled or sealed as necessary to support final land use.
Stable (rates of change for geochemical, geotechnical and geomorphic (erosion and deposition) processes are acceptable)	Landform stability: ■ Geochemical stability will be managed and monitored ■ Geotechnical stability will be maintained ■ Erosion stability will be achieved.
Non-polluting (long-term performance meets Tshukudu Metals commitments to protect environmental values); and able to sustain the agreed post mining land use	Manage surface and groundwater whereby environmental values and ecosystems downstream in the short term (0 to 100 years) and in the long term (100 to 1,000 years).
Sustainable land use	Land will sustain suitable vegetation for the post mining land use.
	Infrastructure will be removed unless identified for retention by stakeholders (transfer of ownership agreements).
	Manage soil quality to meet post mining land use.
Socially acceptable	The agreed final land use will be based upon the view of stakeholders and their expectations in the knowledge that these may change.
	Minimisation of the social, environmental and economic liabilities whilst instilling benefits beyond closure (ICMM[10], 2008).
	Establish a closure planning group (CPG) in the years preceding mine closure to ensure timely preparation and awareness of the community for mine closure, to maintain transparency and full disclosure.
Adequately provisioned with financial resources for closure	Financial provision and closure planning will: ■ Ensure that closure planning is orderly, cost effective and timely, that costs are adequately represented in company accounts and the community is not left with any closure

[10] International Council of Mining and Metals

Factor (goal from which the objectives are derived)	Rehabilitation objectives
	liability (ICMM, 2008). ■ Allow for ownership of the closure costs at the Project and site level both technically and financially whilst factoring in expenditure into annual operating activities to optimise accountability and accuracy of estimates (ICMM, 2008); and ■ Allow the future operation to accrue the funds for successful closure (ICMM, 2008).
Possible to relinquish back to the state or landowner/s after mining	Commitments, agreements and obligations will: ■ Be clear, measurable, with auditable conditions agreed to by regulatory authorities that allow relinquishment of obligations to be planned for and achieved (ICMM, 2008); and ■ Reduce the need for long-term monitoring and maintenance by establishing effective physical and chemical stability of disturbed areas.

12.3 Policy, legal and regulatory framework

The principal pieces of legislation that influence mine closure, rehabilitation, care and maintenance are discussed below (Rescology, 2017).

12.3.1 Environmental Assessment Act (2010)

The requirement for a decommissioning program and a rehabilitation or restoration plan is mentioned in requirements for an Environmental Management Plan in Form B (regulation 5) and in the requirements for an Environmental Impact Statement in Form E (regulation 8). The terms restoration and rehabilitation are also defined under EA Act and these have been included in the glossary of the conceptual mine closure report (Appendix N) (rescology, 2017).

12.3.2 Mines and Minerals Act (1999)

The Mines and Minerals Act refers to a requirement to rehabilitate reclaim or restore land to the condition it was in prior to mining (s 65 (3)) where failure to do so could lead to a debt to government equivalent to the costs of the undertaking. This debt is recoverable in a court of law on the proviso that the cost of restoration of any part as determined by an arbitrator as not to have been necessary. The Mines and Minerals Act uses the term restoration, which implies more rigor than rehabilitation. Surrender of tenure and relinquishment of land requires compliance with any reasonable requirement by the Director of Mines or the Director of Geological Survey as to the rehabilitation and reclamation of the area. Closure involving cessation of operations including care and maintenance requires disclosure to the DoM of a full list of assets to be moved or retained including notification of any hazardous materials, excavation and infrastructure in the license area. On this basis, Tshukudu Metals will be authorised to remove or leave assets and liabilities in the area, this may include compensation to proponent for retention of assets for the purposes of future mining. Any water dam or impounded waters must be left intact after mining (S77 (3, 4 and 5)). Additional regulation may be imposed under the act concerning protection of the environment or for utilisation of natural resources by mining (Part XII of the Regulations) It is an offence under the act to fail to decommission and demolish a site as per the agreement with the DoM, to cause unlawful environmental damage or fail to rehabilitate an area (Part XIII, s82 i and l).

12.3.3 Mines Quarries Works and Machinery (1973)

This Act provides for the safety, health and welfare of persons engaged in prospecting, mining and quarrying operations including any works, which are ancillary to operations. It makes provision for inspection and regulation of mines, quarries, works and machinery and for matters that are incidental by association (Government of Botswana, 1973). The Act is broadly applicable to mine closure although specific obligations are in the regulations.

The regulations (s11 (1)) affecting mine closure may influence safety aspects of infrastructure being retained on the site including landform design and water resources, with mention for protection of the environment, safety regarding the disposal of waste with explicit reference to cessation of mining under clause (k). Copies of surveys, plans and sections for mines, quarries and works are required.

12.3.4 Agricultural Resources Conservation Act (1974)

This Act makes provision for the conservation and improvement of the agricultural resources of Botswana. The Act defines agriculture resources in Section 2 of the Act as soils, water, animal life and fauna (animals, birds, reptiles, fish and insects) and other things to be declared as agriculture resources by regulations. By this definition, the Act covers a wide range of environmental issues, which are relevant to financial provision.

Sections 16 and 18 of the Act explicitly provides for the protection of the physical environment including the protection of slopes, protection of land against erosion, preservation of vegetation, prevention of silting of dams, preservation of the soil and its fertility and the drainage of land (construction, maintenance, or repair of artificial or natural drains, gullies, contour banks). All Tshukudu Metals construction and operations activities within the T3 Project Area must be in line with this act such that environmental degradation of the area is minimised, if not avoided.

12.3.5 Tshukudu Metals Environmental Policy

The Tshukudu Metals policy (included in Appendix N) advocates for sound environmental performance being integral to an efficient and successful exploration company.

Commitments of the policy relevant to mine closure include:

- Continual improvement and alignment with community values and expectations
- Minimise the disturbance footprint and pursue active rehabilitation to restore areas affected by activities
- Set measurable objectives and targets for the management of environment aspects. Ensuring these are adequately resourced, monitored and reviewed.
- Comply with applicable legal and other requirements as a minimum standard (Rescology, 2017).

12.4 Rehabilitation plan

Rehabilitation management is an on-going process. Tshukudu Metals intends to progressively rehabilitate the site, although this is limited to some extent by the nature of mining. The mine closure risks at PFS level have been assessed and summarised in Table 17.1 of the closure plan (Appendix N). On this basis conceptual management strategies have been provided with commitments to mitigate risk to environment and community by mine closure.

Following the cessation of the mining activities, the mine area will undergo rehabilitation. The proposed programmes address the environmental factors impacted by mining. The potential social impacts by mine closure are acknowledged and Tshukudu intend to conduct further work to enable effective transition of the work force to mine closure. Decommissioning of the mine will involve the activities as outline in the following sections.

12.4.1 Site preparation

Prior to the commencement of any demolition activities, the following tasks will be completed:

- All sumps will be dewatered
- All items will be decommissioned, de-oiled, depressurised and isolated
- All power and water services will be certified safe for demolition
- All hydrocarbon tanks, pipes and sumps will be emptied prior to removal
- All hazardous material will be removed and transported to an appropriately licensed facility.

12.4.2 Site infrastructure and services

All surface infrastructure will be removed or demolished unless there is a requirement by a future landholder to acquire these. Opportunities for sale and re-use will be optimised where feasible.

Concrete footings and slabs will be broken up and removed. Non-contaminated material will be disposed of at a licensed landfill.

All pipes and structures deeper than 400mm below ground level will be sealed to prevent possible ingress and ponding of water.

Telecommunication infrastructure will be dismantled unless required by the new landowner.

12.4.3 Contamination

The Client will commission contaminated sites investigations necessary to mitigate risk to the environment and community. Following completion of the assessments, remediation plans will be developed and implemented.

In advance of mine closure, a preliminary site investigation will be done to identify sources of contamination including phase 1 sampling analysis of the key infrastructure areas.

Where possible, all sources of contamination will be remediated in the operational phase.

12.4.4 Groundwater management

It is anticipated that there may a geochemical contaminant plume because of mining activity and that this will be contained within the Project development envelope, within the lease boundary area and approximately 500m to 1km beyond the pit perimeter (WBS, 2017).

Further work in relation to pit lake limnology will inform the groundwater management strategy for closure.

12.4.5 Stormwater management

During the closure planning phase, surface water management infrastructure needed for closure will be identified. U drains will be developed in a way that materials removed during construction will be retained adjacent to the structures enabling ease of backfill for closure. Bunds not required will be flattened by redistribution of materials across the footprint used to borrow the material for construction.

12.4.6 Fuel storage areas

Closure of the fuel and storage area requires key consideration for contracts with fuel suppliers and farm in arrangements. Agreements regarding who assumes responsibility for contaminated site clean-up and remediation is required.

Closure of the facilities will include:

- Removal of remaining fuel supplies
- Decontamination of equipment including tanks, piping and dispensing equipment as required
- Removal of equipment
- Demolishing buildings and tanks where required
- Removing piping and electricals
- Removal of walls and concrete slabs
- Disposal of non-hazardous material at a licensed and appropriate landfill
- Sampling soils beneath and surrounding the facility
- Remediation of soils as required including removal and treatment on site or disposal in a licensed facility
- Recontouring of the footprint to integrate the area back into the surrounding environment.

12.4.7 Fencing

Areas to remain fenced after closure will be identified in relation to final land use. Fences will be kept to a minimum or completely removed depending on the associated risks and cost implications of maintaining fences after mining.

12.4.8 Vegetation

Successful revegetation is critical to returning land to its former or agreed final use and to ensuring stable and functioning ecosystems prevail after mining. Further work towards rehabilitation planning and implementation will take place in the detailed closure planning phase. Revegetation strategy is likely to focus on reinstatement of agricultural land and natural ecosystems.

12.4.9 Waste management

A waste management plan forms part of the environmental management plan developed during the ESIA. The detailed closure planning will contribute as necessary to aspects of this in future.

Preliminary closure commitments include:

- Hazardous waste will be removed off site and disposed of in a registered facility
- Scrap metal, structural steel and hydrocarbon free mechanical equipment will be stored in the scrap yard which will be rehabilitated when all materials have been removed
- The mine putrescible landfill facility will be covered with suitable waste rock materials and revegetated
- All exploration drill pads will be free of exploration drill bags and where necessary drill collars rehabilitated.

12.4.10 Open pit

Specific requirements in relation to the open pit rehabilitation and closure include:

- Prior to the sand stripping commencing, the top and subsoils of the area will be salvaged
- Restrict vegetation clearance to only that required around the pit and dumps. Rehabilitate temporarily impacted areas immediately (such as dewatering infrastructure)
- Ensure the storm water drainage system prevents stormwater from accessing the open pit
- Due to the cost associated with the backfilling of the entire open pit, the post closure landform will allow for the pit to remain open. It also has to be noted that it is considered standard industry practice for open pits of this nature to remain open post closure.
- The area will remain fenced to further limit access to the pit itself. In addition to the fence and in keeping with industry standard, an abandonment bund will be built to industry specifications (Rescology 2017)
- Benches will be shaped to manage drainage (subject to detailed geotechnical studies)

- All equipment must be removed from the pit, but water management structures are recommended to remain in place

12.4.11 Dumps (waste and sand)

Specific requirements in relation to the dumps rehabilitation and closure include:

- Prior to the preparation of the dumping areas, the top and subsoils will be salvaged
- Top and subsoil piles must be kept separately from rock dumps throughout the life of mine, to ensure the soils are available for rehabilitation works at closure
- The soil piles must be managed throughout the life of mine by:
  - Ensuring minimal handling and transport of soils
  - Restricted access to topsoil areas by mining to avoid compaction, soil loss and minimise weed prevalence
  - Ensuring topsoil stockpiles height optimise topsoil viability
  - Cover piles with woody debris to prevent erosion and encourage revegetation
  - Implement planting of small (indigenous) shrubs on dumps to maintain viability and further minimise erosion
- Waste rock dumps will continue to “grow” as mining continues, but slopes are areas reaching their anticipated final shape and size should be rehabilitated during operation where practical, by installation of the outer cover based upon engineering designs (outer cover including vegetation).
- If any tyres are used in the waste dump toes during the construction for stability, these must be removed prior to rehabilitation, and disposed as per the recommendations from the waste management plan
- Storm water drainage channels must remain in place to minimise erosion

12.4.12 Tailings facilities

Specific requirements in relation to the tailings facilities rehabilitation and closure must include:

- Prior to the preparation and compaction of the tailings facility base, the top and subsoils will be salvaged
- At closure, a tailings cover is planned. The cover will comprise of a blend competent rock and topsoil the proportions of which will be determined by the materials characterization and erosion modeling, trials and investigations. Thickness of the cover at this stage is planned for 0.5m
- Dumps must be fenced off to prevent livestock denuding them of vegetation (during rehabilitation)

12.4.13 Processing plant

As with the other impacted areas, prior to the construction top and subsoils of the processing plant will be salvaged.

- The plant will be completely dismantled, and the concrete foundations removed and disposed of in a similar manner to any other building rubble
- Soils used on ramps for crushers will be flattened, contoured and topped with topsoil and allowed to vegetate naturally

12.4.14 Site offices and accommodation camps

As with the other impacted areas, prior to the construction top and subsoils will be salvaged.

- Site offices will be dismantled, and the foundations removed and disposed of in a similar manner to any other building rubble (for all infrastructure not transferred to new ownership at closure).

12.4.15 Social

The closure of the Project is expected to have significant social impacts, mainly related to the employment loss at closure. However, the closure of the mine will also have an impact on local business and support services and may result in migration of people to other areas for work. Recommendations to address this include:

- Consider establishing pension plans for employees from start of employment
- Support re-skilling and re-employment before mine closure.

It is further recommended that the Client reviews (in liaison with relevant authorities) the strategies in relation to social services, health, social pathologies, migration etc., and hand over relevant materials to relevant authorities.

12.4.16 Monitoring and maintenance plan

All guidelines will be correctly followed, and maintenance will be limited to the periodic checking of boundary fences to ensure that fenced off properties are secure and not being utilised for other purposes to ensure that safety is maintained. Entry to the site will be strictly monitored and kept to a minimum to prevent heavy traffic over recuperating re-vegetated areas. Due to the concept of design for closure, the main long-term impacts will be the open pit and the presence of dumps, affecting the aesthetics of the area. Water chemistry monitoring will be necessary around the tailings dams, and at the pit lake, and Botswana Bureau of Standards applicable standards are recommended to be the basis of the monitoring. Access will also need to be monitored to ensure that the open pits are fully secured at all times for the safety of people and animals.

The post closure period is usually ten years, however it is expected that this will be less than ten years before the mine site and dumps are fully vegetated and ecology restored at the proposed Mine site. A monitoring committee will be set up to monitor the effectiveness of the rehabilitation programme. The following organisations will be approached and invited to join Tshukudu Metals on this committee:

- Department of Mines
- Department of Water Affair
- Department of Environmental Affairs
- Local planning and land management authorities.

The Closure Committee should maintain meetings at least once every six months for two years after mine closure to monitor the re-vegetation process and levels of erosion and water chemistry. The committee shall be dissolved once the closure certificate has been awarded.

A conceptual closure monitoring program is provided in Table 19.1 of the Closure report (Appendix N), providing indicators and draft completion criteria (in Table 16.1 of Appendix N).

12.4.17 Scheduling

Progressive mine site rehabilitation as espoused by the concept of “design for closure” entails extensive planning and careful scheduling to optimise the process and minimise the costs such that there is minimal double handling of material. The objective is to achieve a stable and safe landscape with minimum material movement and therefore minimum costs. The following basic stages are envisaged to be completed sequentially towards mine closure:

- Stage 1 activities are final preparations at pre-closure, envisaged to take place at minimum two years before cessation of mining operations. A detailed closure plan will be developed during the FS stage of the project. The closure plan is regularly updated, every 3 years and risk logs evaluated each time. It is Tshukudu Metal’s intention to consult with government and stakeholders with each revision to ensure progress closure progress commensurate with improved knowledge and the expectation of stakeholders.and reviewed throughout the LOM.

  The final version and preparation will include activities to achieve successful rehabilitation. This will be documented, and success criteria agreed upon by a suitably qualified and capable consultant team, interested and concerned regulators, and stakeholders.

- Stage 2 activities involve commencement of closure activities and these are:
  - Plant site decommissioning and dismantling
  - Material and equipment removal and salvage
  - Concrete slab fracturing/ removal of foundations
  - Debris disposal
  - Removal of contaminated soil (it is recommended that contaminated materials should be progressively bioremediated in a locally owned and operated facility as part of the waste dump)

- Stage 3 involves restoration of the landscape and ecology as far as possible as per Section 65 of the Botswana Mines and Minerals Act and ensuring that the mine site is fully secured from access by unauthorised personnel and animals. The activities include:

  - Levelling and top soil dressing of all areas under which surface facilities were erected/built
  - Installation of outer covers on dumps
  - Protection and signage of the pit site and slimes dam site
  - Post closure monitoring.
- During stages 2 and 3, the Closure Committee will be monitoring progress, and documenting each aspect of the rehabilitation process.

Stage 4 will involve submitting all the necessary documentation in the required formats to the relevant regulators. Post closure monitoring will commence at this stage and will be done until the Regulators are completely satisfied, after which will be the final submission of all documentation required. The final stage is that of the issuance of a Clearance Certificate (Stage 5).

12.5 Cost

The closure costs should be relevant at the project and site level with expenditure factored into annual operating activities.

At the conceptual stage closure costs are expected to be a broad estimate (ICMM, 2008).

Closure costs have an accuracy of 30% and are based on preliminary mine site layouts and areas of disturbance by infrastructure type and a conceptual monitoring program.

Four structural elements to the cost estimates have been developed for each element of the closure plan:

- The quantity of the activity
- The cost rate per unit quantity
- An allowance that is sensible to apply
- A contingency.

The product of quantities and rates is the base cost. An allowance has been added to the base costs for conditions known from previous experience are likely to occur. A contingency is added to the base costs plus allowance to account for the possibility of something changing (ICMM, 2008).

As outlined within this chapter, the closure and rehabilitation activities for certain areas can commence during the mine operation. Therefore, the closure and rehabilitation costs are summarized separately for the operational phase and closure phase. There is also a column showing the post closure costs, which allow for monitoring of the rehabilitation, and maintenance of the closure works. A period of 10 years post closure has been assumed for the rehabilitation and re-vegetation to be successfully established.

The closure costs are based on the, or include the following:

- The current cost of earthmoving and other civil construction works
- Contingencies of 10%
- Preliminaries and general contractor costs to allow for a third party contractor to undertake the closure works
- Design and supervision of the closure works (5%).

The closure and rehabilitation costs must be reviewed regularly and updated, to reflect the latest site situation. They must also be corrected for inflation annually. The preliminary operational cost estimate for closure of the T3 Project is shown in Table 12.2 below.

Table 12.2: Preliminary (operational) closure cost estimate in US$

Items	Annual costs (US$)	Subtotals (Life of Mine – 14 years) of annual costs
Personnel		
Environmental manager (expat)	20% of 187,500	697,200
Environmental officer	20% of 50,000	
Environmental field assistants	20% of 12,000	
Management		
Hygiene		
Topsoil		
Stakeholder engagement		
Landscape evolution modelling		
Salvage - seed and woody debris, transplants		
Fencing		
Survey and areas mapping		
Document control and storage	50,000	700,000
Monitoring - integrated into closure		
Erosion		
Dust - air quality		
Waste rock		
Flora		
Fauna		
Stakeholder engagement	35,000	490,000
Closure trials		
Slope - stability and composition		
Revegetation	5,000	70,000
Closure performance		
Annual audits by closure specialist	25,000	350,000
Closure - rehabilitation implementation plan		115,000
Update closure plans		225,000
Once off purchase closure infrastructure, plant and equipment		300,000
Total	**164,800.00**	**2,947,200.00**

The above costs are based on annual progressive rehabilitation. However, as part of the closure cost calculations two other scenarios and closure costs have been calculated, as shown in Table 12.3 below.

Table 12.3: Closure liability for non-progressive closure scenario in US$

Items	Costs (US$)
Deferred closure (end on LoM)	10,012,024
Sudden closure care and maintenance costs (3 years)	3,276,328

The following are the assumption associated with the above costings:

- Environmental management costs capture most ecological monitoring costs and values presented here are for the designated integration of closure specific requirements into an existing environmental monitoring program.
- Recycling and removal of HCs, plastics, cardboard, aluminium cans, etc is an environmental management cost.
- Stakeholder engagement for closure will be conducted annually driven by closure specialists and transferred later to the Closure Management Group (Operations based Leadership responsible for closure performance) before returning back to specialist in the pre-closure and post closure phase.
- Assumes 20% time allocation of environmental personnel. Assumes time for closure management group is built into job descriptions, cost of which are unallocated.
- Mine surveyor pick up/survey data is suitable to routinely inform levels for closure planning and a dedicated annual survey of areas of disturbance or stockpile heights, etc is not required.
- Assumes waste and materials management handling is an operational mine cost and data and records are suitable to inform closure requirements with no drilling or waste characterisation required external to this.
- Assumes hydrogeological modelling is accurate and up to date and a ground water drilling program to mitigate risk by contaminant plumes is not required for mine closure.
- Assumes any legal requirements imposed in future to backfill pits are an operational cost.
- Assumes shaping of the starter embankments on the TSF and shaping of final embankment is covered in other costs (Rescology , 2017).

12.6 Conclusion

This Chapter has outlined the (environmental) closure requirements for the T3 Mine Project, based on the work completed at pre-development stage of the Project. Several key conclusions and recommendations in relation to closure apply:

- Assumptions made in these closure guidelines and cost estimates must be reviewed, verified and updated regularly during the Project construction and operational phases, to ensure they reflect the actual Project situation, and costs are sufficiently covered in the closure budget.
- Availability of topsoil and subsoil are key to successful rehabilitation, and the soils must be managed during the construction and operation, to ensure maximum quantities are available for closure works. The cost of handling the soils (stripping as well as re-covering) is expected to be the largest cost item in the overall rehabilitation cost.

- There will be opportunities for on-going rehabilitation during the operational phase. Commitment from the Client in relation to this on-going rehabilitation is required (where practicable). As per the draft completion criteria in the Conceptual Closure Plan, commitment is required commitment to providing evidence of regular revisions of the cost model based on updated costs and changes in operations, changes in disturbance, progressive rehabilitation, new technology and advancing project-based knowledge of closure.
- The social impacts in relation to employment loss will be significant. Tshukudu Metals should liaise with relevant authorities, to enable them to start careful planning of re-training and re-employment of people prior to transition of the workforce to mine closure.

13 Recommendations

The various specialist studies (refer to Appendices C to N) recommended for a number of specific management plans to be developed during project implementation. These recommendations for management plans (and coordination with stakeholders) are summarised in the following Sections. For the details in relation to these, please refer to the relevant specialist Sections in the relevant Appendices.

13.1 Development of Detailed Management Plans

The general management and monitoring requirements for the implementation of the ESIA recommendations are included within this report. For some parameters recommendations have been made by the specialists for the development of specific management and/or monitoring plans during project implementation, once the full project details, phasing and implementation are known. These recommended plans include:

- Flora and fauna clearance plan/procedure
- Traffic and Vehicle Management Plan
- Ground water management and monitoring plan (see details in Section 13.1.1)
- ARD-ML management and monitoring plan (See details in Section 13.1.2)
- Pit lake study and management plan, and liaison with Water Apportionment Board
- Integrated and mine site-specific Waste Management plan, and liaison and agreement with Ghanzi District on landfill disposal
- Detailed progressive closure and decommissioning plan (including some further soil testing)
- Stakeholder Engagement strategy
- Corporate Social Responsibility Programme (CSR)
- Grievance Mechanisms
- Emergency response plan
- Health management plan
- Safety management plan
- HR and training plan and procedures.

It must be noted that the Client has already commenced with the development of some of the listed plans.

13.1.1 Groundwater management plan

The main recommendations drawn from the field investigation, pumping test analysis and the groundwater model are as follows:

Long term pumping tests: The specialist recommends that 28-day pumping tests are undertaken on four of the existing boreholes in order give a better understanding of the long term bore yields and their potential reduction with time; allow the derivation of aquifer parameters for the groundwater model; and provide groundwater level data with which to calibrate the numerical groundwater model.

Additional bores: The following options are proposed:

- Drill / construct an additional five dewatering boreholes close to Pushback 1; or
- Drill and construct an additional six dewatering boreholes close to Pushback 2. Allowance should be made to drill 50 percent more boreholes to allow for dry and/or low yielding bores.

Groundwater model: The groundwater model should be refined with the long term pumping test data and the pre-operation/lead-in time pumping rates and level monitoring data. Additional predictive model runs should be undertaken to optimise the dewatering borefield layout as new pit shells and mine plans become available. A six months dewatering lead-in time should be implemented in order to field test the installed dewatering system and re-calibrate the transient groundwater model.

Groundwater management plan (GMP): As part of the groundwater management plan (GMP) a groundwater monitoring network should be established that should include the installation of groundwater data loggers to automatically record groundwater levels. The installation of vibrating wire must be included.

13.1.2 Geochemical management

Given the high tonnage of waste rock to be mined (in the order of 200 Mt) and limited number of samples analysed to date (67 waste rock samples and 18 high lead/zinc samples) subsequent design phases will require additional characterisation to develop robust waste management plans.

The testwork completed to date has indicated that acid formation of waste material is unlikely to pose a risk to the project. However, additional testing of a significant number of samples for a reduced ABA suite (e.g. total sulfur and carbon, ANC and NAG) is recommended to ensure that the samples tested to date are representative of the overall deposit.

The waste rock is variably enriched and the high lead/zinc material is highly enriched, but there is no reliable correlation between total concentrations and readily soluble concentrations of metals and metalloids. Therefore, kinetic testing is required on a range of materials to develop an understanding of the leachate concentrations over time to inform design controls and any requirements for seepage reduction. It may beneficial to commence these cells as part of the ongoing FS based on the samples currently held by the laboratory to ensure that the data is available for the detailed design phase as the cells will likely run for between 6 to 12 months.

14 Conclusion

Conclusions drawn from the ESIA studies carried out on behalf of the Client by Loci Environmental are that numerous environmental impacts will be yielded by the proposed copper mining (and associated infrastructure) Project. Most of the biophysical impacts will be negative in nature while the socio economic impacts such as employment opportunities, business opportunities and economic development are positive.

In terms of the physical and biophysical environment, there are no red flags or fatal flaws with the proposed project that are likely to yield substantial environmental impacts upon the study area which cannot be accommodated through vigilant mitigation measures set forth in the project Environmental and Social Management Plan (ESMP). As the life of the proposed copper mine may be less than two decades, it is likely that most of the negative impacts predicted will be medium to long-term with some permanent impacts. It is recommended that progressive rehabilitation will be implemented, but decommissioning of most areas can only be done after closure, and rehabilitation of these areas implemented after 12 years from the commencement of the development.

The abstraction of groundwater will cause the progressive lowering of the piezometric surface and the expansion of the cone of depression for the period that abstraction occurs. During the life of the mine recycling of process water will occur, which will reduce raw groundwater consumption. Regional monitoring boreholes are required to assess the expansion of the cone of depression, to indicate potential effects on private water users and for updating the groundwater model. On cessation of pumping, water levels will slowly recover, and the natural groundwater flow direction would return, and a pit-lake will develop.

The main potential pollutants on site are sewage, hydrocarbons, the chemicals used in the processing plant and their associated storage facilities (tailings storage facility, chemical storage and fuelling areas. Acid rock drainage is considered not to be a risk; however, periodic checks should be undertaken. There should be no effects of chemical contamination of groundwater, given the rigorous pollution prevention and control measures on site, along with regular inspections to ensure that these potential pollutants are not mobilised. However, if leakage of minerals does occur the effects would slowly increase the ionic composition of the groundwater. Residual pollution effects could result from either a single major hydrocarbon spillage, or a slow gradual leakage, and from sewage contamination. The fractured nature of the aquifer would make the clean-up of hydrocarbon contamination and from sewage contamination difficult.

While effective and thorough decommissioning and rehabilitation has the potential to remedy some biophysical environmental impacts such as cleared vegetation and regeneration of compromised habitat, this will only be possible through vigilant environmental management and monitoring during construction and operation of the proposed development. Some of the key aspects in this regard are:

- Full compliance with the mitigation and monitoring measures (unless more successful measures are identified during operations) outlined within this report, and the Environmental and Social Management and Monitoring Plan.
- Regional monitoring boreholes are required to assess the expansion of the cone of depression, to indicate potential effects on private users and for updating the groundwater model.
- Continuous wildlife monitoring, and liaison with relevant authorities.
- Regular noise and air quality monitoring.

- Employment of a social team to ensure social mitigation and enhancement as outlined in this report.
- Reservation of a sufficient budget for rehabilitation activities after closure.

The ESIA study has been undertaken based on the technical scope of works as designed at the pre-feasibility and feasibility study stages. For any further changes to the technical scope, the ESIS report is to be updated further, to reflect the scope change, and liaison with the DEA is required.

During the operational phase of the Project, it is also recommended that the management and monitoring plan are reviewed regularly and are updated to effectively manage the environmental mitigation based on the latest site conditions.

15 Bibliography

Adams, Martin, Paul Devitt, D'Arcy Gibbs, Ray Purcell, and Richard White (1990) Botswana – Western Region Study. A Review of the Development Potential of Kgalagadi and Ghanzi Districts. Gaborone, Botswana: Ministry of Agriculture and Oxford: Mokoro Limited.

Albertson, Arthur (1998) Dobe Land Mapping Project. Report to Kuru Development Trust, D'Kar, Botswana

Albertson, Arthur (2000b) Traditional Land-Use Systems of Selected Traditional Territories in the Central Kalahari Game Reserve. Report to First People of the Kalahari, Ghanzi, Botswana

Alexander, G. & Marais, J. 2007. A Guide to the Reptiles of Southern Africa. Struik Nature, Cape Town.

Anon, 2009. Botswana Fourth National Report to the Convention of National Biodiversity. Government of Botswana.

Applied Research Unit (1996) Report of the Central Kalahari Game Reserve: A Socio-Economic, Population, and Needs Assessment. Gaborone, Botswana: Ministry of Local Government, Lands, and Housing

Barnard, Alan (1976) Nharo Bushman Kinship and the Transformation of Khoi Kin Categories. Ph.D Dissertation, University of London

Bleek, Dorothea F. (1928) The Naron: A Bushman Tribe of the Kalahari. Cambridge: Cambridge University Press.

BHC, 2015: Terms of reference for the environmental impact assessment for the development of a new BDF military camp with associated services & infrastructure in Ghanzi. (Tender BHC 010-2015/16)

Bohrer, G., Beck. P.S.A., Ngene, S.M., Skidmore, A.K. & Douglas-Hamiton, I. 2014. Elephant movement closely tracks precipitation-driven vegetation dynamics in a Kenyan forest-savanna landscape. Movement Ecology 2, 2 1-12.

Botswana Institute for Development Policy Analysis (BIDPA) (2015) Review of the Remote Area Development Program. Gaborone, Botswana: Ministry of Local Government.

Botswana Institute of Development Policy Analysis (BIDPA).

Botswana Society, ed. pp. 21-28. Gaborone: Botswana Society

Boycott, R.C. & Bourquin, O. 2000. The Southern African Tortoise Book: A Guide to Southern African Tortoises, Terrapins, and Turtles. O Bouruin, Hilton.

Campbell, A. C. and Graham Child (1971) The Impact of Man on the Environment of Botswana. Botswana Notes and Records 3:91-110.

Carruthers, V.C. 2001. Frogs and Frogging in Southern Africa. Struik Nature, Cape Town.

Central Statistics Office (1991), Guide To The Villages of Botswana. Ministry of Finance and Development Planning.

Central Statistics Office (2001), Population and Housing Census. Ministry of Finance and Development Planning.

Central Statistics Office (2011), Population of Towns, Villages and Associated Localities. Ministry of Finance and Development Planning.

Childers, G., Stanley, J. and Rick, K. (1982) Government Settlement or Peoples' Community? A Study of Local Institutions in Ghanzi District. Gaborone, Botswana: Applied Research Unit, Ministry of Local Government and Lands.

Clauss, B. & Clauss, R. 2002. Common Amphibians and Reptiles of Botswana. Gamsberg Macmillan Publishers, Windhoek.

Coates Palgrave, K. 1983. Trees of Southern Africa (2nd Edition) Struik Nature, Cape Town.

Cooke, H. J. (1985) The Kalahari Today: A Case of Conflict Over Resource Use. Geographical Journal 151(1):75-85Cumming, D. & Jones, B. 2005. Elephants in Southern Africa: management issues and options. WWF (African Elephant Program) – SARPO.

Convention on Migratory Species. 2017. Multi-species Action Plan to Conserve African-Eurasian Vultures.

Driver, A., Cowling, R.M. and Maze, K. 2003. Planning for Living Landscapes: Perspectives and Lessons from South Africa. Washington DC: Centre for Applied Biodiversity Science as Conservation International; Cape Town: Botanical Society of South Africa.

D.W.A. 1994. Protection Zones and Guidelines for Major Wellfields, Aquifers and Dams in Botswana. Final Report. Water Surveys Botswana Karunya Consulting, 2016. Scoping Report: Environmental and Social Baseline report – Final report

Foster & A. C. Skinner Groundwater protection: the science and practice of land surface zoning. Groundwater Quality: Remediation and Protection (Proceedings of the Prague Conference May 1995). IAHS Pub!. no. 225, 1995.

Fraser-Celin, V-L., Hovorka A.J., Hovorka, G.I. & Maude, G. 2017. Farmer-African wild dog (Lycaon pactus) relations in the eastern Kalahari region of Botswana. Koedoe, 59 (2).

Garstang, M., Davis, R.E., Leggett, K. & Frauenfeld, O.W., Greco, S. 2014. Response of African Elephants (Loxodonta africana) to seasonal changes in rainfall. PLOS ONE 9, 10.

Guidelines for the rehabilitation of mined land. 2007. Chamber of Mines of South Africa/ Coaltech. IUCN 2016. IUCN Red List of Threatened Species. Version 2010.2. <www.iucnredlist.org>.

Guidelines for Landscape and Visual Impact Assessment 2nd Ed. (Landscape Institute/Institute of Environmental Management & Assessment - UK, 2002).

Johnson, S. 2005. Good Practice Guidance for Mining and Biodiversity. International Council on Mining and Metals.

Kabelo, M. & Mafokate, D. 2004. A Checklist of Botswana Grasses. Southern African Botanical Diversity Network. Report No. 24. SABONET, Pretoria and Gaborone.

Kent, V.T. & Hill, R.A. 2013. The Importance of Farmland for the Conservation of the Brown Hyaena Parahyaena brunnea. Flora and Fauna International, Oryx, 47(3), 431-440.

King, L.E., Douglas-Hamilton, I. & Vollrath, F. 2007. African Elephants run from the sound of disturbed bees. Current Biology 17, 19, R832-R833.

King, L.E., Douglas-Hamilton, I. & Vollrath, F. 2011. Beehive fences as effective deterrents for crop-raiding elephants: field trials in northern Kenya. African Journal of Ecology 49, 431-439.

Leburu, T, 2017. Archaeological Impact Assessment for Proposed T3 Copper Project.

Moepeng, P. & Tisdell, C. (2006). Poverty and Social Deprivation in Botswana: A Rural Case Study. Social economics, poverty and development. Working Paper, No. 45. The University of Queensland.

Molosiwa, C., 1987. Preliminary Evaluation of the Ghanzi Wellfield Groundwater Potential. For DWA

Monuments and Relics Act 2001.Government Printer. Gaborone.

Marais, J. 2004. A Complete Guide to the Snakes of Southern Africa. Struik Nature, Cape Town.

National Water Master Plan, 1992. Volume 5 - Hydrogeology (revised). Snowy Mountains Engineering Co., et al. Report for DWA.

NACA (2008), Botswana AIDS Impact Survey II and III (2008). Central Statistics Office and National AIDS Coordinating Agency.

Ndaimani, H., Murwira, A., Masocha, M. & Zengeya, F.M. 2017. Elephant (Loxodonta africana) GPS collar data show multiple peaks of occurrence farther from water sources.

NEPAD – CAADP Implementation (2005): Beekeeping Development
Scholes, R.J. & Archer, S.R. 1997. Tree-grass intercalation in savannas. Annual Review of Ecology and Systematics. 28(1997), 517-544.

Ngama, S., Korte, L., Bindelle, J., Vermeulen, C. & Poulsen, J.R. 2016. How bees deter elephants: beehive trails with forest elephants (Loxodonta africana cyclotis) in Gabon. PLOS ONE 10, 1371

Philipson, D. W., 1975. A Handbook to the Victoria Falls Region. Longman Publishing Group

Public Health Act 1968 Government Printer. Gaborone.

Selaolo. E, 1998 Tracer Studies and Groundwater Recharge Assessment in the Eastern Fringe of the Botswana Kalahari - The Letlhakeng-Botlhapatlou Area PhD Free University of Amsterdam

Stuart, C. & Stuart, M. 2013. A Field Guide to the Tracks and Signs of Southern, Central and East African Wildlife. Struik Nature, Cape Town.

Stuart, C. & Stuart, M. 2015. Mammals of Southern Africa (5th Edition). Struik Nature, Cape Town.

T3 Copper Project – Groundwater Investigation Review, 2018a. Knight Piesold Ref PE18-00924.

T3 Copper Project – Geochemical Characterisation of Waste Rock 2018. Knight Piesold Ref PE301-00758/03 Rev A.

T3 Copper Project –Pre-feasibility Study Report, 2018. MOD Resources Limited.

Tribal Land Act 2001. Government printer Gaborone

Unesco website. www.unesco.org. Presidential Task Group report 1997. Retrieved 16 February 2013.

Van Wyk, B. & Van Wyk, P. 1997. Field Guide to Trees of Southern Africa. Struik Nature, Cape Town.

Van Oudtshoorn, F. 2012. Guide to Grasses of Southern Africa (3rd Edition). Briza Publications, Pretoria.

Waste Management Act 19987. Government Printer. Gaborone

Waterworks Act 1962. Government Printer. Gaborone.

Weare, P.R. & Yalala, A. Provisional Vegetation Map of Botswana.

World Conservation Union and UNEP-World Conservation Monitoring Centre. www.unep-wcmc. Org. Retrieved 20 February 2013.

Appendix A

DEA Correspondence

Appendix B

Consultation documents

Appendix C

Hydrogeological and Geochemical Specialist Reports

Appendix D

Biodiversity Studies

Appendix E

Noise Assessment

Appendix F

Air Quality Assessment

Appendix G

Soils report

Appendix H

Landscape and visual assessment

Appendix I

Waste specialist report

Appendix J

Traffic Assessment

Appendix K

Community Health Impact Assessment

Appendix L

Social Impact Assessment

Appendix M

Cultural Heritage and Archaeological Impact Assessment

Appendix N

Conceptual Closure Report

Appendix O

Prospecting license

Appendix P

BEAPA certificates