Technical Report

AS-R-2013-09-10

Blackthorn Resources Limited: Environmental Impact Statement:

Proposed Kitumba Copper Project, Mumbwa District, Central Province

Prepared for: Zambia Environmental Management Agency

February 2014

Document version 3.0 – Final Draft

Compiled by M Grobler

L Stolp

AGES

Purpose with Passion

Proudly Supporting

TOUCHING AFRICA

Technical report: AS-R-2014-02-28

Prepared by

AGES

Purpose with Passion

Technical report: AS-R-2014-02-28

Blackthorn Resources Limited:
Environmental Impact Statement:
Proposed Kitumba Copper Project, Mumbwa District, Central Province, Zambia

February 2014

Conducted on behalf of:

Blackthorn Resources Limited

Ian Hart

☎: +260 211 250 397

☎: +260 211 250 291

: +260 971 257 416 Zambia

: +61 457 431 006 Australia

: i.hart@blackthornresources.com.au

Zambia

7B Lagos Road, Rhodes Park

PO BOX 50005 Lusaka 15101

Zambia

Sydney – Head Office

Level 5, Suite 502

80 William Street

Sydney NSW 2011 Australia

Compiled by:

M Grobler (BSc Hons Conservation Ecology, Pri.Sci.Nat)

L Stolp (BSc (LArch) BSc Hons Environmental Management)

GAUTENG PROVINCE: Block E, The Village Office Block, 309 Glenwood Road (Cnr. Glenwood & Oberon Avenues) Faerie Glen 0081, Pretoria, Postnet No 74, Private Bag X07, Arcadia, 0007

Tel: +27 12 751 2160, Fax: +27 86 607 2406, www.ages-group.com

REPORT DISTRIBUTION LIST

Name	Institution
Ian Hart	Blackthorn Resources Limited
James Mwale	Zambia Environmental Management Agency (ZEMA)
Interested and Affected Parties and Commenting Authorities – ZEMA to distribute	

DOCUMENT HISTORY

Report no	Date	Version	Status
AS-R-2013-09-10	September 2013	1.0	Draft
AS-R-2013-09-10	December 2013	2.0	Updated Draft
AS-R-2014-02-28	February 2014	3.0	Final Draft

AGES Gauteng - Africa Geo-Environmental Services Gauteng (Pty) Ltd - exercises due care and diligence in rendering services and preparing documents, Africa Geo-Environmental Services Gauteng (Pty) Ltd accepts no liability, and the client, by receiving this document, indemnifies AGES Gauteng (Pty) Ltd and its directors, managers, agents and employees against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by Africa Geo-Environmental Services Gauteng (Pty) Ltd and by the use of the information contained in this document.

List of Abbreviations, Acronyms and Symbols

Abbreviation	Description
%	Per cent
Ag	Silver
AGES	Africa Geo-Environmental Services Gauteng (Pty) Ltd
AIDS	Acquired Immunodeficiency Syndrome
AMD	Acid Mine Drainage
ART	Antiretroviral Treatment
Au	Gold
BTR	Blackthorn Resources Limited
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
Co	Cobalt
CPI	Consumer Price Index
CSI	Corporate Social Investment
Cu	Copper
CWSP	Clean water storage pond
DEAT	Department of Environmental Affairs and Tourism (South Africa)
DFS	Definitive Feasibility Study
DWSP	Dirty water storage pond
ECZ	Environmental Council of Zambia
EIA or EIS	Environmental Impact Assessment or Environmental Impact Study
EMA	Environmental Management Act
EMP	Environmental Management Plan
EPB	Environmental Project Brief
FEL	Front-End Loader
GDP	Gross Domestic Product
GMAs	Game Management Areas
Ha	Hectares
HAC	Hazardous Area Classification
HGM	Hydro-Geomorphic
HIV	Human immunodeficiency virus
I&AP	Interested and Affected Party
IFC	International Finance Corporation
IOCG	iron-oxide copper-gold
IUCN	International Union for Conservation of Nature
Km	Kilometres
KNP	Kafue National Park
KNRT	Kaindu Natural Resource Trust
KPCC	Kaindu Project Coordinating Committee
ℓ/s	Litres per second
LoM	Life of Mine
m/s	Metres per second
MAE	Mean annual evaporation
mamsl	Meters above mean sea level

MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
mbgl	meters below ground level (i.e. depth)
MFZ	Mumbwa Fault Zone
mm	Millimetres
MMDA	The Mines and Minerals Development Act of 2008
MSD	Mines Safety Department
Mtpa	mega tons per annum
NHCC	National Heritage and conservation Commission
ºC	Degrees Celsius
Pb	Lead
PFS	pre-feasibility study
PMTCT	Prevention of Mother to Child Transmission
RDA	Roads Development Agency
RDL	Red-Data List
RRU	Rural Roads Unit
SLC	Sub-Level Caving
SLP	Social and Labour Plan
ToR	Terms of Reference
TSF	Tailings storage facility
U	Uranium
VCT	Voluntary Counselling and Testing
WM	With Mitigation
WOM	Without Mitigation
WRD	Waste Rock Dump
WRMA	Water Resources Management Act of Zambia (Act No. 21 of 2011)
WUA	Water User Association
ZAF	Zambian Air Force
ZAWA	Zambian Wildlife Authority
ZEMA	Zambia Environmental Management Agency
Zn	Zinc

Table of Contents

1 EXECUTIVE SUMMARY IX
1.1 NON-TECHNICAL SUMMARY (KAONDE) (TRANSLATION PROVIDED BY MR CHOLOBESA) .. XII
1.2 NON-TECHNICAL SUMMARY (ENGLISH) XV
2 INTRODUCTION 1
2.1 PURPOSE OF THIS DOCUMENT 1
2.2 FORMAT OF THIS REPORT 2
2.3 BACKGROUND OF THE PROJECT PROPONENT 4
2.3.1 Information on shareholders and shareholding percentage 4
2.3.2 Previous Experience of Enterprise elsewhere 6
2.3.3 Project cost / investment and implementation date 6
2.4 BRIEF DESCRIPTION OF THE PROJECT 6
2.4.1 Prospecting Phase 6
3 RELEVANT REGULATORY FRAMEWORK 9
3.1 POLICY AND LEGAL FRAMEWORK FOR EIA IN ZAMBIA 9
3.2 ENVIRONMENTAL AUTHORIZATION FOR MINING IN ZAMBIA 9
3.3 WATER USE AUTHORIZATION 10
3.4 OTHER RELEVANT REGULATORY REQUIREMENTS 11
3.5 INTERNATIONAL AND REGIONAL CONVENTIONS AND AGREEMENTS 12
3.6 SUMMARY 13
4 DETAILED PROJECT DESCRIPTION 15
4.1 LAND TENURE AND LOCATION 15
4.2 PROJECT OBJECTIVES AND MOTIVATION 16
4.3 MAIN SITE ACTIVITIES AND PROCESSES, MATERIALS, PRODUCTS AND BY-PRODUCTS ASSOCIATED WITH THE PROJECT PHASES 18
4.3.1 Site establishment Construction Phase 18
4.3.2 Operational Phase 21
4.3.3 Closure Phase 29
4.3.4 The storage and Management of Chemicals, explosives and hazardous wastes 30
4.4 PROJECT WATER BALANCE 32
5 ENVIRONMENTAL BASELINE STUDY 34
5.1 CLIMATE 35
5.1.1 Regional Climatic Conditions 35
5.1.2 Climate of the project area 35
5.2 AIR QUALITY 37
5.2.1 Wind 37
5.2.2 Air temperature 39
5.2.3 Relative humidity 39
5.2.4 Precipitation and evaporation 40
5.2.5 Atmospheric Stability and Mixing Depth 40
5.3 GROUNDWATER AND GEOLOGY 40
5.4 SURFACE WATER 44
5.5 SOILS AND SOIL POTENTIAL 45
5.5.1 Shallow Lithosols / Arenosols associated with rocky ridges and outcrops 45
5.5.2 Medium depth gravelly / sandy Arenosols associated with foot-slopes / valleys 45
5.5.3 Arenosols: Red-yellow apedal soils associated with slightly undulating plains 46
5.5.4 Planosols associated with moist grasslands on ferricrete bedrock 46
5.5.5 Fluvisols associated with ravines in mountainous areas 47
5.6 TOPOGRAPHY 50
5.7 LAND USE AND LAND TENURE 52

5.7.1 *Residential areas* 52
5.7.2 *Mining* 52
5.7.3 *Conservation and Tourism* 54
5.7.4 *Agriculture* 55
5.7.5 *The Mumbwa Prison Farm* 55
5.7.6 *The Zambia Air Force (ZAF)* 56
5.7.7 *Infrastructure* 56
5.8 LANDSCAPE AND VISUAL RESOURCE 56
5.8.1 *Landscape character and visual resource (scenic quality)* 56
5.8.2 *Landscape Quality* 56
5.8.3 *Sense of Place* 57
5.8.4 *Viewer sensitivity* 57
5.9 NOISE AND VIBRATION 60
5.10 BIODIVERSITY AND ECOLOGY (FLORA AND FAUNA) 61
5.10.1 *Vegetation types of the study area* 63
5.10.2 *Wetlands of the study area* 69
5.10.3 *Fauna* 71
5.10.4 *Protected Species* 73
5.10.5 *Invasive alien species* 74
5.10.6 *Summary of Ecological Sensitivity* 74
5.11 ARCHAEOLOGICAL AND CULTURAL ENVIRONMENT (HERITAGE RESOURCES) 76
5.12 SOCIO-CULTURAL AND ECONOMIC ENVIRONMENT 78
5.12.1 *Culture and community power structures* 78
5.12.2 *Population, age, language, religion, education and family life* 79
5.12.3 *HIV/AIDS infection rate and preventative measures in the project area* 81
5.12.4 *Industry* 82
5.12.5 *Service Infrastructure* 83
5.12.6 *Transport and Traffic* 84

6 IMPACTS 86

6.1 STAKEHOLDER ENGAGEMENT AND PUBLIC PARTICIPATION 86
6.1.1 *Interested and Affected Parties* 86
6.1.2 *Summary of Consultation / Issues Discussed* 87
6.2 IMPACT ASSESSMENT METHODOLOGY (AFTER PLOMP, 2004) 89
6.3 IMPACT ASSESSMENT STRUCTURE 90
6.4 IMPACT ASSESSMENT 91
6.5 SIGNIFICANT IMPACTS 91

7 MITIGATION MEASURES FOR ALL IDENTIFIED IMPACTS 107

7.1 SIGNIFICANT ENVIRONMENTAL IMPACTS THAT REMAIN SIGNIFICANT AFTER MITIGATION 107
7.2 SIGNIFICANT SOCIO-CULTURAL IMPACTS THAT REMAIN SIGNIFICANT AFTER MITIGATION 107
7.3 SIGNIFICANT ECONOMIC IMPACTS THAT REMAIN SIGNIFICANT AFTER MITIGATION 107

8 PROJECT ALTERNATIVES 130

8.1 OPPORTUNITIES AND BENEFITS 130
8.1.2 *Socio-economic benefits and investment:* 132
8.2 PROCESS / MINING METHOD ALTERNATIVES 136
8.3 LAYOUT ALTERNATIVES 139
8.3.1 *Main Site Infrastructure* 139
8.3.2 *Tailings Dam Facility Alternatives* 140
8.3.3 *Waste Dump Location* 144
8.3.4 *Water Storage Facility Options* 144
8.4 ROUTE ALTERNATIVES 146
8.5 SERVICES ALTERNATIVES 147
8.5.1 *Water Supply Options* 147

8.5.2 Power supply options *150*
8.5.3 Waste management options *150*
8.5.4 Employee housing options *151*
8.6 SCHEDULING ALTERNATIVES 152
8.7 THE NO-GO ALTERNATIVE 152

9 ENVIRONMENTAL MANAGEMENT PLAN 153

10 DECOMMISSIONING AND REHABILITATION 173

10.1 CLOSURE PLAN OBJECTIVES 173
10.2 CLOSURE ACTIVITIES 174
10.3 FINANCIAL PROVISION 176

11 CONCLUSION 177

11.1 REGULATORY SUMMARY AND WAY FORWARD 177
11.2 CONCLUSION 178

12 APPENDICES 179

13 REFERENCES 180

List of Figures

Figure 1: Regional Locality of the Prospecting License Area and Project Area 8
Figure 2: The project site surroundings 17
Figure 3: Proposed site layout 19
Figure 4: Existing exploration camp 20
Figure 5: Proposed on-site accommodation 20
Figure 6: Process flow diagram 28
Figure 7: Project water balance chart 33
Figure 8: Average Temperatures, Mumbwa (adapted from http://www.climate-charts.com/Locations/z/ZA67655MUMBW0010.php) 36
Figure 9: Average and absolute maximum and minimum temperatures for the Mumbwa area (http://www.myweather2.com/City-Town/Zambia/Mumbwa/climate-profile.aspx) 36
Figure 10: Period Wind Rose for the project site (2010-2012) 38
Figure 11: Daytime and Night time Wind Rose for the project site (2010-2012) 38
Figure 12: Seasonal Wind Rose for the project site (2010-2012) 38
Figure 13: Diurnal variability of mean, maximum and minimum temperature (2010-2012) 39
Figure 14: Monthly and diurnal humidity variations (2010-2012) 39
Figure 15: Geology of Zambia 42
Figure 16: Sites recorded during the Hydro-census 43
Figure 17: Soil types of the Site (Henning B. J., May 2013) 48
Figure 18: Soil potential of the Site (Henning B. J., May 2013) 49
Figure 19: Soil Risk / Impacts (Henning B. J., May 2013) 49
Figure 20: East-West Elevation Profile (adapted from Google Earth Pro) 50
Figure 21: North-West to South-East Elevation Profile (adapted from Google Earth Pro) 50
Figure 22: Surface water drainage and topography 51
Figure 23: Excavations and abandoned samples at an abandoned (presumably illegal) malachite mining operation outside of but in close proximity to the site 53
Figure 24: An old mining shaft that has been 'closed' (left) and general surface conditions at the past artisanal mining sites (right) 53
Figure 25: View of the site from Mumbwa Prison Farm 58
Figure 26: Hilly topography and vegetation 58
Figure 27: Existing night view (top) - project site hidden by topography and (bottom) potential night view (sky glow from unmitigated light impacts from project) 58
Figure 28: Visual receptors in the vicinity of the project site 59
Figure 29: Sites where noise monitoring / measurements were taken 61

Figure 30: Ecoregions of Zambia 63
Figure 31: Vegetation Types of the Site 65
Figure 32: Sensitivity of the vegetation types found on the site 68
Figure 33: Wetlands of the study area 70
Figure 34: Ecological Sensitivity of the study area 75
Figure 35: Archaeological and Heritage Resources in the vicinity of the site 77
Figure 36: Existing Road Conditions 85
Figure 37: Base Case SLC mine Layout and ecological sensitivity 141
Figure 38: Base Case and Alternative 1 underground site layout 142
Figure 39: Alternative 2 Opencast site layout 142
Figure 40: Suggested route for re-alignment of Mushingashi Road 145
Figure 41: Water supply option – Groundwater 149

List of Tables

Table 1: Format of the EIS report 2
Table 2: Details of the project proponent 4
Table 3: The names of the twenty largest registered shareholders of ordinary shares as at 23 September 2013 4
Table 4: shareholding and directors of Blackthorn Resources Zambia Limited 5
Table 5: Minerals for which the prospecting license is held 7
Table 6: Additional Relevant Legislation 11
Table 7: Specific information in terms of the process flow 27
Table 8: Specialist involvement in the EIS 34
Table 9: Summary of Soils on the Project Site 47
Table 10: Summary of Vegetation Types in the study area 67
Table 11: 2008 Mumbwa District Profile 81
Table 12: Impact Significance Criteria 89
Table 13: Impact identification and significance rating WITHOUT MITIGATION 93
Table 14: Identification of mitigation measures, and impact ratings AFTER mitigation 108
Table 15: Summary of Social Opportunities in response to Social Issues 134
Table 16: Comparative assessment - Opencast Underground and Cave mining 137
Table 17: Evaluation of base case process plant location 140
Table 18: Comparative Assessment: TSF Base Case (Alt 1) vs. Alternative 2 143
Table 19: Expected daily trip generation (external transport during production) 146
Table 20: Environmental Management Plan 153

1 EXECUTIVE SUMMARY

Blackthorn Resources Limited (Blackthorn) appointed Africa Geo-Environmental Services Gauteng (PTY) Ltd (AGES) to investigate the feasibility of the proposed Kitumba copper mining Project from an environmental and social impact management perspective, and to facilitate the environmental impact assessment processes required under Zambian law and in accordance with the principles of sustainable development.

The purpose of this Environmental Impact Study (EIS) Report is to evaluate the existing socio-economic and biophysical baseline environments of the proposed project site in order to determine whether any potential fatal flaws exist that may render the project impracticable from an environmental management point of view, and to identify the management measures which would be required to ensure that the project does not detrimentally impact on the receiving environment. This study also discusses environmental legal requirements and authorisations applicable to the project.

The proposed project site is situated in the Mumbwa District, in the north-west region of the Central Province of Zambia, approximately 210 km north-west of Lusaka, and approximately 50 km north-west of the town of Mumbwa at the following coordinates:

Latitude: 14°41'53.15"S Longitude: 26°48'3.20"E

The preliminary mineralogy suggested that the copper is contained in malachite and cuprite which are classified as oxide copper minerals. Sulphide minerals are also present. The copper ore which will be mined comprise primarily sulphide copper (secondary chalcocite and primary chalcopyrite), oxide copper will also be mined but is a lesser component.

The base case project description involves the mining and processing of an iron-oxide copper-gold (IOCG) deposit at a 3 Mtpa production rate at a head grade of 1.7% Cu, using a sub level caving (SLC) mining method. Twin declines will be used for access and haulage. The process plant will produce both cathode copper and copper concentrate, to be shipped from site to Lusaka by road truck. All tailings will report to a Tailings Storage Facility (TSF). The Life of Mine (LoM) is estimated at approximately 11+ years with 2 years for pre-production. A brief description of the major equipment used and the process steps is given below:

- Primary ore crushing
- Grinding and classification
- Rougher flotation to produce a bulk concentrate
- Acid leaching of bulk rougher concentrate
- Filtration of leached concentrate with filtrate processed by solvent extraction and electrowinning (SXEW) to produce copper cathode

- Neutralisation of filtrate residue followed by secondary flotation of filtrate residue
- Secondary flotation concentrate regrind and two stages of cleaner flotation to produce a copper concentrate
- Copper concentrate thickening, filtration and stockpiling
- Tailings thickening and disposal

The current planning indicates that the project development (construction) will commence around 2016. It is currently estimated that the construction phase work force will be approximately 500 people, and the operational phases will generate employment for approximately 400 people or more. Preference will be given to the employment of local community members where possible. The project will aim to provide equal opportunity to women in mining and related operations where feasible.

There are a number of legislative requirements and international best practice principles to which the project will have to adhere, and a number of licenses, authorisations or approvals that will be required prior to the project commencing on site. Worth emphasizing here is adherence to the IFC Environmental Performance Standards and Environmental, Health and Safety Guidelines for Mining, the Mines and Minerals Development Act, 2008 (MMDA), Zambia Environmental Management Act, 2011 (ZEMA) and the Water Resources Management Act, 2011 (WRMA).

As part of the applications for environmental authorizations and mining rights, and due to the requirement that people have the right to be informed about potential decisions that may affect them and that they must be afforded an opportunity to influence those decisions, AGES has been involved in public engagement with surrounding stakeholders and authorities and this report also contains details of the public consultation process followed thus far.

It must be noted that public participation is an on-going consultative and information-sharing process and that good relations must be built and maintained with stakeholders throughout the life of the project and after the project has stopped. Social license to operate can be challenged at any time during a development lifespan and the public consultation process is therefore far from complete. Rather, public participation relating to the project is in its infancy.

A number of specialist investigations were conducted during the EIS which includes: Ecological, soils and land capability and wetland assessments, heritage impact assessment, noise impact assessment, air quality impact assessment, visual impact assessment, traffic impact assessment, hydro-geological impact assessment and water supply option analysis and a closure plan and estimate for financial provision. The specialist team characterized the existing environment in their respective field which may be impacted by the project, quantified what those impacts may be, suggested mitigation and management measures to reduce the identified impacts and assessed a number of alternatives to be considered in the project implementation going forward.

The purpose of identifying and evaluating feasible alternatives in terms of a development proposal is to find the most effective way of meeting the project needs, either through enhancing the environmental benefits of the proposed activity, and / or through reducing or avoiding negative impacts. A number of different alternative types are discussed in this report, many of which will require careful consideration and decision-making during subsequent phases of the project. The report also identifies opportunities and benefits that may be associated with the project.

Comment is also made in this report on the importance of ensuring that the project leaves a positive legacy behind, and the compilation and implementation of detailed rehabilitation measures concurrently with the mining activities as well as post-closure. Financial provision for rehabilitation, closure and after care was also estimated.

After completion of the EIS, a number of potential negative environmental impacts associated with the project have been identified, along with management and mitigation measures aimed at managing, reducing or avoiding any negative impacts, and enhancing positive impacts. None of the identified potential negative impacts are expected to be of sufficient severity and likelihood that they cannot be managed to acceptable levels by the implementation of detailed management and mitigation measures as stipulated in this report and the associated specialist reports.

From an environmental impact management point of view it is recommended that the project continue to the definitive feasibility phase (DFS) in order that existing knowledge gaps may be filled and further confidence in the environmental acceptability of the project can be gained.

This EIS is submitted to the ZEMA in support of an application for environmental authorization for the proposed project. This report is also submitted (via the ZEMA) to the Mines Safety Department (MSD), under the Ministry of Mines and Minerals Development in support of the Mining Licence under Clause 25 of the Mines and Minerals Development Act 2008, and to the relevant Water Users association or water board as the case may be in support of an application for the right to use water at the proposed mining development.

____

Signature of the Chief Executive of the Developers

Full Names: _________________________________ Date: ___________________________________

1.1 Non-Technical Summary (Kaonde) (Translation provided by Mr Cholobesa)

BYAMBO BYANEMBWA MUBWIPI [BYA BULA BUNSENDWE].

NO KAMPANYI WABA BLACKTHORN WAASONTA KAMPANYI WABA AFRIKA GEO-ENVIROMENTAL GAUTENG [PTY] LTD [AGES] KUBA'MBA BAPALANGUZYE NE KUTANA BYA KONSHA KUFUMA MU-INO MINGILO YAKETEKELWA KWINGIJIWA PA MUKOCHI WA COOPA UTELWA'MBA KITUMBA KWESANKANYA NA BINTU BITUZHOKOLOKA NE MAKATAZHO AKUMA KUBWIKALO BWA BANTU NE MASHINDA O'BAKENGIJISHA MUKUKEPESHAKO MAKATAZHO KABIJI NE KUMONA KUBA'MBA MINGILO YAKUPITALUKA NE KUMONA MAKATAZHO AKONSHA KWIYA NAMAMBO A MINGILO INO NE MASHINDA AKABIKWAPO MU KWESEKA KUKEPESHAKO MAKATAZHO MUKWESAKANYA NA MUZHILO YA MUKYALO KYA ZAMBIA.

KINE KINTU KYA LENGELA KWIKALA NA INO MINGILO YAKU PITULUKA NE KUTAGISHA PA BYA KONSHA KUMWEKANA INGE INO MINGILO YAKUPOYA MABWE YAUBIWA KUBIKAPO NE MAKATAZHO AKONSHA KUMWEKANA KUBINTU BITU ZHOKOLOKA. UNO REPOOTI UBENA KUPITULUKA NE KUMONA BINTU BYO BIJI PA KINO KIMYE MUMASHINDA ANO AJI NOBE BWIKALO BWA MUUNTU NE BYA BUUNONSHI BWAKYALO KABIJI NE KUTAGISHA BULONGO PA BINTU BYOONSE BITANWA MU INO MPUNZHA ITUZHOKOLOKA NE NKOMINO YABYA PA MUTUNDU YEENSE WABINTU BITANWA KU INO MPUNZHA KWA KETEKELWA KUBIWA INO MINGILO MUKUKEBA KUBA'MBA BAYUKE KA'NA KUJIPO BINTU BIMO BYASHALAPO NANGWA KUBULA KUTAGISHIWAAPO BULONGO BYANEMA KINE KINE BY KONSHA KULENGELA MWINGILO UNO WAKUKEBA KUPOYA MABWE WAMWEKA NOBE KECHI WA KONSHA KWINGIWA NE NAMA'MBO AKUMA PA MINGILO IKENGIWA PA KUMONA PA BINTU BITU ZHOKOLOKA KABIJI NE KUYUKA MASHINDA AKA KEBEWA KWINGISHIWA MUKUMONA KUBA'MBA UNO MWINGILO WA KUPOYA MABWE KAUJI KULETA MAKATAZHO ABAYA A KINE KU BINTU BITU ZHOKOLOKA MU MPUNZHA KUKINGIWANGA INO MINGILO. INO MINGILO YA KUKEBA KEBA EBENA KWISAMBAPO PA BYA FWAINWA KULONDELWA KWESAKANYA NA MIZHILO YAPA BINTU BITU ZHOKOLOKA – KABIJI NE BYOONSE BIKEBEWA KUBIWA MUKWESANKYA NA BINTU MO BYAILA PA MWINGILO UNO WA KUPOYA MABWE A COOPA.

INO MPUNZHA KUKOBIWANGA INO MINGILO INTANWA MU BOOMA WA MUMBWA, KU KABETA KABUYEKE KAJI KUMUZHIKA MUKIBUNJI KIJI PAKACHI KA KYALO KYA ZAMBIA, PABWEPI MA KILOMITA NOBE TU HUNDILEDI NE TENI (210KM) KU KABETA KABUYEKE BWA KUMUZHIKA WA MUZHI MUKATAMPE WA LUSAKA, KABIJI PABWEPI MAKILO MITA MAKUMI ATANU (50KM) KUFUMA KU BOOMA WA MUMBWA NAKU KABETA KA BUYEKE BUJI KU MUZHIKA. UNO COOPA (COPPER) UNTANYIKA MU MUTUNDU WA MABWE UTELWA AAMBA SULPHIDI AJI NOBE KALKOCITI NE CHALKOFURITI BUTMALAKI NE KUPURITI AO BIKWA MU MUTUNDU WA OKOCIDI COOPA NAO MO AJI. JINO JIBWE JA COOPA JIKAPOYEWANGA KE PRIMALI SULPHIDI COOPA BINO OKOCIDI COOPA NAYE UKAPOYEWANGA MU KIPIMO KICHECHE. KULUMBULULA KWAFIKAPO KWA MINGILO INO KWAVWANGAPO KAPOYA ANO MABWE NE KWIAWAMYA

BULONGO UNO OFA COOPA PA MATANI AFIKA MA MILIONI A SAATU PA MWAAKA PA MWAAKA KWINGISHA JISHINDA JAKUPOYA JITELWAMBA SABU LEVAL KEEVING (SUB LEVEL CAVING SLC). BIMBO BIBIJI BIIKAYANGA PANSHI BYO BAKENGISHANGA KUYA PANSHI NE KUSENDA KITOFU. INO MPUNZHA WAKUWAMISHISHA PA MABWE IKALUPULANGA BINTU BIIBIJI. KATHODI COOPA NE COOPA UJI NA BINTU BIKWABO MUKACHI, IKA TUNCHEWANGA KUFUMA KU MUKOCHI KUTWALA KU MIKOCHI (COPPERBELT) KUPITA MUMUZHI WA LUSAKA NA BIMBAYAMBAYA (TRUCKS). UNO MUKOCHI WA KETEKELWA KWIKALA MYAKA JIKUMI NE MWAKA UMO NE KUPITAILA KUBIKAPO MYAKA IBIJI SA BA KYANGYE KUTENDEKA KUFUMYA MABWE PA MUKOCHI.

LUMO LUNENGEZHO LWAMWESHO AMBA KUTWALA PALUTWE KWA MINGILO INO MUBYA KUSHIIMIKA KUKATENDEKA PA KUFIKANGA MU MWAKA WA TWENTY SIXTENI (2016).

PA KINO KIMYE LUNEGEZHOMU KIPUNGU KITANSHI KYA KUSHIMI KIKEKALA NA BAANTU BANKITO BAKETEKELWA KUFIKA KUKIPIMO KYA FIVE HUNDILEDI (500) KABIJI NE KIMYE KYA KUTENDEKA KWINGILA EKA LETA MINGILO YA BAANTU BA KAFIKA KU KIPIMO KYA MA HUNDILEDI AJI FOOLO (400) KAAMPE NE KILAPO. JISHUKO JA KUTWEZHA BA MINGILO JIKAPEWA KUBANGIKAZHI BATANWA KUMPUNZHA KOONKA KANA KYA SWISHIWA.

NOBE JISHINDA JAKU KULOMBA KU SWISHIWA KU BINTU BITU ZHOKOLOKA NE NGOVU ISWISHA MUUNTU KUPOYA MABWE KANO KAMPANYI KATELWAMBA AGES MUBWEPI KETAILE MU MEESAMBO NE BENAKENGI NENA BAANTU BOONSE BOYAKUMA INO MINGILO KABIJI NE BIBESE BYA KUFULUMENDE BYAPUSANA-PUSANA; KABIJI NE UNO LIPOOTI UJI NENA BINTU BYOONSE BYANEMBWA BYA FUUMINE MU MISAMBO INO KUFIKA PAKINO KIMYE. TWAFWAIIWA KUYUKAAMBA KUNO KWISAMBA NA BENAKENGI KE KINTU KIKATWAJIJI NOBE JISHINDA KUUNVWA MILANGULUKO YA BAANTU KABIJI NE KUSHILANGENA BYAAMBO KABIJI NEKUMONA'MBA BULUNDA BWAWAMA BWAIKALAPO KABIJI NE KUTWAJIJILA NABOOBA BOKYAKUMA KIKUPUTU MU KIMYE KYOONSE KYAKWINGILA PA INO MPUNZHA KABIJI NE KIMYE KYO IKAPWA INO MINGILO YA KUPOYA MABWE.

KWAJINGA KUKEBAKEBA BULONGO KU BASHAYUKA KWAUBIWE MU KIMYE KU MWINGILO UNO WA (EIS) AWO WAUBIWE AMO MUJI KUTALA PA BINTU BIJI NABUMI, MAALOBA KABIJI NE MUSHIJI UJI BYEPI KABIJI NE KUTAJISHA PA MUSHIJI AWA WIKALA NA MUNYANGO KIMYE KYOONSE. BYAKISHAKULU, NE KYOONGO, KUMO AMBA LUVULA YETUPEMA UJI BYEPI, MEENSO AKAMONA'NGA BULONGO NYI? BYELA BYENDA PA MUKWAKWA BIKENDENGA BYEPI, BYA MEEMA ATANWA MU MABWE, KABIJI NE KUTALATALA BULONGO NE KUMONA KUKAFUMANGA MEEMA AKUTOMA KABIJI NE BI KOBIWA KANA MUKOCHI WASHINKWA KABIJI NE KUMONA KUBA'MBA MAALI AANGA AKETEKELWA KUTAIWAPO. JINO JIBUMBA JABASHAYUKA JA TAJISHIPO BULONGO PA BITA ZHOKOLOKA NE KUMONA NGANYI MAKAZHO AKONSHA KUMWEKANA, NE MASHINDA AKONSHA KWINGISHIWA MUKUKEPESHAKO MAKAZHO AKONSHA KUMWEKA MUBINO BINTU BYA YUKANYIKWA KABIJI NE KUMONAPO MASHINDA AKWABO AKONSHA KWINGISHIWA PA KIMYE KYA KUTENDEKA MINGILO INO INGE KYAFIKA. KINE KINTU

KYALENGISHA KUBA’MBA TUYUKE KABIJI NE KUPITULAKAMO MU MASHINDA AKONSHA KWINGISHIWA KWESAKANYA NA MULANGULUKO WAKUTWALA PALUTWE MINGILO KE KUKEBA KUTANA BYO TWAKONSHA KUTANA JISHINDA JA FIKILAMO JA KUKEBA KUFIKIZHA BYA KEBEWA KUBIWA MUMWINGILO UNO, KAMPE KUPITILA MUKUKU KOSESHA BUWAME BUKAFUMAMO MU UNO MWINGILO WAKATEKELA KWINGILWA. KABIJI NANGWA KUPITILA MUKUKEPESHAKO BYATAMA BYAKONSHA KUFUMA MUMINGILO INO. MASHINDA’PUSANA PUSANA AAVULA ABYA KONSHA KUBIWA ESAMBIWAPAPO MU LIPOOTI. AYE UNO LIPOOTI KABIJI WATANAPO NE JISUKO JA KUYUKA NE BYAWAMA BYO BAKONSHA KUMWENAMO BULONGO BYA LAMATA KU UNO MWINGILO.

BAAMBA PO MU UNO LIPOOTI PA BUNEME BWAKUMONA’MBA INO MINGILO YASHANKUWA YAWAMA PANYUMA KABIJI NE KUBUNGIZHA PAMO NE KUFIKIZHA KWA YUULA YA KUMONA BYO BAKONSHA KUKWASHA BAANTU BAKATANWA MUMAKATAZHO PA KIMYE KIMOTU NA MINGILO YA KUPOYA MABWE NE YAPANYUMA YAKUSHINKA MUKOCHI. LUNENGEZHO LWAMAALI AKUKWASHA BAANTU KUBA’MBA BIKALE BWIKALO BWAMA PANYUMA YAKUSHINKA KABIJI NE BYA KWIBALAMA BAANTU MU MOBO AKULUTWE NE MAALI AKONSHA KUTAIWAPO BYOONSE BYAUBIWA. KYA KETEKELWA KUBA’MBA BYOONSE BINTU BYAYUKANYIKWA BYA KONSHA KULETA MAKATAZHO A KONSHA KWINGIWAPO MUMASHINDA ASWISHIWA KUPITILA MUKUFIKIZHA MINGILO YA BIKWAPO KWESAKANYA NA BYATANCHIKWA MU LIPOOTI NE MA LIPOOTI AKWABO ABANSENDWA ALAMATAKO.

KWESAKANYA NA BYA NENGEZHIWA PA BYA KONSHA KUMWEKA KUBINTU BITU ZHOKOLOKA KYASWISHIWA AMBA MINGILO ITWAJIJILE MU KIPUNGU KYA KUKEBA KEBA NEKUTANA BYA KONSHA KUFUMA MUMINGILO INO KYO BATELA’MBA DIFINITIVU FESIBILITI PHASE (DFP) MUBWEPI, NE KAFULUMENDE WA KETEKELWA KUPANA MUKUMBU WAWAMA.

UNO EIS WAPANWA KU KUBUNGWE KATANGISHA PA KULAMA BULONGO BINTU BITU ZHOKOLOKA KATELWA’MBA – ZEMA MUBWEPI MUKUTUNDAIKA KULOMBA KWAKUSWISHIWA KWESAKANYA NA BITU ZHOKOLOKA KU INO MINGILO YA KETEKELWA KWINGIWA. UNO LIPOOTI NAYE WATUMWA KUPITILA MU BA ZEMA KU KIBESE KYA KAFULUMENDE KITANGESHA PA KWIVIMBILA KWA BAANTU BATWELA PA MUKOCHI NANGWA’MBA MAINI SEFUTI DIPATIMENTI (MSD), KIJI MU KIBESE KYA KAFULUMENDE KITALA PA MIKOCHI NE KU KUTWALA PALUTWE MINGILO WAMABWE APUSANA PUSANA, NE KABUNGWE KEMINAKO BAANTU BENGIGISHA MEEMA NANGWA KABUNGWE KATENTEKWA NA KAFULUMENDE KATALA PA NGOVU WA PANYIWA KU MUUNTU KWINGISHA MEEMA AJIMU MIKOLA NE BIZHIBA PA MPUNZHA PA KETEKELWA KUBIKWA MINGILO YA KUTWALA PALUTWE BYA KUBAISHAKO MINGILO YAKUPOYA MABWE.

1.2 Non-Technical Summary (English)

Blackthorn Resources Limited (Blackthorn) appointed Africa Geo-Environmental Services Gauteng (PTY) Ltd (AGES) to investigate the feasibility of the proposed Kitumba copper mining Project from an environmental and social impact management perspective, and to facilitate the environmental impact assessment processes required under Zambian law.

The purpose of this Environmental Impact Study (EIS) Report is to evaluate the existing socio-economic and biophysical baseline environments of the proposed project site in order to determine whether any fatal flaws exist that may render the project impracticable from an environmental management point of view, and to identify the management measures which would be required to ensure that the project does not detrimentally impact on the receiving environment. This study also discusses environmental legal requirements and authorisations applicable to the project.

The proposed project site is situated in the Mumbwa District, in the north-west region of the Central Province of Zambia, approximately 210 km north-west of Lusaka, and approximately 50 km north-west of the town of Mumbwa.

It is expected that the copper is contained in malachite and cuprite which are classified as oxide copper minerals. Sulphide minerals are also present. The copper ore which will be mined comprise primarily sulphide copper, oxide copper will also be mined but is a lesser component.

The base case project description involves the mining and processing of an iron-oxide copper-gold (IOCG) deposit at a 3 Mtpa production rate, using a sub level caving (SLC) mining method. Twin declines will be used for access and haulage. The process plant will produce both cathode copper and copper concentrate, to be shipped from site to the Copperbelt via Lusaka by road truck. The Life of Mine (LoM) is estimated at approximately 11+ years with 2 years for pre-production.

The current planning indicates that the project development (construction) will commence around 2016. It is currently estimated that the construction phase work force will be approximately 500 people, and the operational phases will generate employment for approximately 400 people or more. Preference will be given to the employment of local community members where possible.

As part of the applications for environmental authorizations and mining rights AGES has been involved in public engagement with surrounding stakeholders and authorities and this report also contains details of the public consultation process followed thus far. It must be noted that public participation is an on-going consultative and information-sharing process and that good relations must be built and maintained with stakeholders throughout the life of the project and after the project has stopped.

A number of specialist investigations were conducted during the EIS which includes: Ecological, soils and land capability and wetland assessments, heritage impact assessment, noise impact assessment, air quality impact assessment, visual impact assessment, traffic impact assessment, hydro-geological impact assessment and water supply option analysis and a closure plan and estimate for financial provision. The specialist team characterized the existing environment, quantified what those impacts may be, suggested management measures to reduce the identified impacts and assessed a number of alternatives to be considered in the project implementation going forward.

The purpose of identifying and evaluating feasible alternatives in terms of a development proposal is to find the most effective way of meeting the project needs, either through enhancing the environmental benefits of the proposed activity, and / or through reducing negative impacts. A number of different alternative types are discussed in this report. The report also identifies opportunities and benefits that may be associated with the project.

Comment is also made in this report on the importance of ensuring that the project leaves a positive legacy behind, and the compilation and implementation of detailed rehabilitation measures concurrently with the mining activities as well as post-closure. Financial provision for rehabilitation, closure and after care was also estimated.

It is expected that all of the identified potential negative impacts can be managed to acceptable levels by the implementation of detailed management measures as stipulated in this report and the associated specialist reports.

From an environmental impact management point of view it is recommended that the project continue to the definitive feasibility phase (DFS) and the authorities consider granting a positive authorization.

This EIS is submitted to the ZEMA in support of an application for environmental authorization for the proposed project. This report is also submitted (via the ZEMA) to the Mines Safety Department (MSD), under the Ministry of Mines and Minerals Development and to the relevant Water Users association or water board for the right to use water at the proposed mining development.

2 INTRODUCTION

Blackthorn Resources Zambia Limited (Blackthorn hereafter) is investigating the feasibility of the proposed Kitumba Copper Project located in the Mumbwa District of the Central Province of Zambia. The proposed project site is approximately 210 km north-west of Lusaka, and approximately 50 km north-west of the town of Mumbwa at the following coordinates:

Latitude: 14°41'53.15"S Longitude: 26°48'3.20"E

Blackthorn appointed Africa Geo-Environmental Services Gauteng (Pty) Ltd (AGES hereafter) to facilitate the environmental impact assessment (EIA) processes required under Zambian law and in accordance with the principles of sustainable development.

An Environmental Project Brief (EPB) was submitted to the Environmental Council of Zambia (ECZ, now the Zambia Environmental Management Agency, ZEMA) on 22 April 2010. The Reference Number is ECZ/INS/101/4/1. The EPB was approved in a letter dated 28 May 2010. Prospecting activities are under way on the project site in accordance with the conditions of the approval and all other relevant legislation.

The Draft Terms of Reference (ToR) for the EIA Study were prepared after a consultation / scoping meeting with the ZEMA held on 28 November 2012 (key notes are contained in Appendix 1), and submitted to the ZEMA on 13 December 2012. On 15 January 2013, the ZEMA requested amendments to the ToR. The updated ToR was re-submitted to the ZEMA on 22 January 2013. On 23 January 2013 the ToR was approved by the ZEMA, who instructed that the project may continue to the EIA phase. Please refer to Appendix 1 for proof of these submissions and approval.

2.1 Purpose of this Document

In order to proceed with the Project from the current exploration activities to mining activities on the identified resource area it is a legal requirement under the Environmental Management Act, 2011 (EMA) (and other laws, refer to Section 3) that project approval be sought from the Zambian Environmental Management Agency (ZEMA).

Section 29 (1) of the EMA states that “A person shall not undertake any project that may have an effect on the environment without the written approval of the Agency, and except in accordance with any conditions imposed in that approval.”

Therefore, in line with the applicable legislative requirements discussed further in section 3 of this document, an EIA is required before a decision can be made by the relevant authorities on whether the project may proceed to a mining project and if so under what conditions. This Environmental Impact Statement (EIS) was thus duly prepared in accordance with the approved ToR and relevant legislative requirements.

The purpose of this document is to:

- Provide an overview of the relevant environmental and mining legislation applicable to the proposed Kitumba Copper Project (Section 3)
- Provide a detailed description of the proposed project (Section 4);
- Provide a detailed description of the existing environment of and around the proposed development site (section 5);
- Provide details on consultations with the public and relevant stakeholders in the project who may be interested in or affected by the project (Section 6.1).
- Describe the anticipated impacts that the proposed project may have on the receiving biophysical and social environments (section 6);
- Describe measures which may be applied to the proposed project to minimise and manage the anticipated impacts to acceptable levels (section 7);
- Investigate alternatives to the project proposal (section 8);
- Compile an environmental management plan aimed at the implementation of the management and mitigation measures identified (section 9) and
- Deliver comment on the closure and rehabilitation of the proposed operations after mining has ceased (Section 10).

This report thus aims to provide the ZEMA as well as other decision-making authorities (such as the Mines Safety Department (MSD) and Water Users Association (WUA)), and Interested and Affected Parties (I&APs), commenting authorities and other stakeholders, with sufficient information about the proposed project and the project site in order for them to deliver meaningful comments and make informed decisions regarding the future of the proposed Kitumba Copper Project.

2.2 Format of this report

AGES and the project proponent held a consultation / scoping meeting with ZEMA on 28 November 2012, during which the preferred format for the EIS was discussed. The following table identifies the format prescribed by the ZEMA and the relevant sections of this EIS report.

Table 1: Format of the EIS report

No	ZEMA Prescribed Format	Page/Section of this report
1	Executive Summary	Section 1 pg ix
2	Introduction	Section 2 pg 1
	- Total project cost / investment	Section 2.3.3
	- Particulars of shareholders / Directors	Section 2.3

	- Track record / previous experience of enterprise elsewhere	Section 2.3.1
	- Proposed project implementation date	Section 2.3.3
	- Description of project	Section 2.4
3	Relevant regulatory framework	Section 3 pg 9
4	Project Description	Section 4 pg 15
	Land tenure	Section 4.1
	Location (including distances and nature of businesses of surrounding community, satellite images and maps)	Section 4.1
	Objectives	Section 4.2
	Main Activities (include site preparation phase, construction phase, operation phase)	Section 4.3
	Process and Technology (including flow diagrams)	Figure 6
	Raw materials	Section 4.3
	Products and by-products	Section 4.3
5	Environmental Baseline Study	Section 5 pg 34
	Climate (rainfall, temperature, humidity, sunshine etc.)	Section 0
	Air Quality	Section 0
	Geology	Section 5.3
	Hydrology (surface water and ground water quality)	Section 5.3 & 5.4
	Hydrogeology	Section 5.3
	Soils	Section 5.5
	Topography	Section 5.6
	Land Use	Section 5.7
	Land Tenure	Section 5.7
	Landscape	Section 5.8
	Noise and Vibration	Section 5.9
	Fauna (Field survey of animal species, identification of rare or endangered species, terrestrial and aquatic habitats)	Section 5.10
	Flora (terrestrial and aquatic habitats, habitats for rare or endangered species)	
	Archaeological and cultural environment	Section 5.11
	Socio-cultural and economic setup (Administration, social services and amenities, market availability on commodities, illiteracy levels, health and gender equity, traditional and religious practices and rights, sources of raw materials for such events, or location of significant historical or archaeological features)	Section 5.12
6	Impacts	Section 6 pg 86
	Environmental (positive and negative, direct, indirect, residue and cumulative)	Section 6
	Socio-cultural (positive and negative, direct, indirect, residue and cumulative)	Section 6
	Economic (positive and negative, direct, indirect, residue and cumulative)	Section 6
7	Mitigation measures for all identified potential impacts	Section 7 pg 107
8	Project Alternatives (location, process, materials, pollution control etc.).	Section 8 pg 130
9	Environmental Management Plan	Section 9 pg 153
10	Decommissioning and rehabilitation	Section 10 pg 173
11	Appendices	Section 12
	Scoping / ToR report	
	Minutes	
	Maps	
	Certificates & authorizations	

2.3 Background of the Project Proponent

Blackthorn Resources Limited is an Australian-based resources company that is unearthing value from a diverse portfolio of base metal projects in Africa (http://www.blackthornresources.com.au/). The company is listed on the Australian Securities Exchange. The particulars of the Board of Directors are available at http://www.blackthornresources.com.au/profile/board/. The company has an office in Zambia with the following contact details:

Table 2: Details of the project proponent

Ian Hart;
Blackthorn Resources Limited

Phone +260 211 250 397 Phone +260 211 250 291 Mobile +260 971 257 416 Zambia Mobile +61 457 431 006 Australia i.hart@blackthornresources.com.au	Zambia Suite 1A Al Jahazi Villas 151 Kabulonga Road PO BOX 50005 Lusaka 15101, Zambia	Sydney – Head Office Level 5, Suite 502 80 William Street Sydney NSW 2011 Australia Phone +61 2 9357 9000

2.3.1 Information on shareholders and shareholding percentage

Blackthorn Resources (Zambia) Limited is 100% owned by Blackthorn Resources Limited, with the following relevant shareholder information:

2.3.1.1 Voting rights

At meetings of the Company, each shareholder entitled to vote may vote in person or by proxy or attorney, or, in the case of a shareholder which is a body corporate, by duly authorised representative.

On a show of hands every member present or by proxy shall have one vote and upon a poll each share shall have one vote. Table 3 indicates the names of the twenty largest registered shareholders of ordinary shares as at 23 September 2013.

Table 3: The names of the twenty largest registered shareholders of ordinary shares as at 23 September 2013

	No. of shares	% of Total
Singpac Investment Holding Pte Ltd	21,205,853	12.91
JP Morgan Nominees Australia Ltd (Cash Income A/C)	19,882,280	12.10
HSBC Custody Nominees (Australia)	15,458,386	9.41
Citicorp Nominees Pty Ltd	13,752,768	8.37
National Nominees Ltd	4,450,867	2.71
JP Morgan Nominees Australia Ltd	3,569,185	2.17
UBS Nominees Pty Ltd	2,724,414	1.66

HSBC Custody Nominees (Australia)	2,636,317	1.60
Singpac Investment Holding Pte Ltd	2,100,000	1.28
Merrill Lynch (Australia) Nominees Pty Ltd	1,651,326	1.01
BNP Paribas Nominees Pty Ltd (Jarvis A/C Non Treaty DRP)	1,617,206	0.98
Mr Christopher Brown	1,450,460	0.88
SA Capital Funds Management Ltd (SACFM No 1 Fund A/C)	1,161,349	0.71
HSBC Custody Nominees (Australia) (NT Comnwlth Super Corp)	1,093,677	0.67
Mr Yi Weng & Ms Ning Li	1,027,100	0.63
Mr Yi Weng & Ms Ning Li	928,000	0.56
Citicorp Nominees Pty Ltd (Colonial First State Inv A/C)	833,800	0.51
JP Morgan Nominees Australia Limited	806,252	0.49
P & S Fahey Pty Ltd	785,879	0.48
UBS Wealth Management Australia Nominees Pty Ltd	735,258	0.45
	97,870,377	**59.57%**

Shareholders who have given notice of being substantial shareholders in the Company at the date of the Company's latest annual report, where their relevant interest in the number of fully paid ordinary shares are as follows:

Substantial Shareholder	%
Glencore Xstrata	14.2
North Sound	6.0
Acorn Capital	5.7
F Brewer	5.2

The shareholding and directors of Blackthorn Resources Zambia are as follows;

Table 4: shareholding and directors of Blackthorn Resources Zambia Limited

Shareholder	Shares held	Nationality	NRC/Passport No.
Blackthorn Resources Limited	4,999	Australian	Body Corporate ACN 009193980
African Investments Pty Limited	1	Australian	Body Corporate ACN 107540992 1075
Director	Shares held	Nationality	NRC/Passport No.
Scott Frederick LOWE	Nil	Australian	E4068660
Geoffrey Mutale MULENGA	Nil	Zambian	235571/11/1
William Douglas CASH	Nil	Australian	M2907944
William Paul SAUNDERS	Nil	British	943630/67/2

2.3.2 Previous Experience of Enterprise elsewhere

Blackthorn's primary assets are currently in West and Southern Africa targeting Copper, Zinc and Silver. The high-grade Perkoa Zinc/Silver Mine in Burkina Faso has recently been commissioned, with joint venture partner Glencore International managing and operating the mine, as well as providing debt funding for mine development. The Perkoa zinc mine is the largest zinc mine development undertaken in the country to date and there is a growing level of excitement over its progression (http://www.blackthornresources.com.au/projects/perkoa/).

2.3.3 Project cost / investment and implementation date

The current planning indicates that the project development (construction) will commence around 2016. Total life of mine capital expenditure for the project is currently estimated at $400 – $450M. These figures are likely to be refined as the project evaluation and design progresses.

2.4 Brief description of the Project

The proposed project is located in the Mumbwa District, in the north-west region of the Central Province of Zambia. The site is approximately 210 km north-west of Lusaka, and approximately 50 km north-west of the town of Mumbwa (See Figure 1).

The proposed project entails the mining and processing of an iron-oxide copper-gold (IOCG) deposit in an underground mining operation using sub-level caving as the base case mining method at a production rate of 3 mega tons per annum (Mtpa) and at a head grade of 1.7% Copper. The copper to be mined is primarily sulphide (secondary chalcocite and primary chalcopyrite), and oxide is lesser component. 33,000 tonnes per annum of copper cathode and ~ 24,000 tonnes per annum of wet copper sulphide concentrate is planned to be shipped from site by road truck.

Sub-Level Caving (SLC) is an underground mining method which involves controlled drilling and blasting breaking the whole quantity of ore between sub-levels, and subsequent removal of the ore via the haulage access. This mining method is associated with significant economic opportunities when compared to some other mining methods. The knowledge base for SLC is (however) comparatively small as very few mines use the method (https://www.minewiki.org/index.php/Sub-Level_Caving:_Where_Is_It_Headed%3F). The mining method is associated with ground deformations at surface (subsistence).

2.4.1 Prospecting Phase

The Mumbwa large-scale prospecting licence (reference number 8589-HQ-LPL) was first granted on 13 November 2007 and has subsequently been renewed. The Mumbwa tenement covers an area of approximately 250 km^2. Within the Mumbwa tenement the main focus is on the Kitumba Deposit (http://www.blackthornresources.com.au/projects/mumbwa/).

The prospecting project, previously held in joint venture with BHP Billiton, is now owned 100% by Blackthorn

Resources with BHP Billiton retaining a 2% production royalty (http://www.blackthornresources.com.au/projects/mumbwa/). The prospecting license is held for the following minerals:

Table 5: Minerals for which the prospecting license is held

Mineral	Abbreviation
Copper	Cu
Gold	Au
Uranium	U
Lead	Pb
Zinc	Zn
Silver	Ag
Phosphorus	P
Cobalt	Co
Diamonds	

The location of the prospecting license is indicated in Figure 1, with the proposed mining site (the subject of this EIS) indicated in Purple.

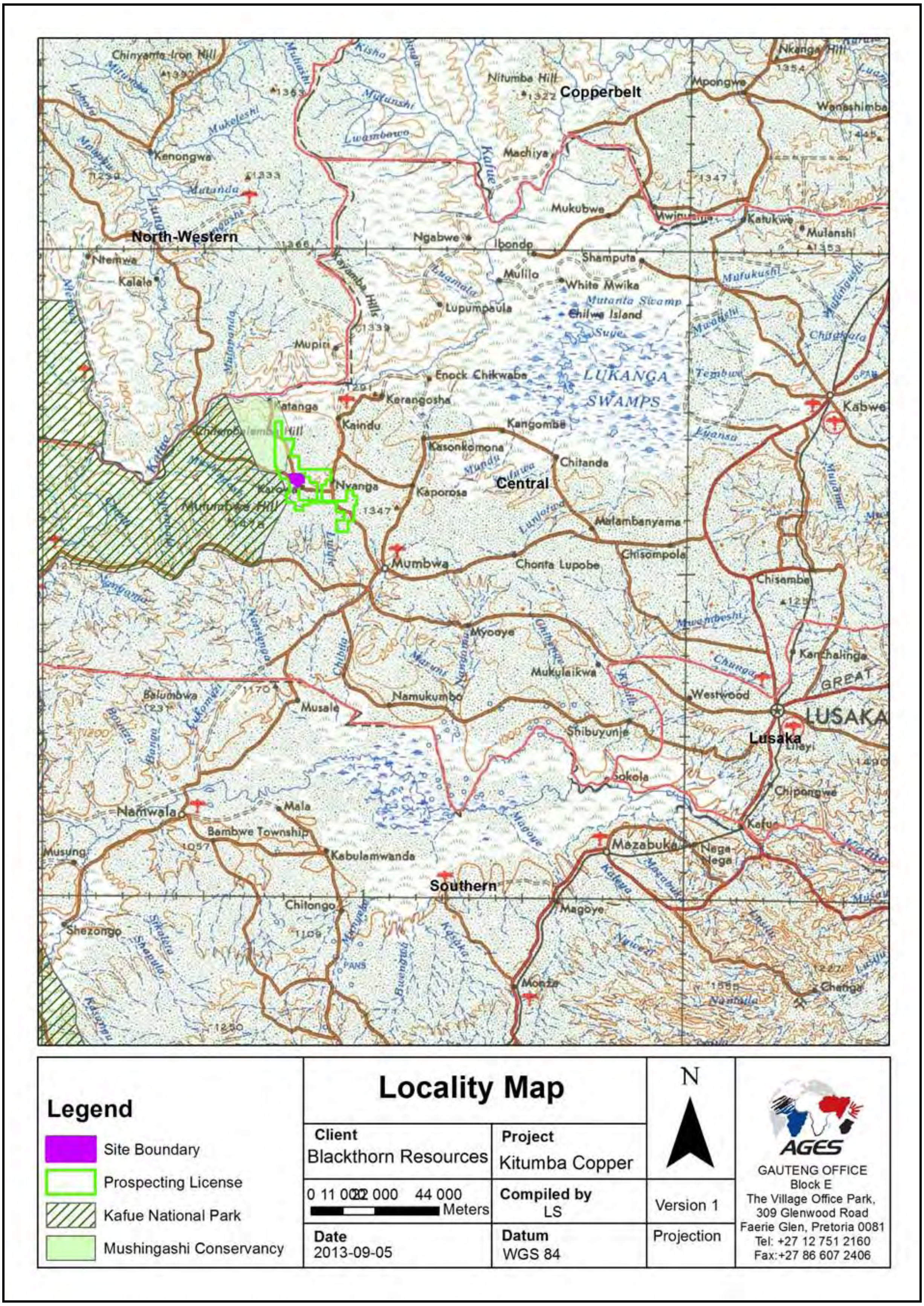

Figure 1: Regional Locality of the Prospecting License Area and Project Area

3 RELEVANT REGULATORY FRAMEWORK

There are a number of regulatory requirements pertaining to environmental management to which the proposed development will have to conform.

The Zambian Constitution (as amended by Act Number 18 of 1996) pledges:

> *"… to ourselves that we shall ensure that the State shall respect the rights and dignity of the human family, uphold the laws of the State and conduct the affairs of the State in such a manner as to preserve, develop, and utilise its resources for this and future generations."*

Thus all projects proposed within Zambia will have to conform to the principles of integrated environmental management (IEM) in the interest of sustainable development within this constitutional framework. A brief summary of the main relevant acts and statutory bodies responsible for environmental management in Zambia are outlined below. The following paragraphs contain the findings of an internal legislative review by AGES. Should professional legal advice be obtained during subsequent project phases, it may come to light that additional environmental legislative requirements are applicable to the proposed project, in which case additional licenses, permits or authorizations will have to be applied for by Blackthorn in due course prior to the commencement of the project.

3.1 Policy and Legal Framework for EIA in Zambia

The primary legislation in Zambia in respect of environmental management and impact assessment is the Environmental Management Act (EMA) of 2011, under which the Zambia Environmental Management Agency (ZEMA) is the relevant authority presiding over environmental management and EIAs in Zambia.

One of the key objectives of the EMA is to "provide for integrated environmental management and the protection and conservation of the environment and the sustainable management and use of natural resources".

Before a developer can commence with an activity listed in the schedules attached to the EIA Regulations, environmental authorization must be obtained from the ZEMA. This process involves the compilation of an Environmental Impact Statement in accordance with Regulation 7(1) of the EIA Regulations.

This document is the Draft EIS Report and is presented to Interested and Affected Parties for comment prior to submission to the ZEMA for decision-making purposes.

3.2 Environmental Authorization for Mining in Zambia

The Mines and Minerals Development Act of 2008 (MMDA) governs all mining operations within Zambia and matters related thereto. Section 25 of the MMDA describes the requirements for an application for a large scale mining license.

25. (5) An applicant shall commission and produce to the Director an environmental impact study on the proposed mining operations approved by the Environmental Council of Zambia (now ZEMA).

Thus this EIS report is also applicable to the required mining right application under the MMDA. The Mines Safety Department (MSD), under the Ministry of Mines and Minerals Development, is responsible for enforcing compliance to regulations on environmental conservation and the protection of human health and safety during mining operations.

ZEMA and MSD work in consultation with each other on issues pertaining to environment and human health in the mining sector.

3.3 Water Use Authorization

The Water Resources Management Act of Zambia (Act No. 21 of 2011) (WRMA) describes legislative requirements for the use of water for mining purposes. The Act states which types of activities require licensing of water use as follows:

71. Subject to this Act, a person who intends to—

- *a) use water for purposes specified under section sixty, other than for the domestic purposes specified under section seventy;*
- *b) construct, acquire any water works, impound, supply or distribute water from any water works or borehole to any other person;*
- *c) de-water any mine, quarry or water works;*
- *d) drain any swamp, marsh, dambo, wetland, re-charge area or other land;*
- *e) construct or acquire any water works for the purpose of draining into, conserving or utilising, in any manner whatsoever, water from a water resource;*
- *f) construct water works necessary to restore the course of a water resource that has changed its course;*
- *g) harvest any rainwater by means of a dam, weir or barrage that is on a water resource;*
- *h) conduct any operation that would interfere with the bank or course of a watercourse;*
- *i) sink, deepen or alter any borehole for any purpose in a water shortage area; or*
- *j) carry out any activity in relation to a water resource as may be prescribed;*

shall apply for a permit and pay such charges, for the use of the water, as may be prescribed.

A water use permit must be applied for under Section 72 of the Act. Section 72 (3) of the Act states that (3) Notwithstanding subsection (1), a person holding a permit or a licence under the Mines and Minerals Development Act, 2008 who requires the use of water for mining purposes, shall make an application to the Director of Mines, setting out the volume of water required, the nature of the proposed use and such other information as may be prescribed.

An application for a water use permit for mining purposes will be handed in to the Director of Mines in accordance with the above. The Director of Mines will assess the application and will thereafter forward the application including his/her comments and recommendations to the Water User Association (WUA).

ZEMA, the Director of Mines and the Water Board / relevant WUA work in consultation with each other on issues pertaining to environment and water use in the mining sector. This EIS report is therefore also in support of an application for water use rights and contains all necessary and relevant information in this regard.

3.4 Other Relevant Regulatory Requirements

Other legislation relevant to the project are listed and summarized in Table 6.

Table 6: Additional Relevant Legislation

Relevant Act	Description and Project Compliance	Authority
Air Pollution Control (Licensing and Emission Standards) Regulations, 1996 (SI No. 141 of 1996).	The regulations set out licensing requirements for emissions to the environment and ambient air quality guidelines and emission limits and provides for licensing of point source polluters. Blackthorn will consult with the ZEMA to confirm whether a license is required. Air quality monitoring at the operations will have to be conducted throughout the life of the operations to ensure that air quality and emission standards are not being exceeded.	ZEMA
Water Pollution Control (Effluent and Waste Water) Regulations, 1993 (SI No. 72 of 1993)	The Regulations set out the licensing requirements for effluent and wastewater discharges to the environment and provide discharge limits. Blackthorn has to apply for a license if they plan to discharge effluent or wastewater into the environment.	ZEMA
Hazardous Waste Management Regulations, 2001 (SI No. 125 of 2001)	The Regulations set out requirements for the control and monitoring of hazardous wastes. A Waste Register for the project has to be compiled by Blackthorn to determine whether any waste generated is classified as hazardous waste	ZEMA
Waste Management (Licensing of Transporters of Waste and Waste Disposal Sites) Regulations, 1993 (SI No. 71 of 1993)	Sets out the licensing requirements for solid non-hazardous waste transportation and operations of waste disposal sites. The project may not require a license in terms of these regulations, but will have to ensure that the transporter(s) of waste associated with the project, and the waste disposal sites, are appropriately licensed.	ZEMA
National Heritage Conservation Act, 1989	The Act provides for the establishment of the National Heritage and conservation Commission (NHCC) responsible for the conservation and management of heritage resources. If artefacts of cultural heritage value are discovered at the Project site, they will be handled in accordance with the provisions of the Act.	NHCC
Pesticides and Toxic Substances Regulations, 1994 (SI No. 20 of 1994)	The legislation Provides for licensing importation, transportation, distribution, storage, use and handling of pesticides and toxic substances. Hazardous substances (including, but not limited to those used in the beneficiation plant, and hydrocarbons, explosives etc.) will be associated with the project, and therefore Blackthorn will have to apply and obtain appropriate licenses for	ZEMA

	storage, handling, etc., in accordance with the regulations.	
Mines and Minerals (Environmental Protection Fund) Regulations, 1998 (SI No. 102 of 1998)	The regulations provide a mechanism for setting up and operating the Environmental Protection Fund. The Project will be subject to independent annual environmental audits and evaluation with in order to determine the company's environmental performance and contribution towards the EPF.	Mines Safety Department (MSD)
The Land Act, 1995	Provides for the allocation of land into categories that include state, local authority and traditional land. The land on which the proposed project is situated is under the authority of Chief Kaindu and agreements between relevant parties will have to be determined. Blackthorn is in possession of prospecting rights over the tenement.	Ministry of Lands
The Local Government Act, 1995 and Local Government (Amendment) Act 2010	These Acts provide for the establishment of local councils and districts, and specify the functions of local government, some of which relate pollution control and environmental management. Blackthorn has and will continue to liaise with the relevant local authorities and will have to comply with the relevant by-laws enacted by these authorities.	Ministry of Local government and Housing
Town and Country Planning Act, Chapter 283:	The Act provides for the preparation, approval and revocation of development plans by planning authorities, and for the control of development and subdivision of land. Building plans for ancillary structures such as staff households which will require approval from Mumbwa District Council.	Mumbwa District Council
Forest Act, 1973	The Act provides for the establishment and management of National Forests and Local Forests and makes provision for the conservation and protection of forests and trees. The Act also provides for the licensing and sale of forest produce. It is also one of the legislative mechanisms for the implementation of the Convention of Biological Diversity. If rare trees specified in the Act are identified within the Project area, they will be conserved and protected as far as possible. PART XII of the Forests Act however states that "Nothing in this Act shall affect the rights of the holder of a prospecting licence, exploration licence or mining licence to take forest produce in accordance with the provisions of the Mines and Minerals Act". No licence application is therefore considered necessary for the mining lease area at present, unless the relevant authorities should indicate otherwise.	Ministry of Tourism Environment and Natural Resources
Public Health Act, 1995	The Act relates mainly to the control and notification of infectious diseases, sanitation and housing and places an obligation on all individuals and property owners not to allow nuisance situations which could lead to the spread of infectious diseases. Employees at the project site may be housed on site in certain instances and in surrounding villages in other cases, and it will be Blackthorn's responsibility to ensure that staff are aware of what constitutes an infectious disease and what should be done in case of infectious diseases being detected.	Ministry of Local Government and Housing
Explosives Act, (Volume 9 Chapter 115)		

3.5 International and Regional Conventions and Agreements

Zambia is a signatory to a number of international and regional conventions. Those listed below include some of the most important conventions and agreements in terms of sustainable development:

- **Convention on Wetlands of International Importance, (1975)**

The Convention aims at promoting conservation and sustainable use of wetlands and their resources.

There are wetlands present on the project site and the finalization of the site layout should aim to avoid impacts to these wetlands wherever possible.

- **Convention on the Protection of World Cultural and Natural Heritage (1972)**

The Convention aims at ensuring the identification, protection, conservation, presentation and transmission to future generations of cultural and natural heritage. No cultural, heritage or archaeological sites have been identified on the project area itself.

- **Convention on Biological Diversity (CBD) (ratified in 1993)**

The objectives the Zambia's National Biodiversity Action Plans include ensuring the conservation of a full range of Zambia's natural ecosystems through a network of protected areas, development and implementation of strategies for conservation of biodiversity, sustainable use and management of biological resources.

No Biological resources of significant conservation value have been identified on the project site, although it is recommended that a biological offset be negotiated in order to compensate for biological diversity which will be affected by the project. This is especially relevant in terms of the project's proximity to conservation areas.

- **Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (Basel Convention) (1994)**

Zambia has formally agreed to the Basel Convention which aims to protect human health and the environment against the adverse effects resulting from the generation, management, movement and disposal of hazardous waste. Additionally, many countries to whom hazardous waste may be sent have ratified the Basel Convention and the provisions thereof will have to be heeded in the waste management practices of the project.

- **Convention on the Ban of the Import into Africa and the Control of Trans-boundary Movement of Hazardous Wastes within Africa (Bamako Convention)**

Zambia has also signed the 1991 Bamako Convention although the ratification has yet to be finalised. The convention is supplementary to the Basel Convention and covers movement of hazardous waste into or between signatory African countries. The provisions of the convention will have to be considered in the preparation of the waste management plan.

3.6 Summary

Licenses and permits that have thus far been identified in terms of environmental management legislation that are required in terms of the development of the proposed project are:

- Environmental Authorisation (ZEMA)

- Mining Right (ZEMA and the MMDA)
- Water Use Authorisation (ZEMA and the Water Board and/or WUA)

No other required permits or licenses have been identified at this time in terms of environmental legislation applicable to the project.

4 DETAILED PROJECT DESCRIPTION

The following section provides a description of the Land tenure and Location (including distances and nature of businesses of surrounding community, satellite images and maps), and objectives of the project. The main site activities associated with the various project phases are described, together with the proposed process and technologies to be employed at the project site. The raw materials and supplies associated with the project, as well as the products and by-products are also included.

4.1 Land tenure and location

The project site is located in the Mumbwa District, Central Province, Zambia, approximately 210 km northwest of the capital Lusaka (Figure 1). The project site is located in a rural area, with the closest large town, Mumbwa, approximately 50 km south east of the site. The closest settlements to the site are Kafucamo and Mpundu. The villages of Kaindu and Kalenda are located to the East and North East of the resource area. These settlements form part of the Kaonde tribe under the leadership of Chief Kaindu.

The proposed mining site is located within the boundaries of the Blackthorn prospecting license 8589-HQ-LPL (See Figure 1).

Access to the site from Lusaka is gained via approximately 160 km of well-maintained westerly paved road (M9) to Mumbwa, followed by approximately 50 km of dirt road (D181) northwest from Mumbwa. The nearest railhead and nearest commercial airport is at Lusaka, while registered airstrips are located at Mumbwa and at Hippo Lodge in the Kafue National Park. Road conditions between Lusaka and Mumbwa are fairly good. Road conditions between Mumbwa and the project site are very poor. A Traffic Specialist has been appointed and consultation with the Road Development Agency (RDA) has confirmed that they are planning to construct the D181 including the section relevant to this project towards the end of 2014.

No established power supply exists within the study area. ZESCO is in the process of constructing a rural power network as part of its regional electrification program. They are also initiating the construction of a high voltage (330 kV) power line from the Mumbwa substation through Kasempa to the First Quantum Minerals (FQM) Kalumbila Project in the Northwest Province. The Kitumba area does receive weak cellular phone coverage due to its elevation. Elevation ranges from approximately 1100 to 1400 meters above mean sea level (mamsl).

The project site is approximately 5 km from the Mushingashi Conservancy border at the closest point (linear distance) and approximately 5.5 km from the Kafue National Park at the closest point (linear distance). No agriculture is allowed within these areas and the area is infested with tsetse fly. Population and livestock farming are therefore limited in the surroundings.

Minor tourism and licensed hunting are practiced in the surrounding areas (Robertson, Hall, & Gallant, 2012). There are existing mining operations in close proximity to the site which are not thought to be legal and it appears that these operations have resulted in significant ecological damage and considerably unsafe environments. This is discussed in more detail under Section 5.7.2 of this report.

Surrounding land uses in relation to the project site are illustrated in Figure 2.

4.2 Project objectives and motivation

Zambia plays an important role in the global copper mining industry. The country contains the largest known reserves of copper in Africa, holding 6% of known copper reserves in the world (The World Bank, 2011).

The Wold Bank (2011) reports that copper also plays a critical role in Zambia's economy, but that Zambia as a country could benefit more from the mining industry. Zambia has relied on mining for its development ever since commercial copper mining started in 1928 (Lungu, 2009).

The Kitumba deposit (target mining resource for this project) represents a viable resource for mining in terms of the current resource estimates. The results of the latest drilling campaigns have confirmed the existence of a substantial mineralized Iron Oxide Copper-Gold (IOCG) deposit at Kitumba and the presence of a significant high grade core to the deposit (Robertson, Hall, & Gallant, 2012).

It is currently estimated that the construction phase work force will be approximately 500 people, and the operational phases will generate employment for approximately 400 people or more. Preference will be given to the employment of local community members where possible, and the employment of females will be encouraged.

The principal project objective is thus to exploit the Kitumba IOCG mineral reserve in an economically viable and environmentally sustainable manner for the benefit of shareholders as well as current and future generations of Zambians, causing the minimum possible ecological damage while bringing economic opportunities to Zambia in the areas surrounding the development site.

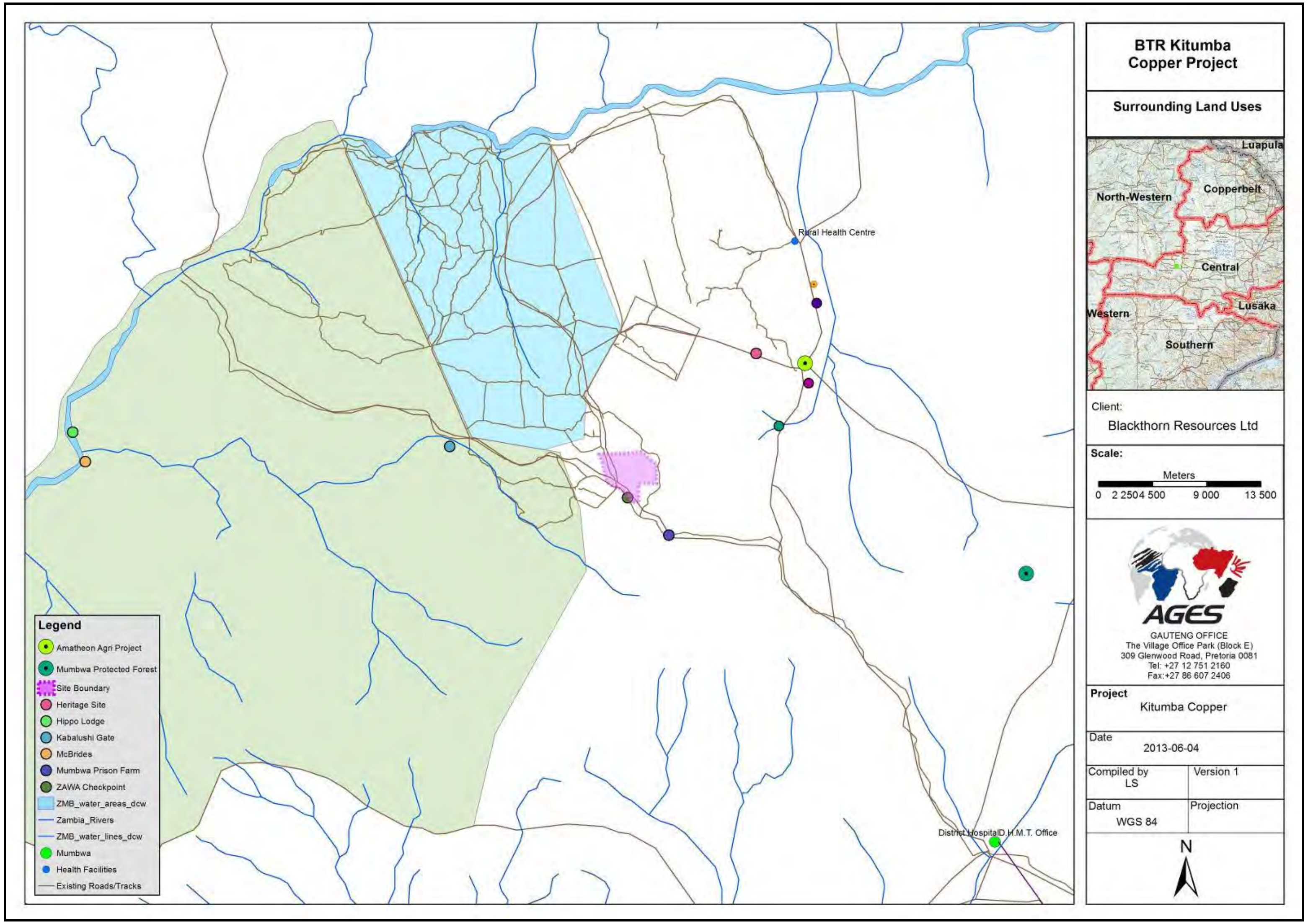

Figure 2: The project site surroundings

4.3 Main site activities and processes, materials, products and by-products associated with the project phases

The Mumbwa area has numerous historic artisanal copper mines dating from the late 19th century and has been explored for large Iron Oxide Copper Gold (IOCG) style deposits since the mid-1990s (http://www.blackthornresources.com.au/projects /mumbwa/).

The current prospecting activities on the site as described above involve extensive drilling programmes over a variety of phases, with data interpretation phases occurring in between. The site has thus been experiencing a cycle of drilling programmes and care and maintenance status

The exploration camp was constructed by BHP Billiton at the start of exploration activities and is still in use. It is planned that the camp will be expanded and upgraded to accommodate the proposed mining project as well. The camp has generator-supplied electricity and running water (reportedly not potable although some of the locals do drink from the taps without ill effect) as well as septic tank sewerage systems, a fully equipped kitchen, accommodation facilities and fully functional office facilities. The Core shed is also located at the camp.

4.3.1 Site establishment Construction Phase

Due to the prospecting activities occurring at the project site, much of the activities typically associated with site establishment will be carried over to the proposed mining project. Activities associated with the construction phase would include fencing of the entire mining site and provision of appropriate and secured access; vegetation clearance and construction of roads and site infrastructure (offices, accommodation facilities and the processing plant etc.).

The proposed layout of the project site is illustrated in Figure 3. The existing and proposed accommodation facilities are illustrated in Figure 4 and Figure 5.

The majority of supplies (food, cleaning detergents, bottled water etc.) are and will continue to be sources from Lusaka. Local produce is purchased in Mumbwa where possible. Domestic waste is removed by a contractor and disposed of at Landfill. This practice will likely continue in the operational phase although recycling options are encouraged.

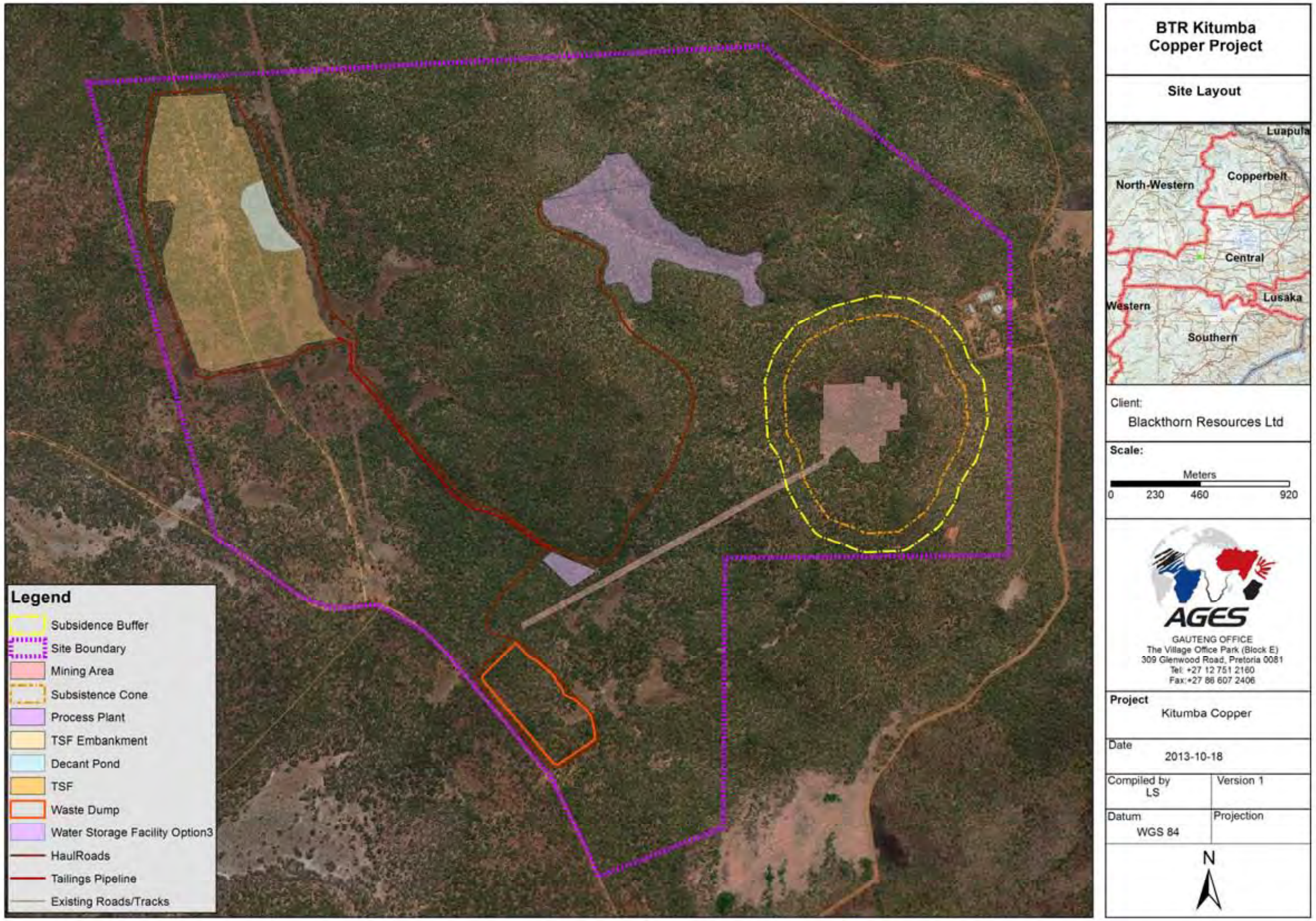

Figure 3: Proposed site layout

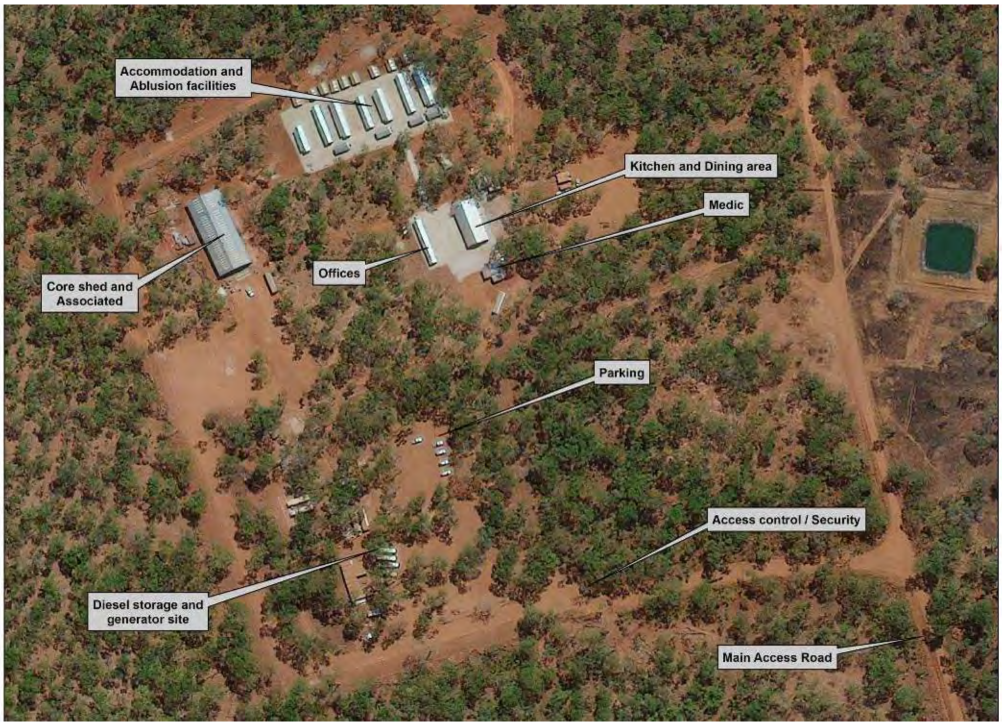

Figure 4: Existing exploration camp

Figure 5: Proposed on-site accommodation

4.3.2 Operational Phase

The proposed project entails an underground mining operation using a sub-level caving mining method at a 3 mega tons per annum (Mtpa) production rate. Twin declines will be used for access and haulage The copper to be mined is primarily sulphide (secondary chalcocite and primary chalcopyrite), and oxide is lesser component The process plant will produce both cathode copper and copper concentrate to be shipped off site by road truck. All waste material from the Processing Plant facilities will report to the TSF as thickened Tailings.

Under normal operating condition no surface discharge of process water or rainfall will occur from the tailings storage facility with water recycled to the process plant for reuse in the process circuit. In the event of extreme rainfall of greater than 1 in 100 year average recurrence interval there is the potential for water to be discharged from the tailings storage facility via an engineered spillway which has been designed to pass flows up to the probably maximum flood (~1 in 100,000 year recurrence interval). This water will be directed through an engineered discharge channel to a point at which the discharge cannot result in erosion or damage to the tailings storage facility or other infrastructure and will then be release to the natural creek system located to the south west of the tailings storage facility. On closure after the tailings beach has been covered and rehabilitated rainfall which falls on the facility will also be discharged through the same engineered spillway and discharge channel to the natural creek system.

On site facilities will include underground mining (Sub-Level Caving); processing plant; water storage facilities; waste dump; and a tailings facility. Water supply and power supply infrastructure will also be included, as well as haul roads, access road(s) and conveyors where appropriate. Additionally, office facilities and employee housing and associated infrastructure are to be located on the site. The existing exploration camp will serve as an ideal base for providing the first of these facilities but will be expanded / upgraded as necessary. It is currently estimated that the construction phase work force will be approximately 500 people, and the operational phases will generate employment for approximately 400 people. The project will aim to provide equal opportunity to women in mining and related operations where feasible. Employees will be able to travel to the site by bus (service and vehicles to be supplied by the project proponent) from Mumbwa and Lusaka.

Plant-related machinery will include trucks, loaders, production drills, tool-carriers, graders and light vehicles. A brief description of the major equipment used and the process steps is given below:

- Primary ore crushing
- Grinding and classification
- Rougher flotation to produce a bulk concentrate
- Acid leaching of bulk rougher concentrate
- Filtration of leached concentrate with filtrate processed by solvent extraction and electrowinning

(SXEW) to produce copper cathode

- Neutralisation of filtrate residue followed by secondary flotation of filtrate residue
- Secondary flotation concentrate regrind and two stages of cleaner flotation to produce a copper concentrate
- Copper concentrate thickening, filtration and stockpiling
- Tailings thickening and disposal

Personnel on site will include site supervisors, operators, drivers, drillers, a service crew, general workers, the mine management, foreman, engineers, supervisors, geologists, administrative and support staff, safety and training staff, maintenance staff, leading hands and fitters. It is recommended that an Environmental Manager should also form part of the on-site personnel, although this function may be fulfilled by a designated person along with his/her other responsibilities. Personnel during the operational phase will be approximately 280 people on site at any given time. During construction there will be approximately 350 people on site. Preference will be given to the employment of Zambian citizens where possible, and skills development training will form an integral part of mine operations.

Sub-level caving extracts ore via sublevels developed in the ore body at regular spacing. Minimal blasting, all underground, is involved during normal operations, and during the first two years of pre-production there will be blasting throughout the mine development, approximately 95 % of the blasting occurring underground. Sub-level caving is associated with a subsistence effect above the mining zone. The approximate area of the subsidence zone is 80 hectares (the subsidence cone). A buffer zone of 100 meters around the subsistence cone will also be implemented.

4.3.2.1 Detailed description of the operational phase and process design

Primary Crushing and Stockpiling: Run-of-mine (ROM) ore will be reclaimed from the ROM stockpile by front-end loader (FEL) and fed into the ROM bin from where it will be fed, by an apron feeder, into a jaw crusher. The crushed ore will be transported by the surge bin feed conveyor to the surge bin.

A 200 mm static grizzly positioned over the ROM bin will prevent rocks or trash from entering the bin and a rock breaker will be installed to break oversize material. The ROM bin will have a surge capacity of approximately 150 t or 0.5 hours.

Ore from the surge bin, which has a capacity of approximately 150 t, is fed by a variable speed apron feeder onto the SAG mill feed conveyor. A weightometer installed on the conveyor will control the speed of the apron feeder to achieve the desired mill feed rate as set by the operator.

In order to maintain steady operation through the primary crusher when the surge bin is full an overflow chute allows material to feed onto the emergency stockpile feed conveyor for discharge onto the emergency stockpile. A weightometer installed on the emergency stockpile feed conveyor monitors the amount of ore sent to the emergency stockpile. Material is reclaimed from the emergency stockpile by FEL and will be fed to the SAG mill feed conveyor via a hopper located over the conveyor.

A dust collection system will be installed on the stockpile feed conveyor at the jaw crusher discharge to reduce airborne dust around the primary crusher area.

A clean-up hopper will be provided to allow scats and other spillage to be returned to the SAG mill feed conveyor using a skid-steer loader. Drive-in style sump pumps will service the area to facilitate area clean-up. The sump pumps will deliver spillage hosed into the sump to the cyclone feed hopper located in the grinding area.

Grinding & Classification (PFDs 3135-F-201 & 202)

The circuit will consist of a SAG mill operating in open circuit with a ball mill operating in closed circuit with a cyclone cluster.

The SAG mill will be 8.53 m diameter x 4.35 m EGL mill, with a 6 MW variable speed motor. The mill will operate with between 8 and 13% ball charge. Ore will be fed to the ball mill at a controlled rate, nominally 375 dry tph, and water added to the feed chute to achieve the desired mill discharge density. Feed to the SAG mill will have a F80 of 137 mm.

The ball mill will be 6.10 m diameter x 9.05 m EGL mill, with a 6 MW variable speed motor. The mill will operate with between 29 and 36% ball charge.

Product from the SAG mill will discharge over a trommel with 20 mm apertures. Trommel oversize will be screened with screen oversize discharging onto the scats conveyor which feed the recycle crusher. Product from the recycle crusher will be returned to the SAG mill feed conveyor.

SAG mill trommel undersize will gravitate to the cyclone feed hopper where it will be combined with ball mill trommel undersize before being pumped to the primary cyclone cluster by cyclone feed pumps operating in a duty / standby configuration. A density gauge on the cyclone feed line will be used to control the cyclone feed density by controlling the addition of dilution water to the cyclone feed hopper.

The cyclone cluster will be a fully manual operation with manual valves and local pressure indication. Cyclone underflow will be directed to the ball mill feed chute whilst the overflow will be directed to the trash screen ahead of the rougher flotation.

Two vertical spindle sump pumps, one located at the feed end of the mills and another at the discharge end of the mills will service the area. The concrete floor under the mill area will slope to the sumps to facilitate clean-up.

Grinding media for the SAG mill will be introduced to the SAG feed conveyor from the SAG mill ball charge hopper located over the conveyor. Ball mill grinding media will be introduced by use of a ball charging hoist located on the cyclone tower. Balls will be charged using a kibble.

Primary Rougher Flotation and Filtration: The cyclone overflow will pass over a linear screen to remove foreign material prior to rougher flotation. Trash will report to the trash bunker where it will be periodically removed by skid-steer loader. Slurry will gravitate from the linear screen underpan through a linear sampler, which will take a continuous sample to feed the On-Stream Analyser (OSA). The remainder of the stream will flow to the rougher flotation cells.

Slurry from the sampling unit will gravitate into the sulphide rougher conditioning tank where PAX (collector) and MIBC (frother) will be added. Process water will also be added to dilute the slurry to the appropriate density. The sulphide rougher conditioning tank discharges to the head of a bank of four sulphide rougher flotation cells, 100 m3 forced air tank cells, arranged in series. Sulphide rougher concentrate will gravitate into the rougher concentrate hopper with sulphide rougher tailings gravitating to the oxide rougher condition tank.

In the oxide rougher conditioning tank additional collector and frother will be added together with the sulphidising reagent sodium hydrosulphide (NaHS). NaHS is used to sulphidise the surface of oxide minerals so that they will respond to flotation with “normal” collectors. The oxide rougher conditioning tank discharges to the head of a bank of four oxide rougher flotation cells, 100 m3 forced air tank cells, arranged in series. Oxide rougher concentrate will gravitate into the oxide rougher concentrate hopper from where it will be pumped to rougher concentrate hopper. Oxide rougher tailings will be directed to the final tails hopper.

Rougher concentrate feed pumps operating in duty / standby mode transfer rougher concentrate to the rougher concentrate filter feed tank from where rougher concentrate filter feed pumps operating in duty / standby mode pump the rougher concentrate to the rougher concentrate filter press.

Filtrate from the filter will be collected in the rougher concentrate filtrate tank from where it will be pumped by one of two rougher concentrate filtrate pumps operating in duty / standby mode to the final tails hopper. Residue (filter cake) from the filter will be discharged onto the rougher concentrate transfer conveyor which will discharge the rougher concentrate residue into the concentrate leach surge tank.

Vertical spindle sump pumps in both the sulphide rougher and oxide rougher areas collect spillage in that area and pump it to either the appropriate conditioning tank or the final tails hopper.

Concentrate Leach and Filtration: The rougher concentrate will be slurried in the concentrate leach surge tank with sulphuric acid and raffinate (acidic solution from solvent extraction) before being pumped to the first of three agitated concentrate leach tanks arranged in series. Flow between the leach tanks will be by cascading of the overflow. The purpose of the acid is to leach acid soluble copper from the concentrate into solution.

Leached slurry discharging from the 3rd concentrate leach tank will flow into the leach filter feed surge tank from where it will be pumped by one of two pumps operating in duty / standby mode to the leach filter press. Filtrate from the filter press will be collected in the PLS surge tank from where it will be pumped by one of two PLS transfer pumps operating in duty / standby mode to the PLS pond. Raffinate will be used as a wash solution through the filter press.

Residue (filter cake) from the filter press will be discharged from the filter onto the leach residue transfer conveyor which will discharge the residue into the first of four agitated neutralisation tanks.

A vertical spindle sump pump in area collects spillage and pumps it to the concentrate leach surge tank.

Neutralisation and Secondary Rougher Flotation: Leach filter residue will be neutralised by the addition of lime slurry in a series of four neutralisation tanks. Flow between the leach tanks will be by cascading of the overflows. Neutralisation is necessary to remove excess acid from the slurry prior to the next flotation stage.

Secondary sulphide flotation feed pumps operating in duty / standby mode pump the neutralised slurry to the secondary sulphide rougher conditioning tank. Two vertical spindle sump pumps located at either end of the area collect spillage and pump it into the neutralisation circuit.

Provision is made for the addition of frother, collector, lime and process water to the neutralised slurry in the secondary sulphide rougher conditioning tank which discharges to the head of a bank of four secondary sulphide rougher flotation cells, 20 m^3 forced air tank cells, arranged in series. Secondary sulphide rougher concentrate will gravitate into the secondary sulphide rougher concentrate hopper from where it will be pumped to the regrind circuit by one of two secondary sulphide rougher concentrate pumps operating in duty / standby mode. Secondary sulphide rougher tailings flow into the secondary sulphide rougher tails hopper from where it will be pumped to the final tails hopper by one of two secondary sulphide rougher tails pumps operating in duty / standby mode.

A vertical spindle sump pump will service this area for spillage clean-up.

Regrind and Cleaner Flotation: Secondary sulphide rougher concentrate and sulphide regrind mill discharge will be combined in the sulphide regrind cyclone feed hopper before being pumped by one of two sulphide regrind cyclone feed pumps operating in duty / standby mode to the sulphide regrind cyclone cluster. The cyclone cluster will be a fully manual operation with manual valves and local pressure indication. Cyclone underflow will be directed to the sulphide regrind mill whilst the overflow will be directed to sulphide cleaner 1 flotation bank.

The sulphide regrind mill operates in closed circuit with the cyclone cluster. Grinding media will be added to the regrind mill via a kibble discharging balls into the underflow launder of the cyclone cluster.

The regrind area will be serviced by one vertical spindle sump pump in the area.

Sulphide cleaner 1 will be a bank of 5 forced air trough cells, while Sulphide cleaner 2 will be a single forced air trough cell. Provision is made for the addition of collector, frother and lime at the feed box ahead of the bank. Concentrate will gravitate to the sulphide cleaners concentrate hoppers from where it will be pumped by one of two sulphide cleaner concentrate pumps operating in duty / standby mode to the feed box of the sulphide cleaner 2 flotation cell or the feed box of the concentrate thickener respectively. Sulphide cleaner 1 tails will be directed to the final tails hopper. Sulphide cleaner 2 tails gravitate to sulphide cleaner 2 tails hopper from where it will be pumped by one of two sulphide cleaner concentrate pumps operating in duty / standby mode to the feed box of sulphide cleaner 1 flotation bank. Vertical spindle sump pumps in the regrind area and cleaner area service each area.

Concentrate Thickening and Filtration: Secondary sulphide concentrate will be pumped to the feed box of the 6 m diameter high rate thickener concentrate thickener where it will be mixed with a dilute flocculant. Thickener underflow at 60% solids by weight will be pumped by thickener underflow pumps in a duty / standby arrangement to the concentrate storage tank. Thickener overflow will gravitate to the concentrate thickener overflow tank from where it will be pumped to the process water pond for re-use in the process.

Concentrate will be pumped from the storage tank, which has sufficient capacity for 12 h of filter feed, by filter feed pumps in a duty / standby arrangement, to the concentrate filter - an automatic pressure filter. Filtrate will be collected in the filtrate tank from where it will be returned to the concentrate thickener by filtrate pumps operating in a duty / standby arrangement. “Dry” concentrate will be discharged from the filter onto the concentrate conveyor for transport to the concentrate stockpile. Vertical spindle sump pumps in both the concentrate thickener area and filter area service these areas for spillage clean-up.

Tailings Disposal: Oxide rougher tails together with secondary sulphide rougher tails and sulphide cleaner 1 tails will be pumped to the feed box of the 23 m diameter high rate tailings thickeners where they will be mixed with dilute flocculant and rougher concentrate filtrate. Thickener underflow at 50% solids by weight will be pumped to the tailings storage facility by one of two sets of two stage tails pumps operating in a duty / standby arrangement. Thickener overflow will gravitate to the process water tank for re-use in the process. A single vertical spindle sump pump will service this area for spillage clean-up.

The process flow is illustrated in Figure 6. The addition of lime to the process will ensure that neutralisation of the waste stream and thus address the possibility of acid mine drainage occurring. The lime will be sourced as hydrated lime from an offsite supplier.

The Life of Mine (LoM) is not expected to exceed 20 years and is currently planned to be 11 + years. Product will consist of copper cathode as well as wet copper sulphide concentrate. 33,000 tonnes per annum of copper cathode and ~ 24,000 tonnes per annum of wet copper sulphide concentrate is planned to be shipped from site by road truck. The current assumption is that the concentrates will be placed with local Zambian smelters on the Copperbelt (via Lusaka most likely), while the cathodes will be transported to an appropriate port such as Dar es Salaam (Tanzania) or Durban (South Africa) for export (also probably via Lusaka).

The following specific information applies to the process flow diagram:

Table 7: Specific information in terms of the process flow

Particle size reduction	Refer to the descriptions above
Types of crushers	Refer to the descriptions above
Reagents to be used	The following reagents will be used as described above (sourced from off-site suppliers unless otherwise indicated) • Frother (MIBC) • PAX • Flocculant • NaHS (Sodium Hydrosulphide) • Extractant • Diluent • Hydrated Lime • Guar • Cobalt Sulphate • Sulphuric Acid
Types of leaching vessels and process	Please refer to the process description above where these processes are discussed in detail
Capacity of the copper electro winning plant and the amount of electricity needed	The process design for the solvent extraction – electrowinning plant has been based on the Production of 33,000 tpa copper with the following electricity requirements: 69000 Amps, 184 Volts
The method used when drying the copper concentrate and the moisture content of the copper sulphide concentrate	Refer to the process description above
Clarify the type of lime to be used for neutralization	Hydrated lime from an external supplier

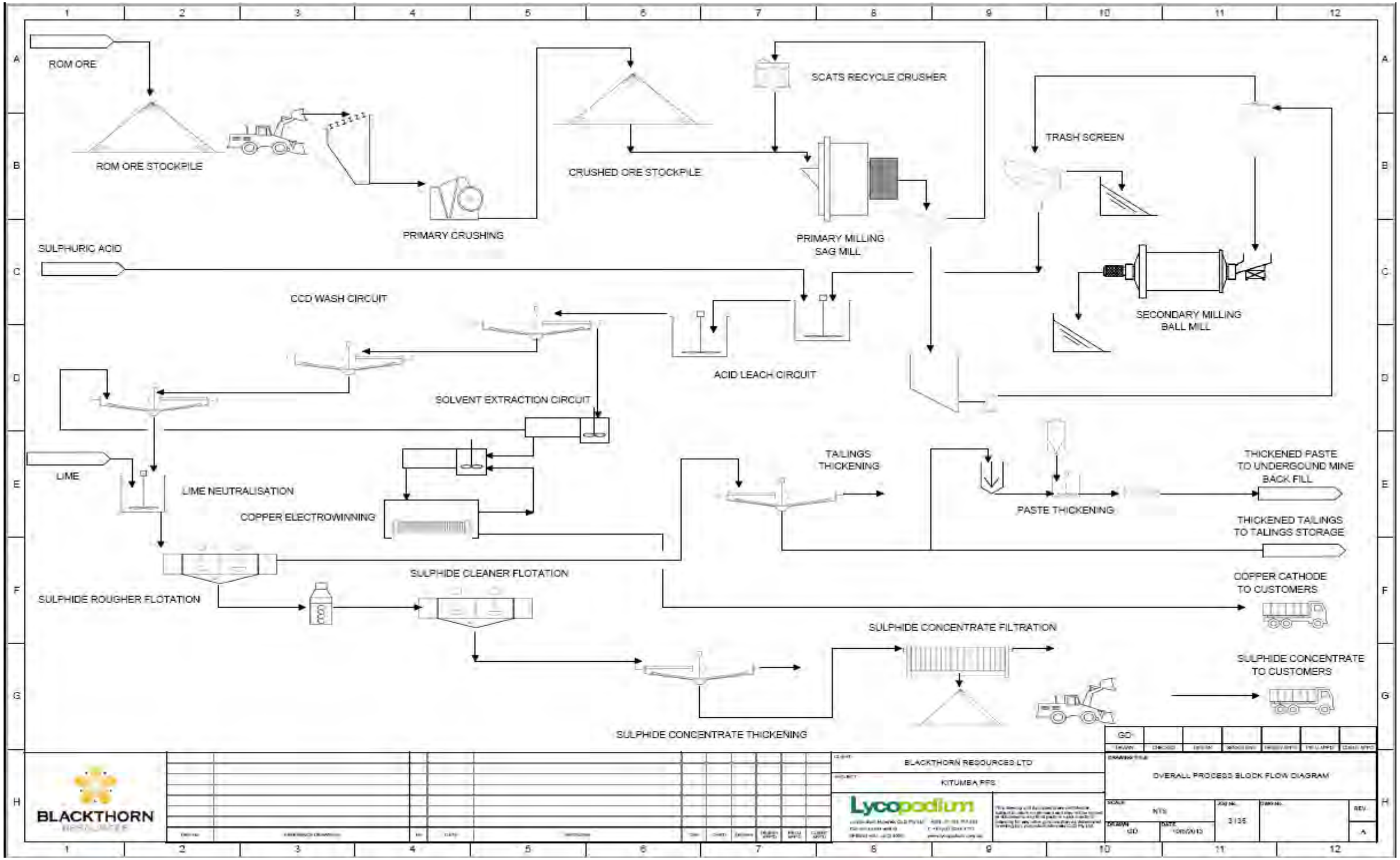

Figure 6: Process flow diagram

4.3.3 Closure Phase

The rehabilitation, closure and aftercare plan will be associated with the following primary activities:

- Dismantling of the processing plant, administrative facilities, workshops and other buildings, which will involve the removal of all equipment for salvage or re-sale. Items with no salvage value to the mine, but which might have value to individuals will be sold. Any fixed assets that can be profitably removed, will also be removed for salvage or resale. All remaining items will be treated as waste and disposed of in a designated waste disposal area.

- All rubble and waste from the dismantling of the processing plant will be disposed of in a designated waste disposal area. This excludes any tailings or slurry dam materials;

- All structures are to be demolished or dismantled, and foundations to be removed to a minimum of 500 mm below the natural ground level. All excavations will be filled with 350 mm waste rock from the stockpiled waste material and 150 mm topsoil. Terraced areas will be cut back to a slope incline of no more than 18º; and the entire disturbed area will be ripped to a depth of 500 mm, covered with topsoil and vegetated.

- Roads will be ripped, reshaped, covered with 150 mm topsoil and vegetated. Access portals to decline shafts will be sealed with a double-layered reinforced brick wall with concrete foundation. A 1Q thick reinforced concrete plug will be used to seal ventilation shafts. All structures and ventilation equipment are to be demolished, with all terracing and foundations to be removed to a minimum of 500 mm below the natural ground level. All excavation will be filled with 400 mm waste rock and the entire rehabilitated area will be covered with 100 mm topsoil. This applies to the area where the ventilation infrastructure has been removed. Any other disturbed areas will be ripped to a depth of 500 mm, covered with 100 mm topsoil and vegetated.

- The waste dump will remain post-closure, but all dump slopes will be reshaped from 24° to an 18 ° incline angle. Run-off control benches will be constructed on dump slopes at 35 m intervals to prevent storm water damage on the dump slope. The entire dump slope surface will be covered with a minimum of 100 mm topsoil and vegetated. This will serve as both a rainwater penetration cover and a dust fallout prevention measure. Paddocks will be constructed on the dump top surface to assist with evaporation and ensure the prevention of rainwater overtopping. Surface water diversions around the WRD footprint will be left in place during and post the mining operations as part of the general operational mining infrastructure;

- The TSF will remain post-closure, and if not constructed as such, the TSF walls will be reshaped to a slope incline of 18°. Run-off control benches will be constructed at 25 m intervals to prevent storm water damage on the dump slope;

- The entire TSF wall surface will be covered with 100 mm topsoil and vegetated to serve as an evaporative cover and prevent dust-fallout. Paddocks will be constructed on the top surface to assist with evaporation and ensure the prevention of rainwater overtopping;

- Surface water diversions around the TSF footprints will be left in place; and any associated equipment will be removed and disposed of.

- General surface rehabilitation will involve the reshaping of terraced land to a maximum 18° incline angle and to resemble the natural topography. All disturbed areas not covered specifically in the details of the closure and rehabilitation plan will at least be ripped to a depth of 500 mm, covered with 150 mm topsoil and vegetated.

- Fencing which has become redundant will be dismantled and removed for salvage. Where fencing is to be installed for post-closure safety, dismantled fencing will be used first. All concrete fence foundations will be demolished to 500 mm below original ground level. All fence lines are to be ripped to a depth of 500 mm, covered with 150 mm topsoil and vegetated where required.

- Water related infrastructure will remain post closure and be transferred to a suitable authority/owner.

- **It is recommended that a geotechnical study be done to determine the stability of the depression which will inform the rehabilitation of the zone of subsidence. Depending on the geotechnical findings it is proposed that either:**

    - The area be fenced off and handled as an open pit, if considered too unstable to rehabilitate. The sustainability of a fence is not beyond a decade, therefore

    - A waste rock berm that would limit access by livestock such as cattle and especially people should be developed around the depression. This is however expected to be costly and needs to be assessed during future project phases. For example the waste rock could be dumped closer to the area of depression in order to be available post-closure.

    - If stability allows standard rehabilitation measures could be implemented such as the area being ripped, levelled, covered with topsoil and vegetated thereafter but this is dependent on the findings of the geotechnical investigation.

4.3.4 The storage and Management of Chemicals, explosives and hazardous wastes

The process uses a number of chemicals/reagents that require an electrical hazardous area classification, HAC, to be performed in particular this applies to the following reagents:

- Kerosene
- MIBC
- Xanthate

A detailed HAC, including other reagents, will be completed during subsequent phases of project development. Options may exist to substitute for some regents with non-hazardous equivalents.

In general, areas for the storage of chemicals or hydrocarbons which could cause pollution by accidental spillage have to be in a designated area designed for this purpose. Specifically the area has to be bunded, and the flooring material has to be impervious and directed to a sump. The bunded are should be able to contain 1 ½ times the volume of the liquid stored in the bund.

Hazardous wastes will also be stored in designated areas, in closed containers but will be stored for the shortest possible time period before being removed off site and disposed of at a registered/licensed facility.

The Environmental Management Act, 2011 contains the following definitions specifically pertaining to hazardous waste, explosives and toxic substances including chemicals:

> *"Toxic substance" means chemical material, including an object or article, which is poisonous, corrosive, irritant, **explosive**, inflammable or harmful to human beings, animals, plants or the environment;*
>
> *"hazardous waste" means waste which is poisonous, corrosive, irritant, **explosive**, inflammable, toxic or other substance or thing that is harmful to human beings, animals, plants or the environment;"*

The Explosives Act "makes provision for regulating control over the manufacture, use, possession, storage, importation, exportation, transportation and destruction of explosives; and to provide for matters incidental thereto or connected therewith"

In accordance with the relevant legislation, the use of explosives on site is to be controlled, and explosives should only be handled and used by qualified designated persons.

Section 7 (1) of the Act prohibits the importation and exportation of explosives into or from the Republic, unless written authority has been obtained from the Chief Inspector. The project proponent will therefore have to obtain such permission if explosives are to be imported.

Section 3 (1) of the Act states that "Every person having in his possession or under his control any explosive shall take all precautions which, having regard to the purpose for which such explosive is lawfully used, are reasonable, to ensure that such explosive is not lost or stolen or is not at any time available to any person not lawfully entitled to possess or use such explosive."

This implies that the explosives storage magazine at the project site has to be secure at all times.

The Explosives Regulations provides specifically for Transportation of explosives (Part iii and iv), storage of explosives (Part v), acquisition of explosives (Part vi), the use of explosives (Part viii) and other related and relevant matters. These regulations will be strictly adhered to on the project site, including applying and obtaining all relevant licenses for transportation, possession, use and storage of explosives prior to such actions taking place on the site.

The following will apply specifically to explosives management at the proposed project:

1) Emulsion is likely the best explosive for use in stoping (not least because it is not sensitive to water). Emulsion can be delivered to (or manufactured at) site in two components which are categorised as dangerous goods. Consequently emulsion is not to be stored at the magazine.
2) The quantity of explosive required for development is significantly lower than that required for stoping. From the project schedule, it peaks at about 22t per week.
3) The site will require a surface magazine at the beginning of the project, which could possibly be replaced after approximately 2 years by an underground magazine.
4) A magazine compound of around 50m x 50m will be required, which could be sufficient for 2 magazine containers. Explosives would be separated into two different containers:
    a. blasting agents/explosives where the bulk of the mass would be stored; and
    b. Initiating systems (i.e. detonators).
5) An explosive storage requirement of 25t/week will apply: Cap115, Explosives Act Zambia - Second Schedule – the magazine should be located 250m from any site buildings or facilities, 325m from a potential emulsion plant and around 650m from any public facilities or works. Licensed explosive storage facilities in Zambia are required to be bunded with an earth wall equal to the height of the storage facility. These requirements will be strictly adhered to.
6) The currently planned position of the magazine on the surface plan (See Page 22 of Appendix 3-5) is located approximately 1000m away from other site infrastructure, with earth bunding, fencing and lightning protection.

4.4 Project water balance

The project's make-up water requirements of 4,177m3/d (48 ℓ/s) could be obtained from a number of alternative sources as discussed under section 8.5.1 of this report. The project water balance is indicated in Figure 7. This is a conservative chart as dewatering and stormwater are not taken into account.

For additional detail on the environmental water balance, please refer to the Hydrogeological report, contained in Appendix 3.

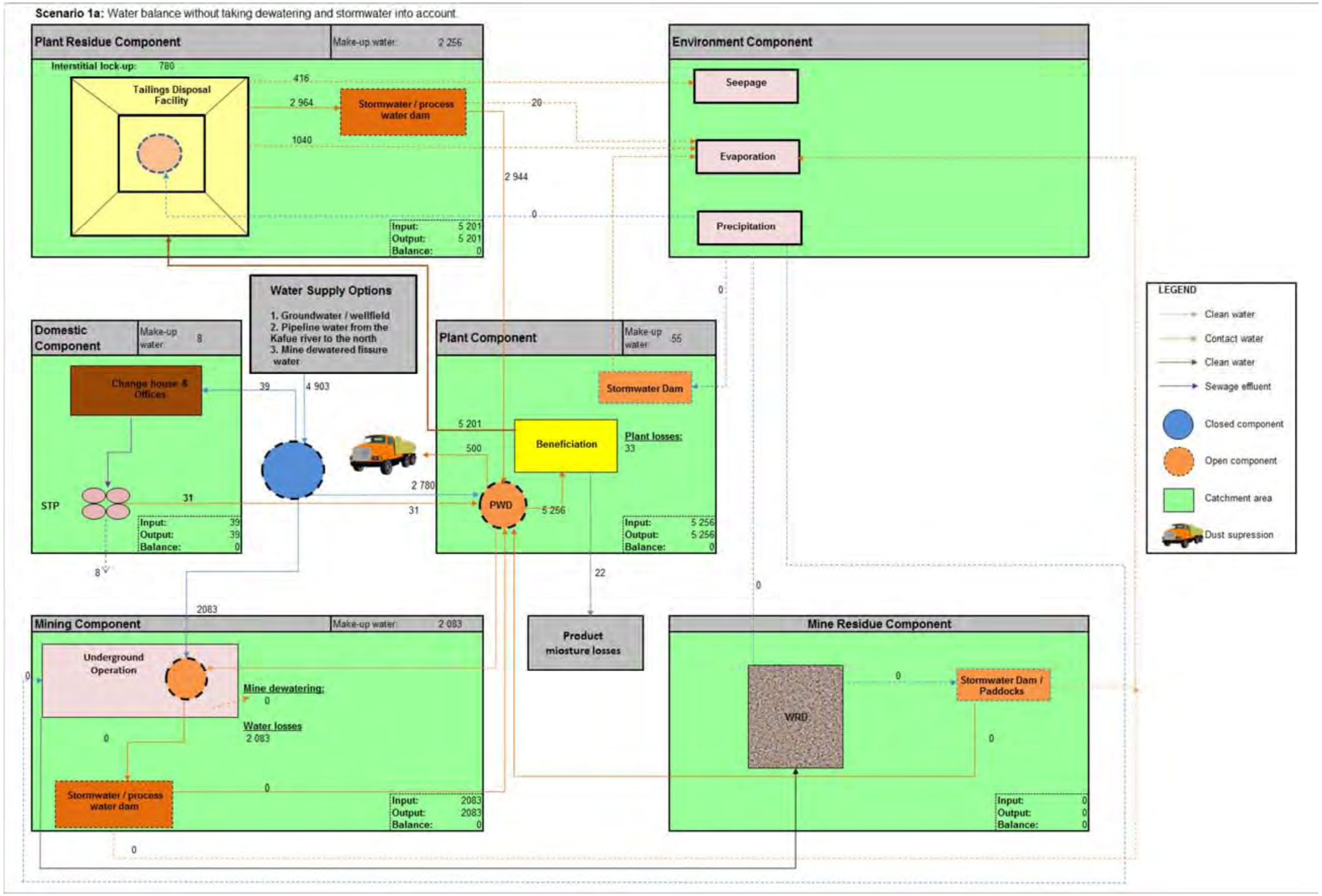

Figure 7: Project water balance chart

5 ENVIRONMENTAL BASELINE STUDY

The information contained in the following Section describes the baseline (current and existing) environmental conditions at the proposed mining site. In each case a description of the regional conditions are included where applicable in order to understand the proposed project site in context.

The baseline environmental description was sourced from Desktop studies, aerial photographs, other EIAs that have been conducted in the nearby surroundings in the past, and a number of specialist studies conducted on site as listed in Table 8. A comprehensive list of sources referenced is contained in Section 13 of this report.

Table 8: Specialist involvement in the EIS

Specialist Field	Company	Author(s)
Lead EIA Consultant	**Africa Geo Environmental Services Gauteng (Pty) Ltd – "AGES"**	**Michael Grobler** **Lelani Stolp**
Air Quality Impact Assessment	Airshed Planning Professionals (Pty) Ltd	H Liebenberg-Enslin and N Gresse
Ecology and Biodiversity	AGES Gauteng	Dr BJ Henning
Heritage and Archaeology	AGES Gauteng	Neels Kruger
Hydro-Geology Impact Assessment and water supply options analysis	AGES Gauteng	Dr. JJP Vivier; R Hansen; JFW Mostert; M Hill and F Meyer
Mine Closure and Rehabilitation	REDE Engineering & Management Services (Pty) Ltd	N de Lange and C F Theron
Noise Impact Assessment	Acusolv	Dr. Ben van Zyl
Social	Ptersa Environmental Management Consultants	San-Marie Aucamp and Ilse Aucamp
Soils, Land Capability and Agricultural Potential	AGES Gauteng (Pty) Ltd	Dr BJ Henning
Traffic	Corli Havenga Transportation Engineers	Cobus Havenga
Visual Impact Assessment	Newtown Landscape Architects	Mitha Cillliers and Graham Young
Wetlands	AGES Gauteng (Pty) Ltd	Dr BJ Henning

5.1 Climate

5.1.1 Regional Climatic Conditions

Zambia is situated in a subtropical climate generally described as pleasant tropical, but seldom unpleasantly hot outside of the valleys (Henning B. J., May 2013). Chapman & Walmsley, 2003, describes three distinct seasons prevalent in Zambia, namely the cool dry season (April/May to August), the hot dry season (August to November); and the rainy season or warm wet season (November to April).

The cool dry season experiences maximum temperatures between 24.5ºC and 27ºC and minimum temperatures ranging between 6.9ºC to 10.4ºC (Mndaweni, Vermeulen, & Rowland, 2009). In depressions, radiation frosts occur on cloudless nights (Henning, 2012). Night frost also occurs in places sheltered from the wind (Henning B. J., May 2013). The countryside dries up gradually and grass fires, fanned by high winds, are a feature of this time of the year.

The hot dry season is associated with a marked rise in temperatures, but new plant growth is witnessed even prior to the first rains. This season is also the main growing period for woody vegetation in the region (Henning B. J., May 2013).

During the warm wet or rainy season mean maximum temperatures vary between 27ºC and 31.4ºC while minimum temperatures range from 13.8ºC to 17.8ºC (Mndaweni, Vermeulen, & Rowland, 2009). There are frequent heavy rains and thunderstorms during this time of year, followed by spells of bright sunshine. Except for very rare showers in August, rain is confined to the wet season, which sometimes starts as early as October and finishes as early as March. At the height of the rainy season, it rains on seven or eight days out of ten.

The mean annual temperature ranges between 18–20ºC (Chapman & Walmsley, 2003). Average annual precipitation for the region is estimated at 890 mm (Mndaweni, Vermeulen, & Rowland, 2009). Nationally, annual rainfall decreases from an average of 1,000 mm in the northern parts of the country to an average of 600 mm in the south (Chapman & Walmsley, 2003).

5.1.2 Climate of the project area

The project site is located in a medium-rainfall area on what is termed the 'central plateau' with rainfall between 800 to 1000 mm per annum (Henning, 2012). Lightning is observed regularly. The altitude ranges from 1 000 m to 1 500 m and the climate is described as mild with temperatures rarely exceeding 35˚C. Average temperatures are moderated by the height of the plateau (Robertson, Hall, & Gallant, 2012) (Henning B. J., May 2013).

Maximum temperatures in the cool season range from 15˚C to 27˚C while minimum temperatures vary from 6 ˚C to 10˚C. Occasional frost occurs on calm nights in valleys and hollows which are sheltered from the wind. Prevailing winds during this season are dry south-easterlies and cause cloudy to overcast conditions (Henning B. J., May 2013). During the hot season maximum temperatures may range from 27˚C to 35˚C.

Mean annual temperature ranges between 18 and 20˚C. The highest annual average temperature is 32˚C and the lowest temperature averages 4˚C.

The average monthly rainfall and maximum and minimum temperature variation for Mumbwa is presented in Figure 8 and Figure 9 respectively.

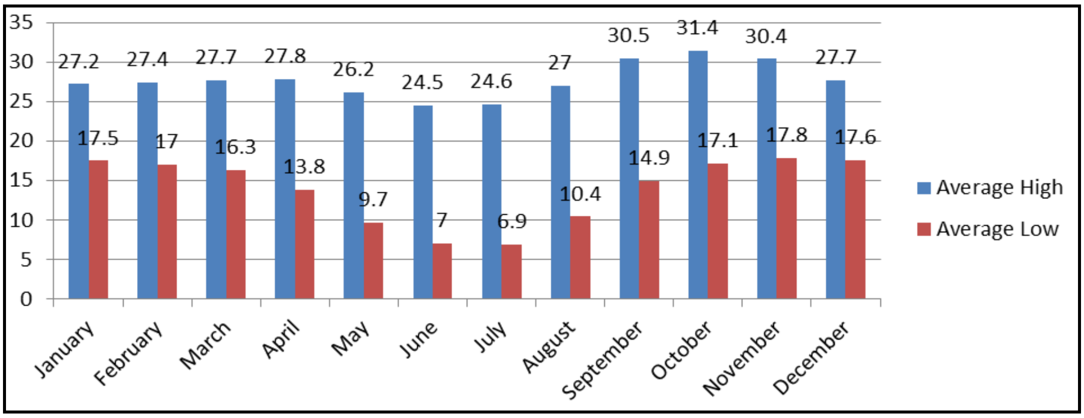

Figure 8: Average Temperatures, Mumbwa (adapted from http://www.climate-charts.com/Locations/z/ZA67655MUMBW0010.php)

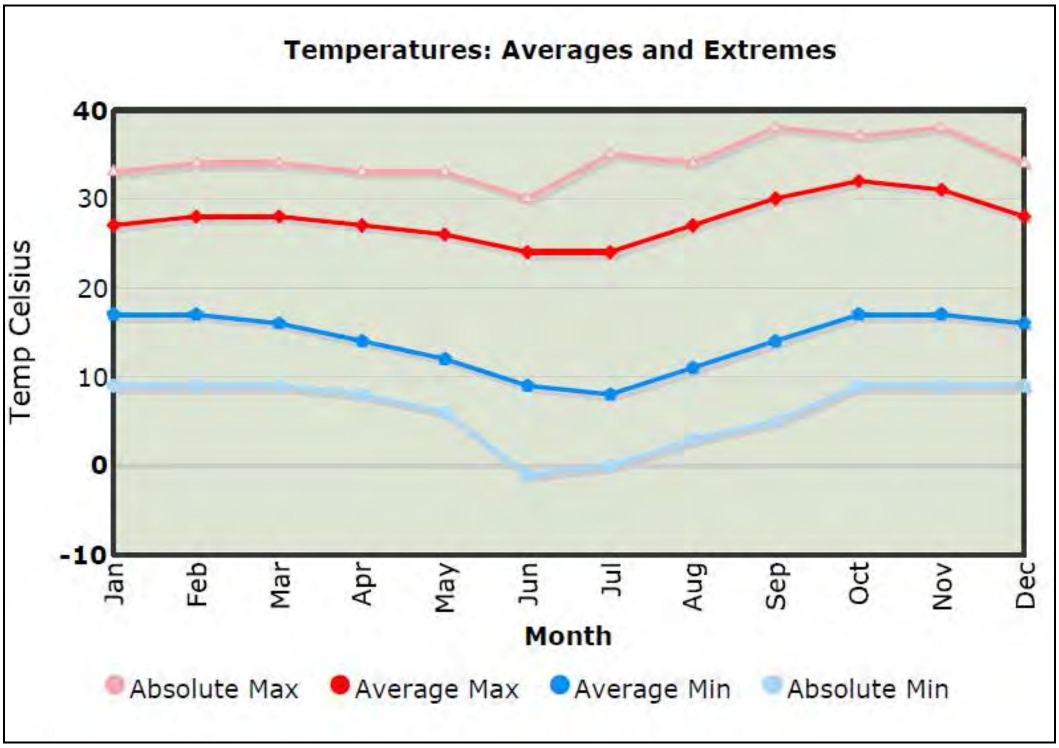

Figure 9: Average and absolute maximum and minimum temperatures for the Mumbwa area (http://www.myweather2.com/City-Town/Zambia/Mumbwa/climate-profile.aspx)

5.2 Air Quality

The existing baseline air quality is typical of the natural and rural environment.

Possible existing sources of atmospheric emissions impacting on air quality in the region include small-scale formal and informal mining activities, informal charcoal production, vehicle entrainment on paved and unpaved roads and vehicle tailpipe emissions (although traffic is very limited), wind-blown dust from exposed areas, emissions from residential fuel burning and natural burning of vegetation.

During March 2013, on-site investigation and measurements yielded the results described below (Liebenberg-Enslin & Gresse, 2013):

Atmospheric processes at both macro and meso-scales need be considered in order to accurately determine the atmospheric dispersion potential (the rate and area where pollutants from a source would affect the surroundings) of a particular area. Parameters that need to be considered in the characterisation of meso-scale ventilation potentials include wind speed, wind direction, ambient air temperature and mixing depth.

5.2.1 Wind

The results of the wind field modelling are communicated in the wind roses presented in Figure 10 - Figure 12. The dominant winds experienced at the project site are from the east and south-east and there is very little variation in the annual wind fields. Diurnal variability does occur in the wind field: during the day predominant winds are from the east, while night-times are characterised by an increase in winds from the south-east.

Winds in excess of 5 m/s are generally required to lift and entrain windblown dust. Wind speeds at the project site are primarily below 5 m/s with strong winds of more than 5 m/s occurring more frequently in relation to weak winds of 2 m/s and less. Moderate wind speeds exceeding 4 m/s occurred for 57.2% of the time with those above 3 m/s for 75.5%.

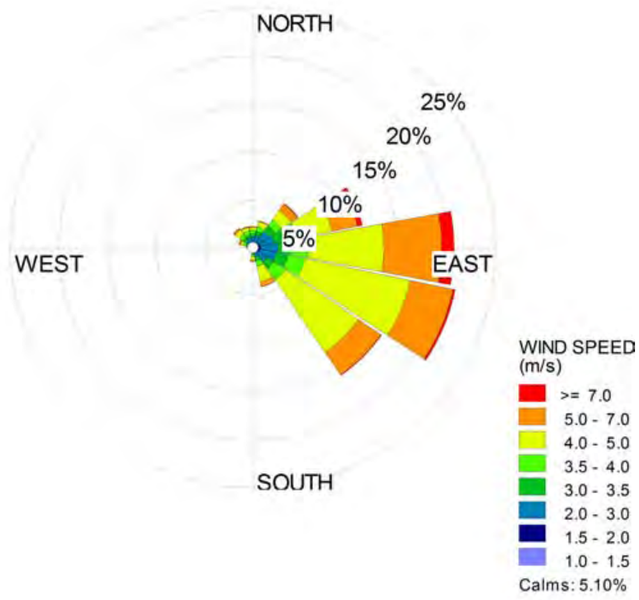

Figure 10: Period Wind Rose for the project site (2010-2012)

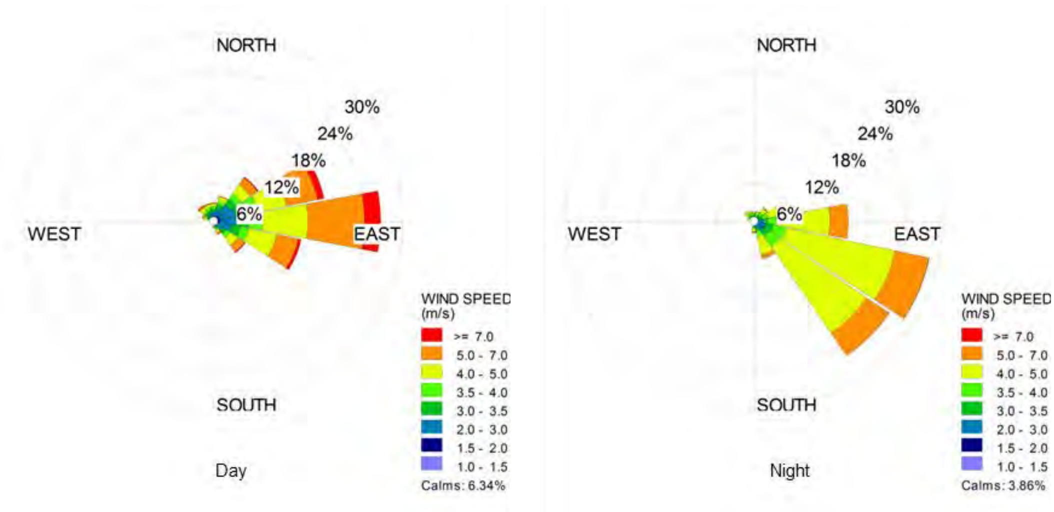

Figure 11: Daytime and Night time Wind Rose for the project site (2010-2012)

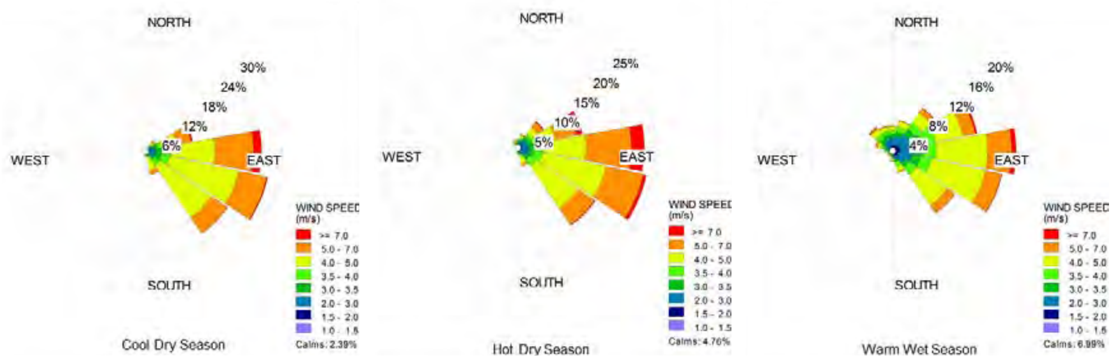

Figure 12: Seasonal Wind Rose for the project site (2010-2012)

5.2.2 Air temperature

The air temperature is considered for determining the development of the mixing and inversion layers and for determining the effect of plume buoyancy. The larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise. Maximum temperatures reach 32.2℃ at 15h00 and 16h00, while the coldest temperature of 6.1℃ is reached around 02h00. Diurnal variability of mean, maximum and minimum temperature for the proposed site from 2010 to 2012 is illustrated in Figure 13.

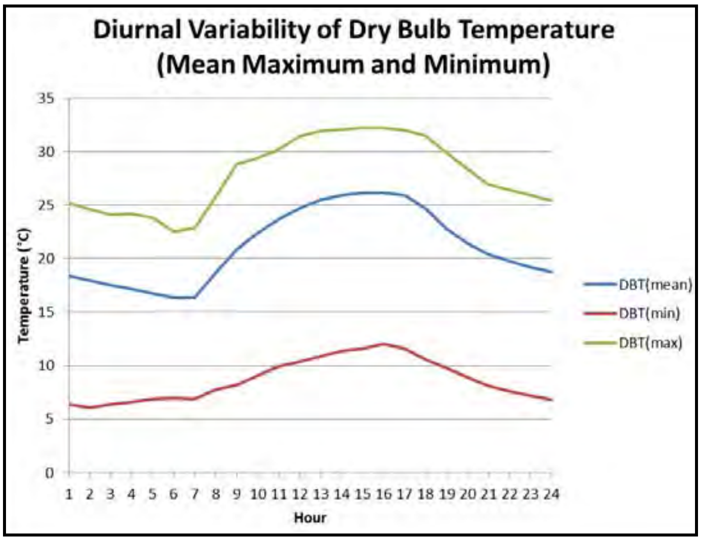

Figure 13: Diurnal variability of mean, maximum and minimum temperature (2010-2012)

5.2.3 Relative humidity

Relative humidity in the area ranges from between 16% to 100%. Monthly and diurnal relative humidity variations are presented in Figure 14.

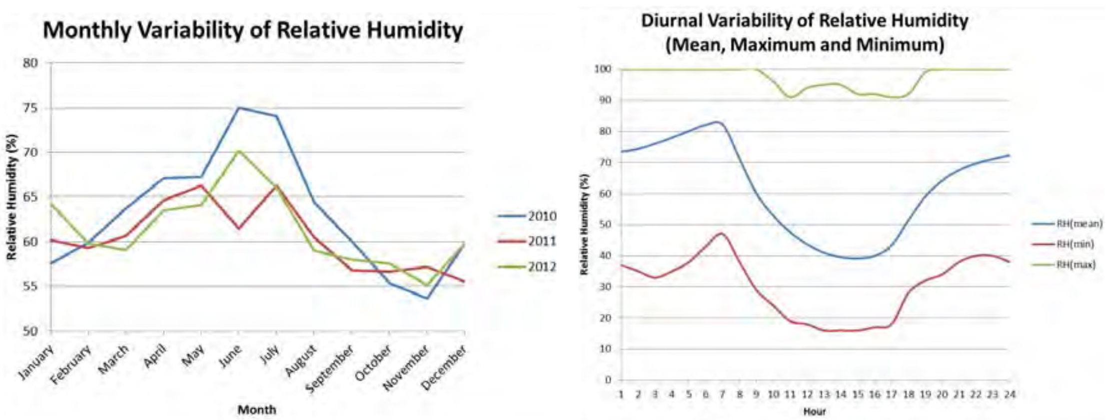

Figure 14: Monthly and diurnal humidity variations (2010-2012)

5.2.4 Precipitation and evaporation

Rainfall (precipitation) represents an effective removal mechanism of atmospheric pollutants and is therefore frequently considered during air pollution studies. Evaporation rates have important implications for the design and implementation of effective dust control programmes and must therefore also be considered. Evaporation is a function of ambient temperature, wind and the saturation deficit of the air.

An on-site weather station was installed during June 2013 and data from this weather station should be considered in future studies. The total rainfall for the town of Mumbwa which is the closest town to the project site is between 747 mm and 880 mm depending on sources considered. Rainfall is restricted to the summer months (November to April).

Air pressure in the area ranges from 867 hPa in August 2010 to 886 hPa in January 2011. The period data investigated includes data from 2010 to 2012 and the average was approximately 875 hPa.

5.2.5 Atmospheric Stability and Mixing Depth

The atmospheric boundary layer constitutes the first few hundred meters of the atmosphere and is directly affected by the earth's surface, either through the retardation of flow due to frictional drag, or as result of heat and moisture exchanges taking place at the surface.

The atmospheric boundary layer is typically unstable during the day due to turbulence caused by the sun's heating effect on the earth's surface. The thickness of this mixing layer depends predominantly on the extent of solar radiation, and the situation is more pronounced during winter due to strong night-time inversions and a slower developing mixing layer. During the night a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral.

For elevated releases such as stack emissions, the highest ground level concentrations would occur during unstable, daytime conditions. In contrast, the highest concentrations for ground level, or near-ground level releases from non-wind dependent sources would occur during weak wind speeds and stable (night-time) atmospheric conditions. The project site predominantly experiences stable conditions (36 % of the time) while unstable conditions are experienced 25% of the time and neutral conditions prevail approximately 17% of the time.

Modelling which was completed in terms of potential air quality impacts indicated that the project would affect air quality beyond the borders of the mining site, but as there are no permanent receptors in the affected area, this is not expected to be a significant concern.

5.3 Groundwater and Geology

The project site in terms of regional geological setting is located to the south of the Katangan copper belt in Zambia. The Neoproterozoic Katangan belt to the north of the project area forms a north-directed thrust-and-fold arc, termed the Lufilian Arc. Refer to Figure 15.

Locally, the Kitumba deposit is hosted within a hematite-dominated breccia system which is developed along the Mumbwa Fault Zone (MFZ) and which outcrops as a prominent north-south trending ridge forming part of the Kitumba Hills (Vivier & Mostert, June 2013). The MFZ is crosscut by a series of northeast trending faults with associated dextral displacements. The central part of the deposit is crosscut by a zone of later north-northwest to northwest trending intense faulting and fracturing. This structural framework resulted in development of secondary permeability which appears to have played a major role in remobilisation and re-concentration of copper and gold mineralisation (Vivier & Mostert, June 2013).

Kitumba represents a deeply weathered system with weathering and oxidation extending to several hundred metres depth. Deep weathering is particularly pronounced in the vicinity of the MFZ and zones of high fracture intensity, where leaching of the hematite-rich breccia systems has typically resulted in porous, vuggy rocks.

Three prominent rock-type associations are recognised at Kitumba: (1) Kundulungu Group metasediments are intruded by (2) quartz-feldspar porphyry granitoids which are in turn intruded by (3) feldspar porphyry syenite complex. The geometry of this system is considered to be sub-vertical and complex, arising from several phases of intrusion commonly in the form of dyke swarms (Vivier & Mostert, June 2013).

The site is underlain by a shallow and a deep aquifer system with structural geology and weathering playing a major role in aquifer development. The shallow aquifer consists of ferricrete and alluvium material and occurs from surface to depths of 10 meters below ground level (mbgl). Wetlands/marshes within the study area are formed as part of the shallow, perched aquifer. The deeper, intermediate aquifer is formed by weathered/fractured bedrock and occurs from 40 mbgl to 200 mbgl. This aquifer is underlain by a deep aquifer deeper than 200 mbgl that consists of solid/fractured bedrock at varying intersection depths (Vivier & Mostert, June 2013).

Geochemical modelling that was conducted for the project indicated that there is a potential for the mine tailings facility to produce acid. The potential for Acid Mine Drainage (AMD) to result from the operations was addressed by the addition of significant quantities of lime to the process to neutralize the waste stream. While there will be sulphides present in the tailings that report to the TSF, the processes are operated at ~ pH 10 – 11 by the addition of lime so the final tails will be at the same pH. As a result the tailings will have a high pH and significant lime content. The formation of AMD has therefore been addressed and is not a significant concern, however the high pH may have alternative implications to the geochemical impacts of the project and further investigation is warranted from a process engineering perspective.

Uranium also occurs in the mine waste, but based on current estimates, the degree of enrichment is not considered severe (Rowles, 18 June 2013). Follow-up radiological and human health impact assessments are still recommended as part of the DFS in order to quantify the risk more definitively.

During August 2012, AGES conducted a preliminary hydrocensus around the target mining area. During March 2013, follow up hydro-geological investigations were undertaken. A total of 93 sites were surveyed and recorded which included 73 boreholes (79%), 6 water wells/pits (6%), 6 rivers/drainages (6%) and 8 surface water bodies (9%). (Refer to Figure 16).

60% of the surveyed sites were in use while the remaining 40% were not in use. Of the 56 boreholes in use, 41% were used for domestic purposes, 25% for monitoring, 12.5% for stock water use, 11% for irrigation, 3.5% for agricultural use, 3.5% for drilling and 3.5% for wildlife watering purposes. 41% of the surveyed sites are equipped and 59% are not. The majority of equipped boreholes are fitted with hand pumps (56%, 18 sites), while 13% of boreholes have submersible pumps installed and another 1 site has a mono pump.

The average regional water level is 21.10 mbgl with a maximum regional water level of 88.45 mbgl and a minimum of 0.0 mbgl. Water levels recorded during the dry season and the wet season respectively varies considerably. Seasonal variations are clearly visible due to a change in climatic conditions influencing groundwater recharge.

The regional aquifer is classified as a Sole Source Aquifer as more than 50% of the groundwater is utilized for domestic and/or livestock purposes and no alternative water resource is available if this aquifer is impacted on. Impacts on the aquifer have to be avoided. If the project depletes or pollutes the aquifer, alternative water has to be supplied to surrounding communities.

Twenty-two of the surveyed hydrocensus sites were selected for chemical analyses and the development of a water quality baseline database. The water quality of both the groundwater and surface water was generally found to be good. The evaluation did not include an assessment of the micro-biological content of water and this should be done in subsequent project phases.

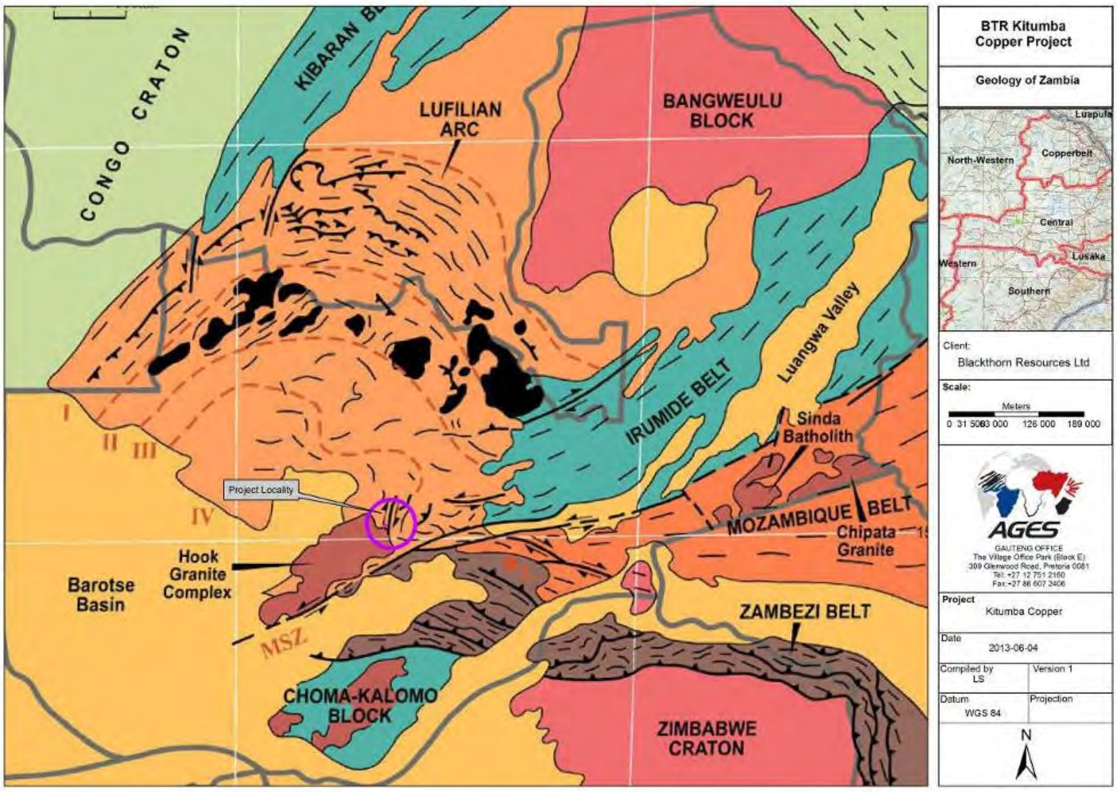

Figure 15: Geology of Zambia

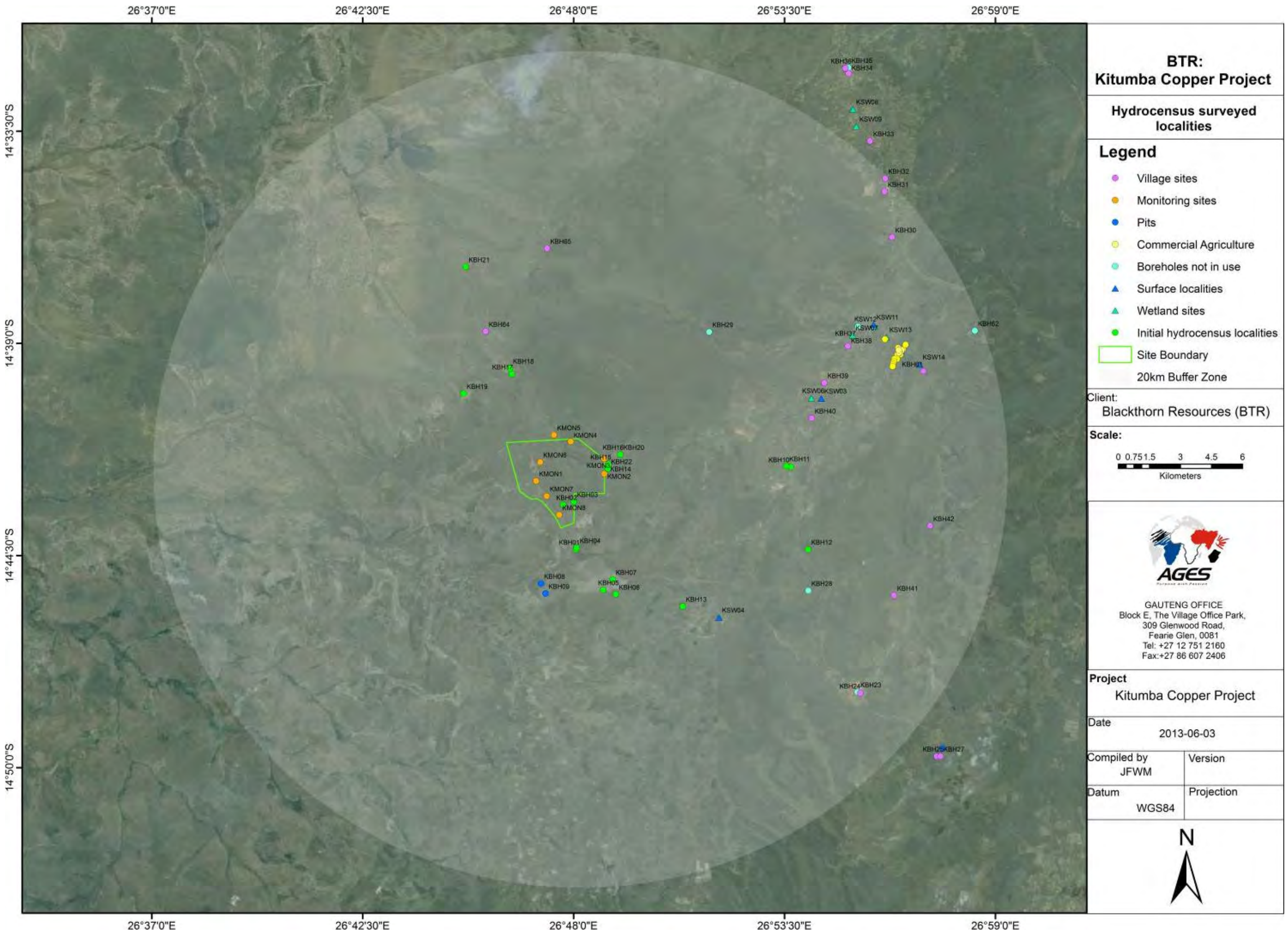

Figure 16: Sites recorded during the Hydro-census

5.4 Surface Water

The nature of the soils present on the proposed development site causes precipitation to drain away into the soils very quickly after precipitation events. While there are a number of drainage lines throughout the site, surface water flow is seldom experienced, except for immediately following rainfall events (Mndaweni, Vermeulen, & Rowland, 2009).

The project is located in the Kafue catchment of the Zambezi River Basin. The Kafue catchment comprises a total area of 156 995 km^2. The Mean Annual Runoff (MAR) for the catchment is 9.88 km^3 (Vivier & Mostert, June 2013 & Zambian Ministry of Energy and Water Development, 2012)

The Kafue River is the most significant surface water feature and the only perennial river in the vicinity of the project site, and is located approximately 30 km north and west of the proposed mining area. Drainage in the study area therefore follows the surface topography towards the lower-lying rivers in the north-west. The River flows in a west-south-westerly direction. The Kafue River is a major tributary to the Zambesi River in the South (Mndaweni, Vermeulen, & Rowland, 2009).

Other drainage features that occur in the study area include dambo wetlands and pans (Henning B. J., May 2013).

Abstraction of surface water from the Kafue River was one option considered for water supply to the proposed mine. Water would be abstracted from the River and piped to the proposed operations, although the exact route has not been determined. Construction of infrastructure related to this water supply option may in itself have significant environmental consequences, and these should be addressed and approval sought from the ZEMA as part of a separate project (separate authorization process) prior to construction commencing on any pipeline or water intake structures, should it be decided to implement this option. Abstraction from groundwater is considered another water supply option and is discussed in more detail as part of the water supply Options Analysis (Vivier & Mostert, June 2013) in Section 8.5.1.

The nature of the proposed mining operations will significantly alter the natural flow patterns of surface water across the project area following precipitation events. Storm water on the site will have to be managed in accordance with best-practice guidelines and legislative requirements. Water classified as “dirty water” will not be allowed to contaminate clean water systems, and clean water will be prevented from entering mining areas and becoming contaminated. Erosion prevention and control measures will have to be implemented throughout the site to prevent siltation of downstream water bodies. The distance to the nearest significant surface water features is a mitigating factor in terms of potential surface water pollution arising from the proposed operations. However, activities on the project site may impact on the downstream Piamanzi River (which is approximately 10 km from the resource area) which is a major tributary to the Kafue River, and this should be prevented.

Potential abstraction from the Kafue River for water supply to the mine is a proposal associated with its own risks and benefits. The legal implications and potential social and ecological damages of such abstraction would have to be understood and mitigated for in the following phases of the project if this option is chosen.

5.5 Soils and Soil Potential

Dr B Henning carried out a specialist assessment of the soils, land use, agricultural potential and land capability of the project site. The site shows variation in terms of soil characteristics and soil types. The geological formations and vegetation patterns showed a strong correlation to the major soil units mapped in the study area. The soil types, profiles and potential identified on the site are discussed below, summarized in Table 9 and illustrated in Figure 17: Soil types of the Site (Henning B. J., May 2013).

5.5.1 Shallow Lithosols / Arenosols associated with rocky ridges and outcrops

Very shallow to shallow soils and exposed bedrock occurring in the moderately steep to steep undulating mountainous terrain of the site associated with rocky ridges (including the resource area) and outcrops derived from Quarts Feldspar Porphyry or Granite. Where bedrock is exposed and topsoil has been removed the soil is classified as lithosols. The basic requirement for recognition of an orthent is that any former soil has been either completely removed or so truncated that the diagnostic horizons typical of all orders other than entisols are absent.

Soil Depth ranges from 50 – 150 mm with a fine sandy to sandy loam texture and a clay content of 5 – 10%.

Agricultural Potential is limited by shallow soils and steepness of terrain (causing high erosion hazard) and lithosols are thus not suitable for arable farming although crop cultivation can occur under good management on plateaus and level terraces. High cost of fertilization required when farming crops on such soils has meant that arenosols are not generally used for farming in Zambia. Soil potential is thus classified as “low”.

The flora typically supported on these shallow soils is generally of very poor nutritive value for grazing, so that typically such areas can only be used as low-density, low quality livestock grazing during the rainy season when the herbaceous layer revives after the burns that occurred during the drier months. The area has little value as grazing in the winter months due to the coarse, unpalatable state of the grass layer, and the occurrence of fire which reduces the grazing value of the area to zero.

5.5.2 Medium depth gravelly / sandy Arenosols associated with foot-slopes / valleys

Shallow, gravelly soils along the valley floors and footslopes in the study area derived from Argillite. Arenosols are sandy-textured and lack any significant soil profile development. They exhibit only a partially formed surface horizon (uppermost layer) that is low in humus, and are bereft of subsurface clay accumulation.

Arenosols typically have very low water-holding capacities, excessive permeability and low nutrient content and agricultural use of these soils requires careful management. Arenosols are also highly acidic in all except very arid climates.

Soil Depth is 50 – 300 mm and average clay content varies from 5 – 10%. Texture is fine sandy loam / gravelly sandy loam soils.

The value of these leached sandveld soils is often further reduced by their gravelly nature which makes them unsuitable for cultivation where the layer occurs within the topsoil and makes them more susceptible to drought where it occupies much of the subsoil, as it apparently does over large areas. The soil potential is thus limited by the soil depth and nutrient status, although it has a slightly deeper soil profile in some areas and also provides better grazing to livestock and game compared to the mountainous regions. The area is classified as having a medium to low agricultural potential. The area can be used as low-quality livestock grazing but only in the wetter months.

5.5.3 Arenosols: Red-yellow apedal soils associated with slightly undulating plains

These Red-yellow apedal sandy soils (Arenosols) cover most of the eastern and south-eastern sections of the project site, and are generally not very fertile due to weathering and leaching; the top soil is sandy and is more fertile where the top soil has higher clay content (derived from Syenite).

Soil depth of these fine sandy loam soils ranges from 400-1000 mm and clay content is between 10 – 15%

The acidity of these soils is limiting for groundnut production, maize and other cereals, and liming may be needed to increase crop yields. The area can thus be utilized for crop cultivation, although intensive soil management is recommended to improve the pH and nutrient content. The soils have a low moisture-holding capacity, but limitations are overcome to some extent by the great depth of rooting which the subsoils afford and by the slower rate at which nutrients are leached. Livestock grazing is viable due to the slightly higher nutrient and organic content of the topsoil in woodland areas that support a mixture of palatable and unpalatable species. The soil has a medium potential for crop cultivation in combination with livestock grazing.

5.5.4 Planosols associated with moist grasslands on ferricrete bedrock

Planosols are soils with a light-coloured, coarse-textured, surface horizon that shows signs of periodic water stagnation and abruptly overlies a dense, slowly permeable subsoil with significantly more clay than the surface horizon. These soils are typically in seasonally waterlogged flat lands. These soils are formed mostly in clayey alluvial and colluvial deposits. Geological processes resulted in the relatively coarse-textured, light-coloured surface soil abruptly overlying finer textured subsoil.

Soil depth ranges from 50 – 150 mm. Texture is sandy clay and clay content is between 15 – 25%.

Planosols in their natural state as observed in the study area support moist grassland dominated by *Loudetia simplex* and *Tristachya rehmanni*, often with scattered shrubs and trees that have shallow root systems that can cope with temporary waterlogging. Local methods of cultivating these soils involve drainage and burning of the topsoil. Concentration of nutrients in the ash and the continuous presence of moisture in the subsoil enable them to produce good crops, but weed growth is a serious problem. This drainage and burning lead to shrinkage and wastage of the peat, and after 20-50 years soils may be exhausted altogether, leaving only a somewhat humic topsoil in the sterile basal white sand.

The seasonally flooded nature of the soils limits crop cultivation, although crops such as rice and cassava can be cultivated under such conditions. The grazing potential of these low-lying areas is high due to the palatable grasses growing throughout the year on these soils.

5.5.5 Fluvisols associated with ravines in mountainous areas

Fluvisols are genetically young soils in alluvial deposits associated with the ravines in the mountainous region of the study area. Under natural conditions periodical flooding is fairly common. The soils have a clear evidence of stratification. Soil horizons are weakly developed, but a distinct topsoil horizon may be present.

Soil depth varies from 300 – 600 mm and average clay content is between 25 – 40%. The soil texture is Brown to dark grey alluvial soils.

Agricultural Potential of these soils is low to very low due to the area being seasonally flooded and the steep nature of the terrain along the ravines. The soils do however produce valuable grazing (medium potential grazing) during dry months to game and livestock.

The land capability is limited to grazing by game and livestock throughout the year. The small area and steep slopes along the ravines make crop cultivation challenging. The grazing potential is high due to the palatable grasses growing throughout the year on these soils.

Table 9: Summary of Soils on the Project Site

Soil Type	**Shallow Lithosols / Arenosols**	**Medium depth gravelly / sandy Arenosols**	**Arenosols: Red-yellow apedal soils**	**Planosols on Ferricrete Bedrock**	**Fluvisols**
Area	Rocky ridges and outcrops	Footslopes and Valleys	Slightly undulating plains	Moist grasslands	Ravines, mountainous areas
Soil Depth	50 – 150 mm	50 – 300 mm	400 - 1000 mm	50 – 150 mm	300 – 600 mm
Texture	fine sandy to sandy loam	Fine / gravelly sandy loam	fine sandy loam	Sandy Clay	Brown – dark-grey alluvial
Clay content	5 – 10%	5 – 10%.	10 – 15%	15 – 25%	25 – 40%
Agricultural Potential	Low	Medium - Low	Medium	Low	Low to Very Low
Grazing potential	Low	Low	Medium	High	High
Risk	High erosion risk; low compaction risk; low risk of impact on land capability	Low erosion risk; high compaction risk; medium-low risk of impact on land capability	Low erosion risk; High compaction risk; medium risk of impact on land capability	High erosion risk; High compaction risk; medium risk of impact on land capability	High erosion risk, medium compaction risk, medium risk of impact on land capability

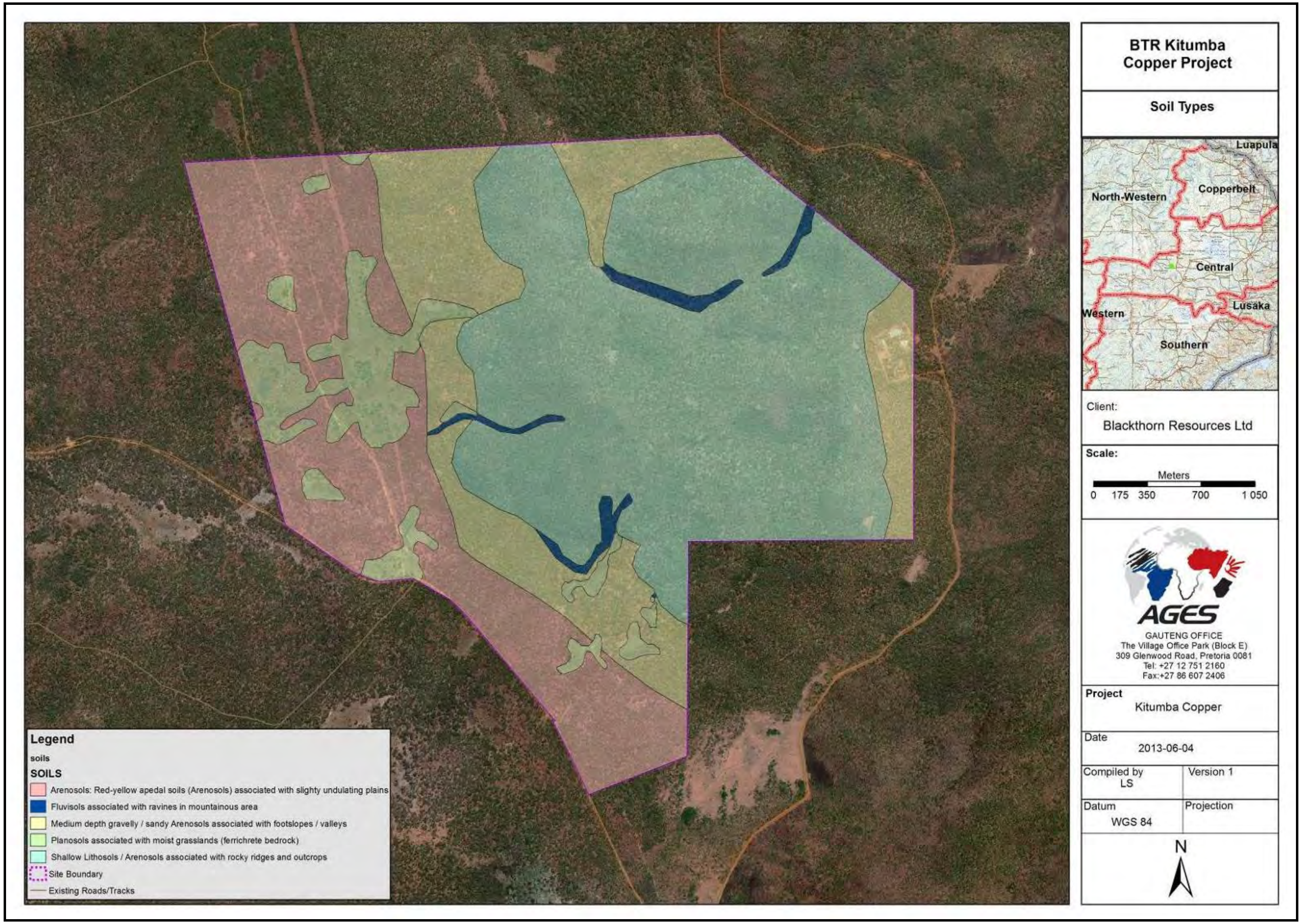

Figure 17: Soil types of the Site (Henning B. J., May 2013)

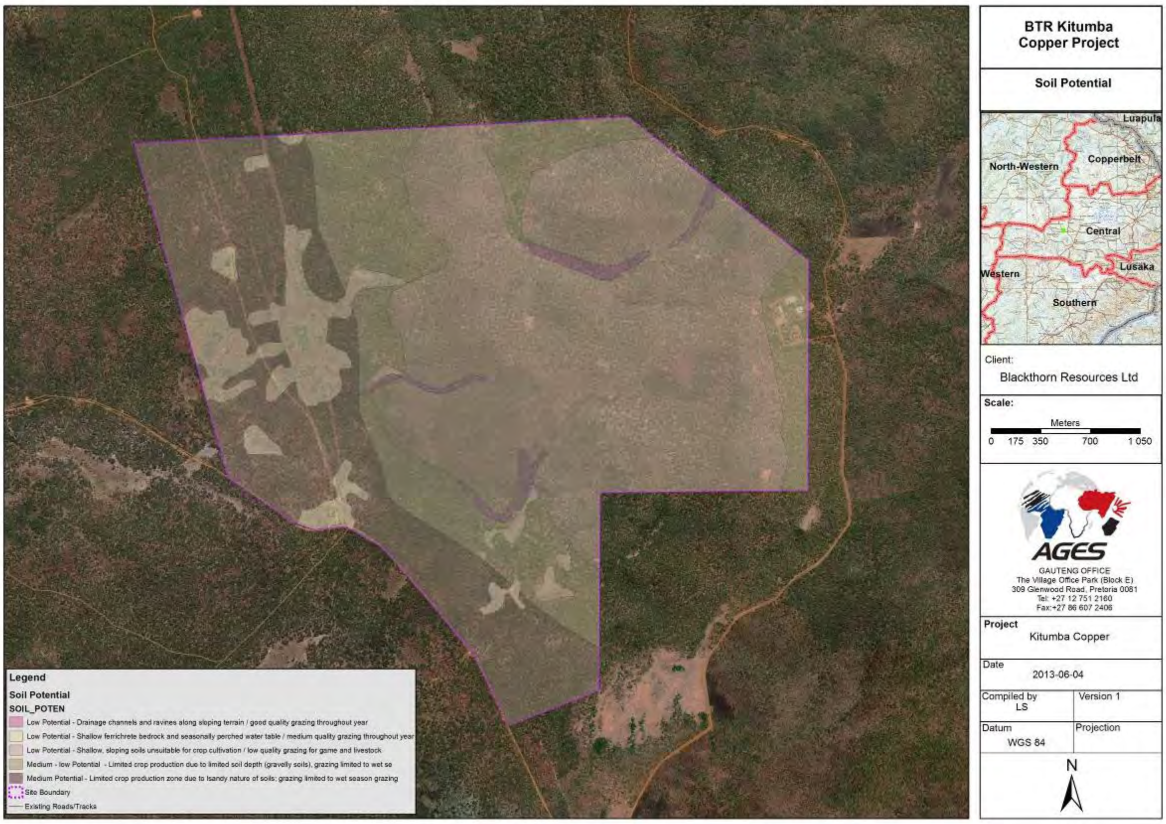

Figure 18: Soil potential of the Site (Henning B. J., May 2013)

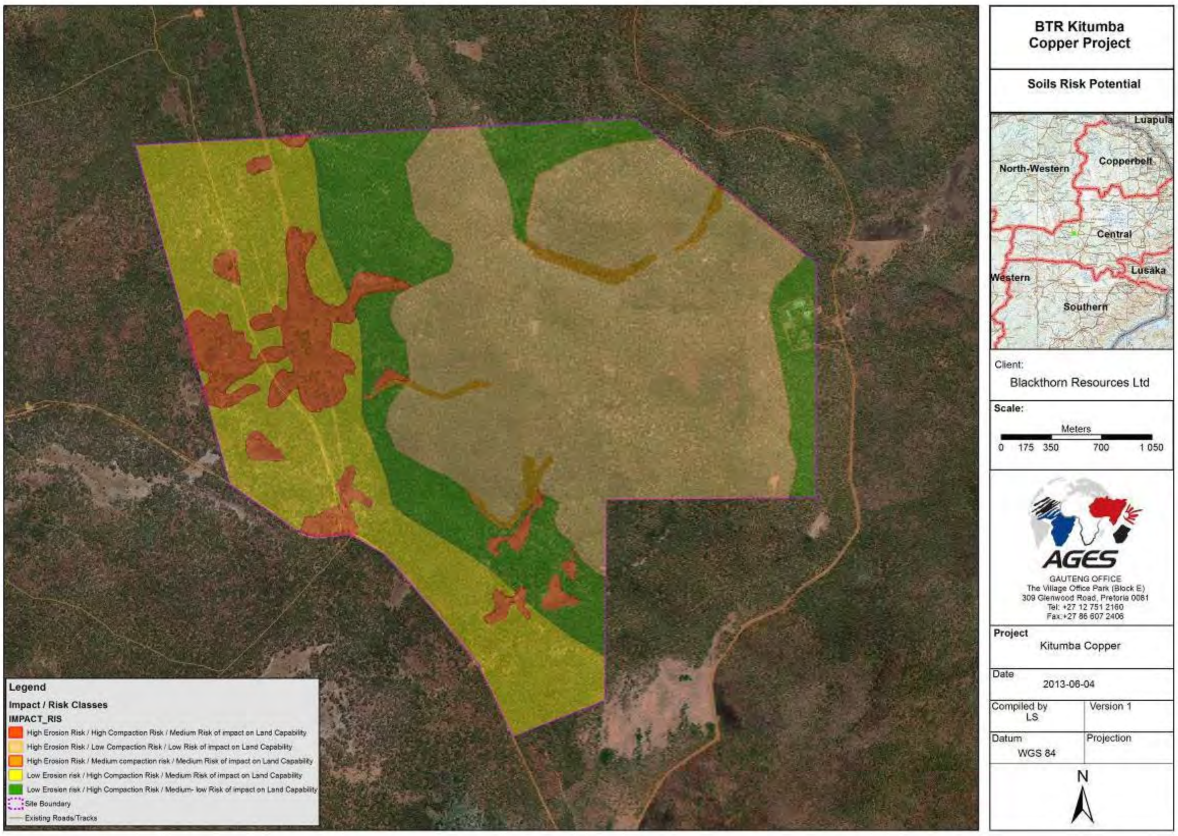

Figure 19: Soil Risk / Impacts (Henning B. J., May 2013)

5.6 Topography

The regional topography can be described as rolling terrain consisting of hills and valleys. Elevation ranges from approximately 1100 to 1400 meters above mean sea level (mamsl). Noticeable topographic high points occur in the area, and the target mining area comprises such a hill (Kitumba Hills). Towards the North of the project area the topography flattens out towards the Kafue River (Mndaweni, Vermeulen, & Rowland, 2009).

The areas north-west of the project area comprises gently undulating plains while the landscape to the west is generally flat with scattered small hills. Figure 20 and Figure 21 present elevation profiles across the area.

The topography of and around the proposed development site may have the potential to effectively mitigate the visual impacts of the project infrastructure. The natural runoff over the site is also dictated by the site-specific topography, and careful planning should take the natural flow of surface water across the site into consideration in order to minimise the potential for water pollution. The topography and natural drainage lines over the site are illustrated in Figure 22.

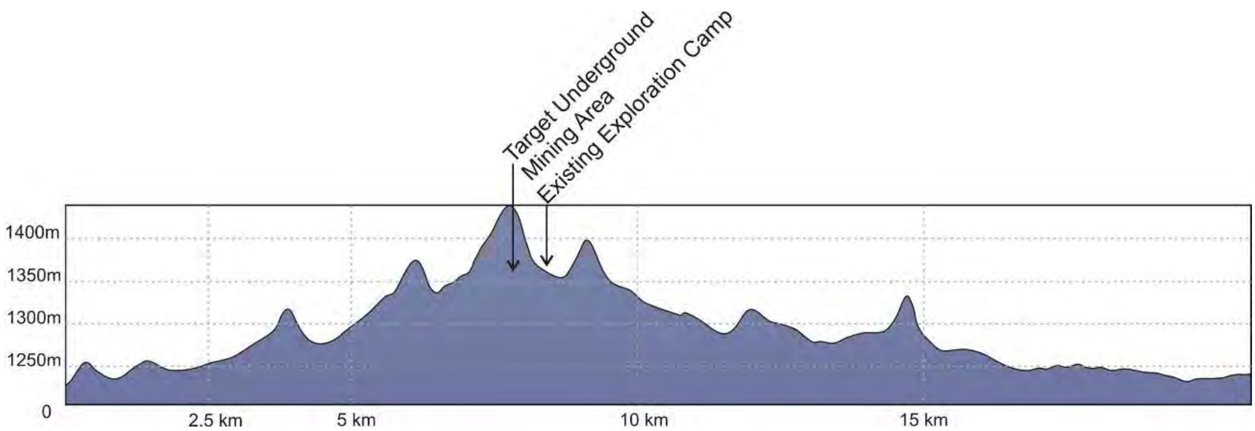

Figure 20: East-West Elevation Profile (adapted from Google Earth Pro)

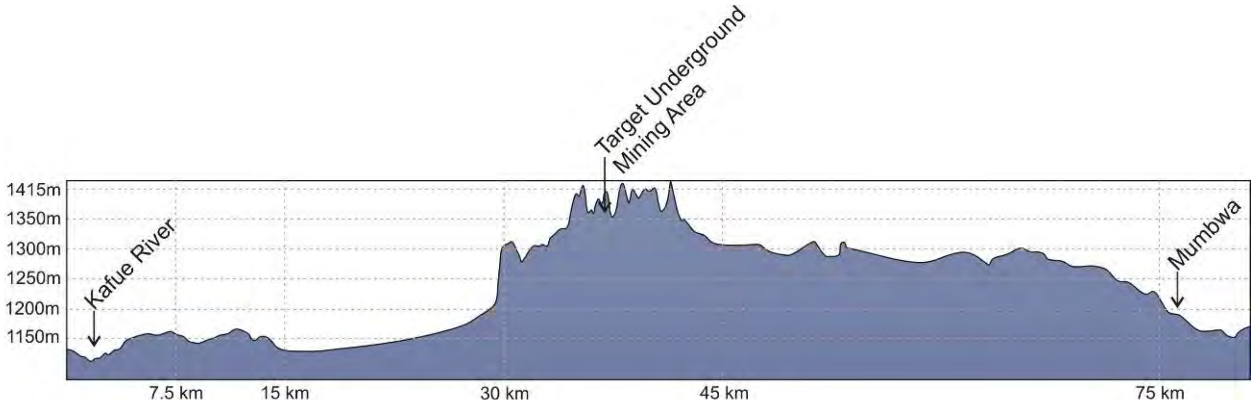

Figure 21: North-West to South-East Elevation Profile (adapted from Google Earth Pro)

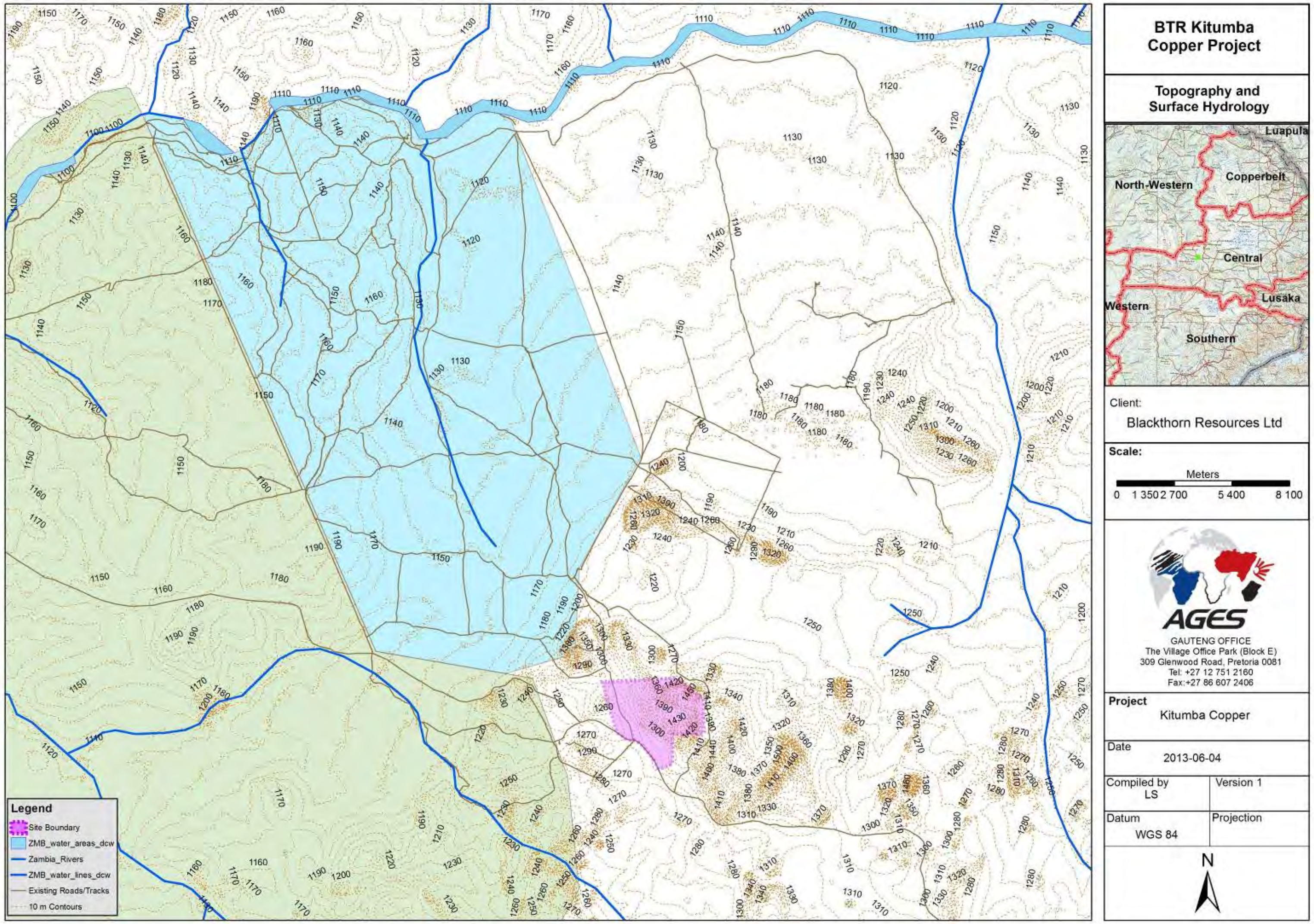

Figure 22: Surface water drainage and topography

5.7 Land Use and Land Tenure

The following paragraphs discuss prominent land uses in the vicinity of the proposed mining project which may affect the project or be affected by the project. Figure 2 shows these land uses in relation to the project site.

5.7.1 Residential areas

The villages of Kaindu, Myombe, Mpundu and Kafucamo are the closest communities to the site. Distances to the project site are as follows:

- Kaindu: approximately 22 km Northwest
- Myombe: approximately 20 km Northwest
- Mpundu: approximately 14.5 km Northwest
- Kafucamo: approximately 12 km Northwest

They form part of the Kaonde tribe and are under the leadership of Chief Kaindu. There are approximately 73 headmen in the Chiefdom of Chief Kaindu and approximately nine of the headmen are in the local area. There are a few councillors in the area as well. The Chiefdom has a committee that deals with community projects, (Kaindu Project Coordinating Committee). The nearest large town to the proposed site is Mumbwa, which is approximately 50 km to the south west, but travel time between Mumbwa and the site is significantly longer than expected due to poor road conditions.

5.7.2 Mining

Mining is central to the Zambian economy and has played a key role in the social and economic development of the country (Aucamp, 2012). Zambia is predominantly a copper mining country and is the largest copper producer in Africa (Mining Sector Profile – www.zdm.org.zm).

Surface areas in close proximity to the project site have in the relatively recent past been excavated, presumably in the facilitation of small-scale malachite mining by foreign parties. The legality of these operations is questionable. A number of 'sample bags' containing excavated material have been abandoned on the site. Figure 23 provides a clear picture of the existing state of the sites.

In the region, historic mining activities are also evident and some of the historically mined areas have also been excavated more recently. Most of these mining areas are not actively being mined currently and are deemed to be extremely unsafe for humans and animals. Figure 24 describes the existing situation:

There are also some small-scale miners who are active in the area who mainly mine copper close to the surface, and as they cannot afford mining equipment they use mainly hammers and chisels to chip out rocks. These miners do not have access to resources such as geologists and mechanical equipment and typical challenges include lack of access to finance, high mineral royalty taxes and security issues (http://maravi.blogspot.com/2009/06/times-small-scale-miners-cry-for-equal.html) as well as material transport, labour and safety concerns (Public Participation interviews, 2013). The Federation of Small-Scale Mining Association of Zambia coordinates mining activities for small-scale mining. Small-scale miners are supposed to obtain permits from the Ministry of Mines and Minerals Development, but many admit they continue their activities illegally and report that it is a problem to acquire the necessary permits. This group is vulnerable and at high risk of being exploited.

Figure 23: Excavations and abandoned samples at an abandoned (presumably illegal) malachite mining operation outside of but in close proximity to the site

Figure 24: An old mining shaft that has been 'closed' (left) and general surface conditions at the past artisanal mining sites (right)

From on-site observations the companies responsible for the illegal mining activities in close proximity of the project site do not conduct their activities in an environmentally responsible way and do not adhere to good labour practises, which have resulted in resentment towards these groups among local people. Such destruction of pristine environments could create negative perceptions among local communities and Zambian Authorities towards mining projects.

5.7.3 Conservation and Tourism

The **Kafue National Park** (KNP), located to the west of the proposed mining area, is the oldest (established in the 1950s) and largest National Park in Zambia and covers an area of approximately 22,500 km^2 (http://www.zambiatourism. com/travel/nationalparks/kafue.htm). It is a declared national park and is one of the five largest national parks in the world. The park is also surrounded by nine Game Management Areas (www.zambiatourism.com).

In recent years the Park has seen an increase in the number of Safari Camps and Lodges that operate in and around the Park, and this has been associated with an increase in visitors to the area and associated increase in investment. Importantly the area enjoys an increased level of protection by the Zambian Wildlife Authority (ZAWA) supported by conscientious efforts of the safari camp and lodge operators (http://www.zambiatourism.com/travel/nationalparks /kafue.htm). The park is managed by ZAWA but the camps and lodges are owned and managed by private operators (Aucamp, 2013). Major tourist activities include game drives or viewing by boat, walking and birding safaris, canoeing, angling, boating, rock climbing, photographic opportunities and trips to hot springs.

The camps closest to the proposed project are the Hippo Lodge and McBrides Camp. Hippo Lodge has four chalets and two safari tents (www.hippolodge.com) and is situated on the banks of the Kafue River. One of the four airstrips in the park is at Hippo Lodge. McBrides Camp is also situated on the banks of the Kafue River. McBrides Camp has seven two-person chalets as well as a campsite and a bush camp (www.mcbridescamp.com) (Aucamp, 2013).

The **Mushingashi Conservation area** is situated to the north west of the site and covers an area in excess of 40,000 hectares. The conservation area borders the KNP and the Kafue River forms its northern border. The area is not fenced, allowing game to roam freely, but also presenting challenges in keeping poaching under control. Intense conservation efforts have enabled growth in local wildlife populations (http://www.mushingashi.net/index.html). Major tourist activities at Mushingashi include safaris, hire of boats and equipment for fishing trips and walking trails with a tracker. Three main categories of tourists visit Mushingashi namely fishermen, photographers and hunters. The majority of visitors to Mushingashi are Zambians. The hunting season is from May until December. (Aucamp, 2013).

Both Mushingashi and KNP can be reached by air travel, but as the presence of the Zambian Air Force (ZAF) in the region restricts air traffic, most visitors use the local roads to access these areas.

5.7.4 Agriculture

There are a number of farms in close proximity to the proposed site. Some farmers are locals while others are farmers from South Africa or Zimbabwe. The Mumbwa Farmer's Association represents many of the local small-scale farmers (Aucamp, 2013).

Livestock farming (mainly cattle) as well as small and medium scale subsistence farming are currently undertaken towards the south-west and east of the site. Small scale cattle farms in Zambia are family holdings characterized by low input and low output. Medium-scale farmers cultivate between 5 and 20 ha, while small-scale farmers cultivate less than 5 ha (Henning, 2012). Cattle play an important role in rural households and are also the main food and cash source for most people in the cattle keeping areas (Henning, 2013).

Crop-livestock mixed systems are the most common system used in the study area and allow diversification of risks, using of more efficient labour, recycling of crop residues, adding value to crops and crop products while providing cash for purchasing farm inputs (Henning, 2012).

The German company Amatheon invested in large-scale irrigation farming in the Mumbwa district in 2012 (http://www.sedarmag.com/blog/2012/11/29/amatheon-investment-to-boost-mumbwa-farming/). The small-scale farmers stated that Amatheon has bought the farms with the best soils and water in the area. The company is reported to enlist local farmers in their agricultural extension scheme. There are differences in the farming practices of the small-scale and commercial farmers, mainly due to availability of resources such as finances and equipment.

Very limited crop cultivation occurs in the direct vicinity of the site mostly due to the climatic conditions and soil forms. Limited livestock grazing occurs in the area at the start of the rainy season when burned areas support the palatable growth stage of the grasses. The presence of tsetse fly also limits these activities. No agricultural activities are supported in the Mushingashi Conservation area or within the Kafue National Park or the applicable buffer zones (Henning, 2012).

The Mumbwa prison farm (see below) grows approximately 240 Ha of maize, some of which is sold externally. Soya beans will be planted in the near future. The prison also has large vegetable gardens that are used to feed the prisoners, but the prison would like to commercialise their produce in future (Aucamp, 2013).

5.7.5 The Mumbwa Prison Farm

The Mumbwa Prison Farm is located to the south east of the project site and hosts approximately 201 prisoners that work on the farm with the purpose to integrate them back in society. The duration of a prisoner's stay depends on their sentence. Most prisoners are there for petty crimes and the farm does not have fences or any other form of access control.

5.7.6 The Zambia Air Force (ZAF)

The Air Force has a bombing practise range close to the proposed site and the area is consequently a no-fly zone without the consent of the ZAF. Locals have indicated that the Air Force also has a vegetable farm in the area, but this could not be confirmed.

5.7.7 Infrastructure

The roads in the vicinity of the site generally comprise dirt tracks, many of which are virtually impassable in the wet season. The Rural Roads Unit (RRU) and the Roads Development Agency (RDA) reportedly have plans to upgrade a number of these roads over the mid to long term. Electricity supply infrastructure is in the process of being installed but it is unknown what the delivery schedule entails. The area has no sewage or storm water drainage networks.

5.8 Landscape and Visual Resource

The value of a visual resource is determined by evaluating the landscape character, landscape quality and "sense of place" of a particular area. Additionally the viewers in the existing environment are considered, as the value of a visual resource and potential alteration of that resource are inevitable perception-based to some degree. During March 2013 a specialist visual impact assessment was carried out for the proposed project and the following paragraphs are based on the baseline characterization contained in that study (Cilliers & Young, June 2013).

5.8.1 Landscape character and visual resource (scenic quality)

Landscape character is dependent of the individual elements that comprise the landscape, including prominent features such as hills, valleys, woods, trees, water bodies, buildings and infrastructure. Thus landscape character is defined by the dominant land form and land use features. Generally, landscapes with greater diversity and / or landscapes that contain distinctive features are considered as having a higher scenic value than landscapes containing little diversity and more common elements. The greater the diversity of form, line, texture and colour in a landscape, the greater the potential for high scenic value or landscape character.

The overall study area can be regarded as having a high visual resource value. While the landscape may be 'common' on a regional scale, the area boasts a variety of land forms and a variety of land use practices.

5.8.2 Landscape Quality

Both objective and subjective factors are considered in the determination of the quality of a visual resource. Where landscape quality, aesthetic value and a strong sense of place occur, the perceived value of the landscape increases.

High value visual resources, such as that associated with the proposed project site, are areas that exhibit a positive character and that have a strong sense of place with unity, richness and harmony. The landscape is expected to be sensitive to change and may be detrimentally affected if change is dealt with inappropriately

5.8.3 Sense of Place

Sense of place is the unique value that is allocated to a specific place or area through the cognitive experience of the user or viewer. The largely unspoilt environs give the area a 'natural' sense of place.

Human interventions such as agricultural and communal activities, small scale mining as well as man-made structures including roads and other infrastructural elements adds a rural element to the 'unspoilt' environment. The sense of place of the study area can thus be described as 'natural' with a rural element.

5.8.4 Viewer sensitivity

The existing topography as well as the lush, dense vegetation in the area limits the extent of what can be viewed from certain vantage points. The Mumbwa Prison Farm was the only viewer location with a day time view of the project site that could be identified. A view of the project area from the Mumbwa prison farm is presented in Figure 25. The hilly topography and vegetation cover possibly providing significant visual screening are illustrated in Figure 26. Figure 27 shows the night-time scene.

The presence of the project would be much more prominent during the night time due to the existing night-time landscape being very dark, with very few artificial lights operating in the area.

Possible sensitive viewer locations are illustrated in Figure 28

Figure 25: View of the site from Mumbwa Prison Farm

Figure 26: Hilly topography and vegetation

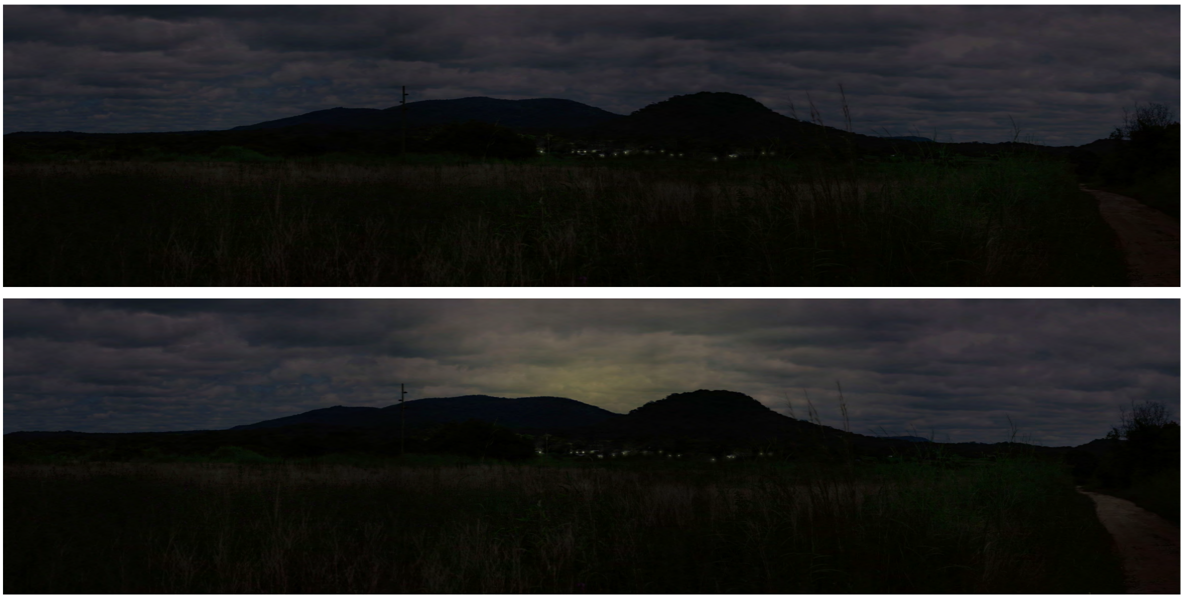

Figure 27: Existing night view (top) - project site hidden by topography and (bottom) potential night view (sky glow from unmitigated light impacts from project)

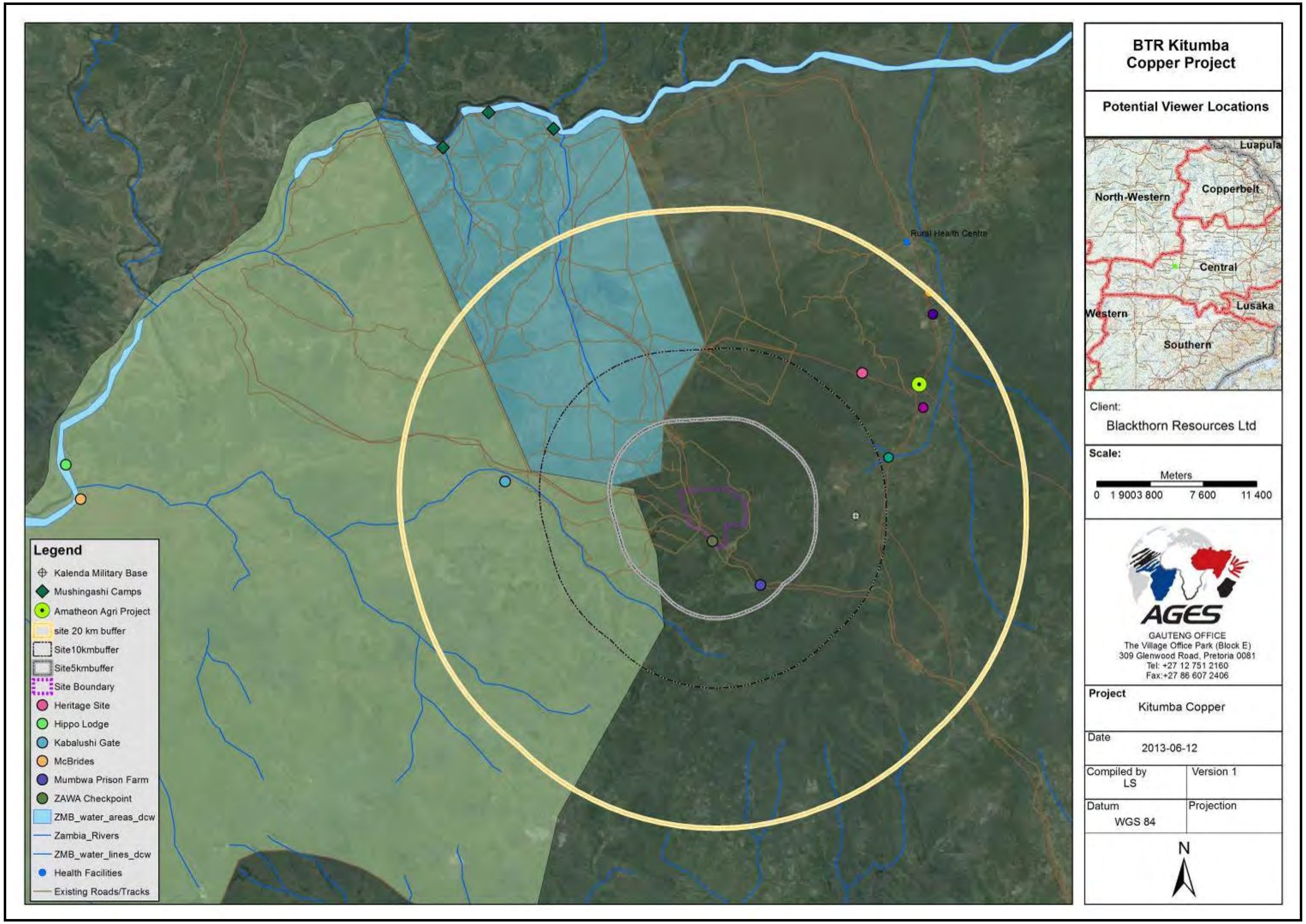

Figure 28: Visual receptors in the vicinity of the project site

5.9 Noise and Vibration

During March 2013, Ben van Zyl of Acusolv carried out a specialist noise impact assessment at the project site. The following description is based on the findings of his investigations. The study (Van Zyl, May 2013) covered the total audible noise footprint of a typical underground mine and processing plant similar in size to the proposed project, and a study area with a radius of 10 km from the site was considered more than adequate.

A good sense of the regional noise climate and of typical ambient noise levels was obtained by means of a series of samples taken at different sites in the vicinity of the project site, and some detailed surveys covering a 24-hour period at fixed locations. These sites and the relative distances to the project site are illustrated in Figure 29.

The region surrounding the project site is sparsely populated, with only a few small communities located to the east and south. The remainder of the surroundings are vacant and/or used for conservation purposes. There are no industrial, mining or substantial agricultural activities in the study area, apart from some small-scale, informal mining activities to the north, and the activities of Amatheon Agri Zambia Ltd. There is practically no audible traffic noise in the area. The only trace of (hardly audible) noise noted during the course of the noise study, was a single event of what appeared to be aircraft noise in the distance. This occurred during daytime and was attributed to air-force flying activities.

The rating of baseline ambient noise conditions in the Kitumba study area should take cognisance of the two main states of human occupation or land use in the vicinity: rural residential (villages and dwellings) and conservation or wilderness area (eco-tourism).

The most fitting noise rating for the areas surrounding the proposed mine site would be Rural District, the lowest ambient noise category with a nominal night-time rating of 35 dBA. This is also 5 dB lower than the actual levels (40 dBA) recorded at M1 and M2.

There are currently no sources of vibrations at the study area.

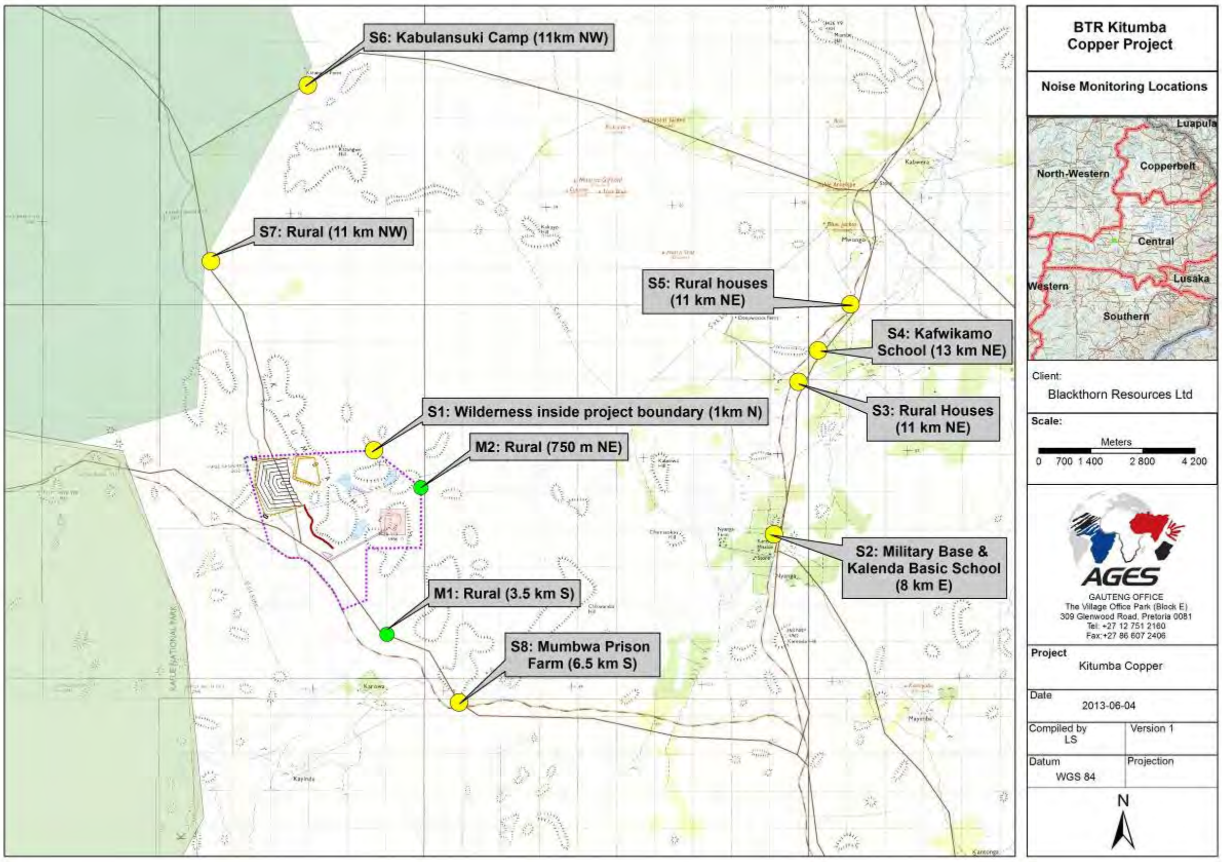

Figure 29: Sites where noise monitoring / measurements were taken

5.10 Biodiversity and Ecology (Flora and Fauna)

The following section is based on the specialist ecological and biodiversity assessment carried out by Dr B Henning in 2013 (Henning B. J., May 2013). The study area falls within the Central Zambezian Miombo Woodland ecoregion, one of the largest ecoregions in Africa. The ecoregion covers about 50% of Zambia, predominantly in the wetter parts. (Henning B. J. May 2013). Ecoregions of Zambia are illustrated in Figure 30.

Mature miombo woodland trees in this area are usually 15 to 20 m tall, with a broadleaf shrub and grass understory beneath. The area has a much higher proportion of evergreen trees than drier Zambezian miombo, but trees in this area are primarily deciduous and predominantly of the subfamily *Caesalpinioideae*, particularly species belonging to the genera *Brachystegia, Julbernardia*, and *Isoberlinia*, which seldom occur outside Miombo. Termitaria or anthill vegetation covers about 3% and is present in all regions except in areas of pure sand and the woodland is interspersed with dambos (grassy wetlands forming the headwaters and margins of rivers which increase biodiversity of the ecoregion) on the flat central African plateau (Henning B. J., May 2013).

In Miombo Woodland, fire is an important ecological factor as the highly seasonal rainfall pattern leaves the vegetation dry for several months of the year, and thunderstorms at the start of the rainy season can easily set the vegetation afire. In addition to being naturally fire-prone, miombo is frequently intentionally burned to clear land for cultivation and other practices (Henning B. J., May 2013). The ecoregion has suffered extensive deforestation, especially in the highly-urbanised Copperbelt Province, the centre of Central Province and around Kasama and Mansa due to charcoal production, mining and, clearing for farming and ranching (Henning B. J., May 2013).

Zambia has a long history in the conservation and management of its biological resources and 44% of the country's surface comprises protected areas in the form of 19 national parks, while 32 Game Management Areas (GMAs) and several protected forests and woodlands cover a further 8.6% of the country (Henning, 2012b).

The landscape of the study area is characterised by moderately undulating hills and ridges (resource area) with valleys and footslopes on sandy to gravelly shallow soils in typical Miombo woodland comprising a two-storeyed woodland with an open or partially closed canopy of semi-evergreen trees 15 to 20 m high, with a forest floor covered by a more or less dense grass cover. Relic patches of evergreen thicket may also occur.

Small pockets of moist grassland areas associated with hardpan ferricrete that occur in between the miombo create perched water table conditions during the wet season. Ravines (non-perennial drainage channels) occur along the slopes of the mountainous region, but these small non-perennial channels do not feed any major tributaries of the major rivers in the larger area and therefore contribute very little to the hydrological regime of the area (Henning B. J., May 2013).

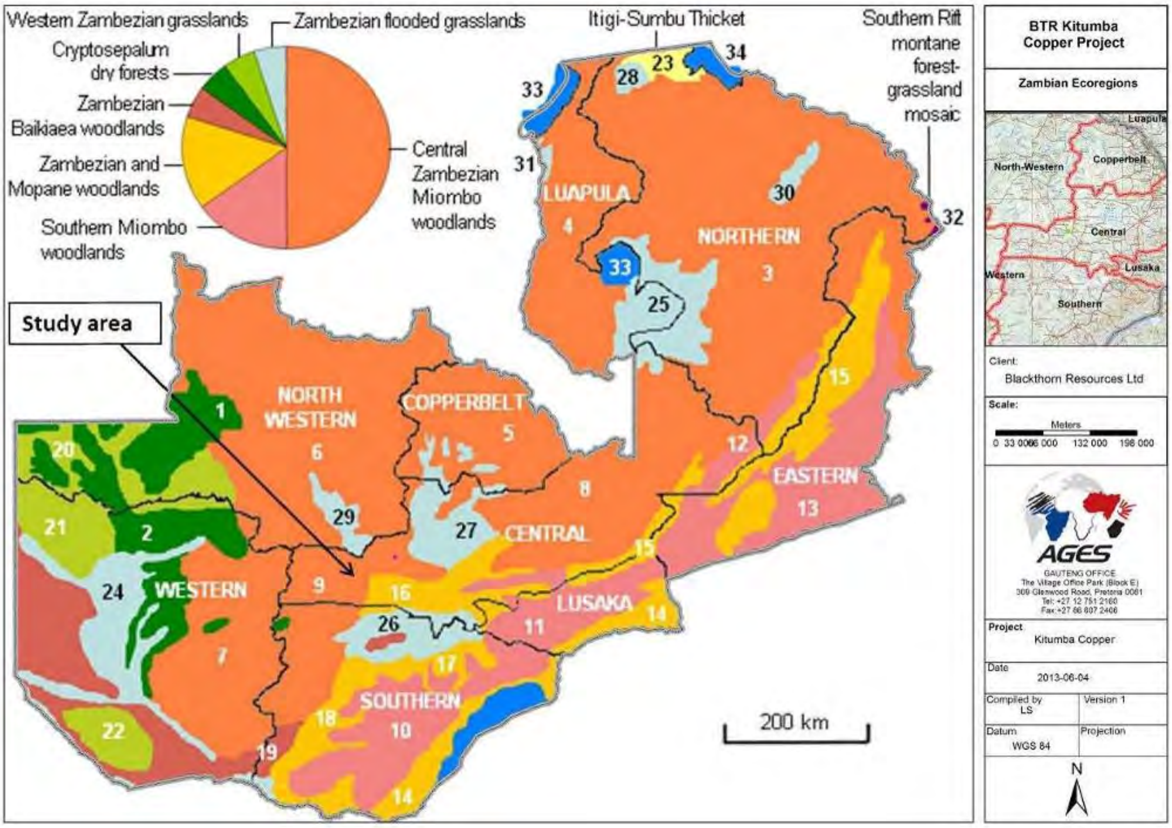

Figure 30: Ecoregions of Zambia

5.10.1 Vegetation types of the study area

During March 2013, Dr B Henning carried out a survey of the project site and the following section is based on the results of his study (Henning B. J., May 2013). The following vegetation units were identified and mapped: (Refer to Figure 31).

- *Isoberlina angolensis* Hill Miombo woodland
- *Isoberlina angolensis – Uapaca kirkiana* eastern footslopes and undulating plains
- Open *Brachystegia boehmii* woodland on deep sandy-loam soils
- *Loudetia simplex – Tristachys rehmanni* moist grassland
- Closed *Miombo* Forest associated with ravines

5.10.1.1 *Isoberlina angolensis* Hill Miombo woodland

This vegetation unit forms part of the moderately to very steep hills, outcrops and ridges occurring throughout the site. Common tall trees include *Brachystegia longifolia, Isoberlinia angolensis and Julbernardia paniculata*. Small trees only occur occasionally. Shrubs include *Acrocephalus rupestris, Schistostephium artemisiifolium* and *Uapaca pilosa*, and subshrubs are mainly *Aloe chabaudii, Sphenostylis marginata, Strobilanthopsis linifolia* and *Vellozia equisetoides*.

The vegetation unit is classified as being moderately – highly sensitive due in most part to the rockiness, steep slopes (erosion risk), plant species composition, pristine state of the vegetation, microhabitats and potential red data fauna that utilise this area as habitat.

5.10.1.2 *Isoberlina angolensis – Uapaca kirkiana* eastern footslopes and undulating plains

This vegetation unit occurs on the slightly undulating eastern and southern footslopes and valleys surrounding the hill miombo woodland. The woody layer forms dense, tall woodland with a more prominent shrub layer by comparison to the former. Common tall trees include *Brachystegia boehmii* and other *Brachystegia, Erythrophleum africanum, Isoberlinia angolensis*, and, locally, *Marquesia macroura*. Small trees include *Bauhinia petersiana, Diplorhynchus condylocarpon, Pseudolachnostylis maprouneifolia, Syzygium guineense* subsp. *Macrocarpum* and *Uapaca kirkiana*. *Baphia massaiensis* subsp. *obovata* (on sandy soils), *Hymenocardia acida*, and *Uapaca pilosa* are common shrubs. The herbaceous layer forms dense, tall stands of *Hyparrhenia bracteata* and medium tall *Themeda triandra*.

Isolated termitaria bushclumps occur in this vegetation unit. These miombo termitaria are characterized by *Albizia amara, Boscia angustifolia, Combretum molle, Euphorbia candelabrum* and *Ziziphus mucronata* in their upper storey.

Degradation of this miombo woodland as the result of repeated heavy burning leads to invasion by munga elements such as Acacia species.

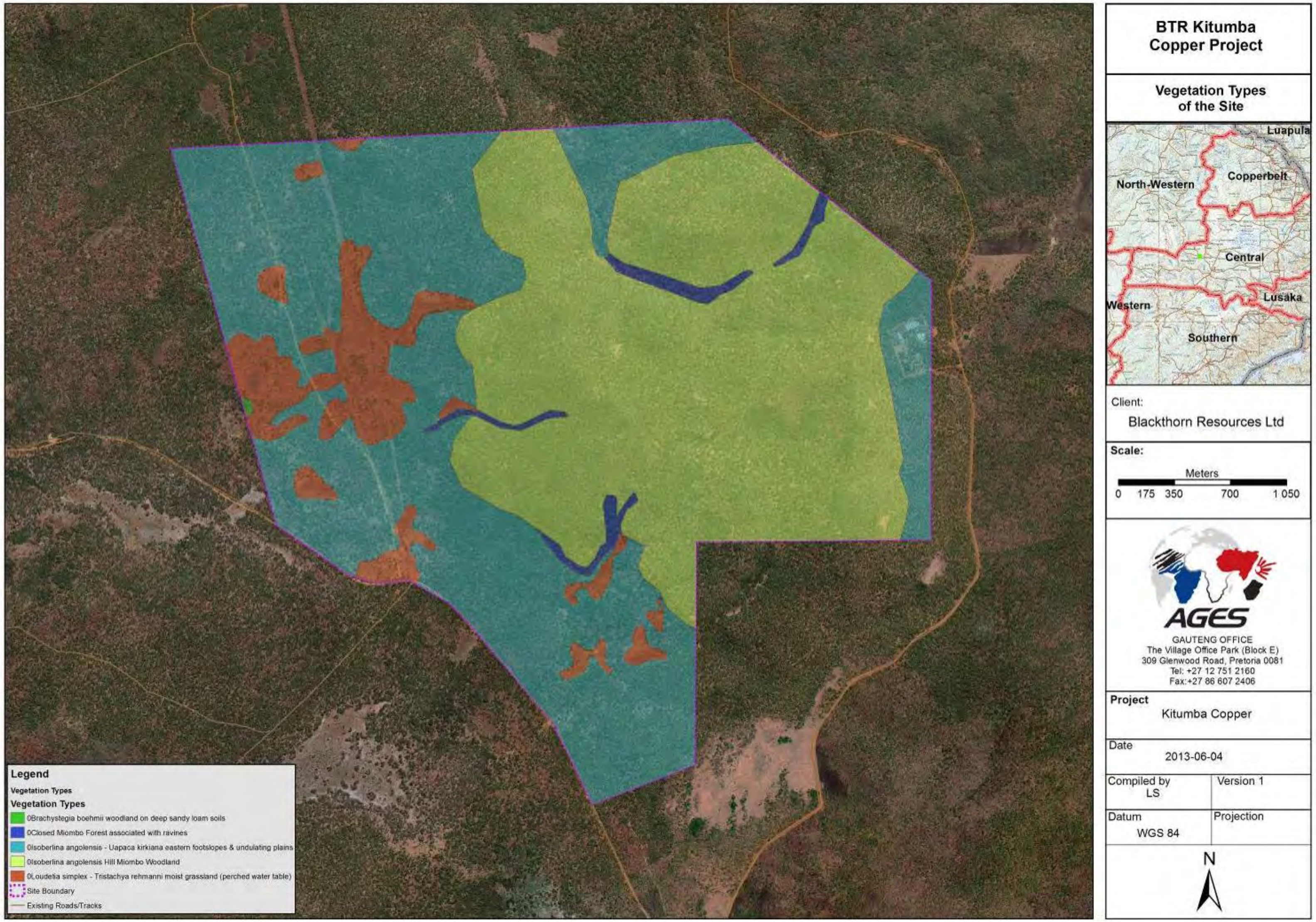

Figure 31: Vegetation Types of the Site

5.10.1.3 Open *Brachystegia boehmii* woodland on deep sandy-loam soils

This vegetation unit occurs on slightly undulating to flat plains along the western section of the study area. The woody layer is characterised by open tall woodland dominated by *Brachystegia boehmii* trees. Smaller tree species such as *Terminalia* and *Combretum* species are more prominent in the woody layer. Typical woody species occurring here also include *Pericopsis angolensis* and *Combretum adenognoium*.

Some isolated termitaria bushclumps occur in the more clayey patches. The grass layer is dominated by tall grass species such as *Hyparrhenia bracteata* and *Themeda triandra*.

5.10.1.4 Loudetia simplex – Tristachys rehmanni moist grassland

The moist grassland vegetation unit occurs as isolated pockets throughout the study area, although being more prominent in the western sections. It can also be referred to as Munga scrub on seasonally flooded dambo soils. The soils are often very shallow that creates a perched water table during the wet season. On the site, these lanosols support moist grassland dominated by *Loudetia simplex* and *Tristachya rehmanni*, often with scattered shrubs and trees that have shallow root systems that can cope with temporary waterlogging.

The woody species composition in the moist grassland areas is restricted to seven tree species, namely *Acacia nilotica, A. seyal, Bauhinia petersiana, Combretum ghasalense, Diospyros kirki, Piliostigma thonningi* and *Terminalia stenostachya*, with a ground cover of scattered woody *Ipomoea vernalis, Lannea edulis* and *Conyza welwitschi*, and herbaceous *Hygrophila pilosa* and *Sphaeranthus humilis*.

No red data species occur in this vegetation unit, although its value as grazing land during the wet season for game species and livestock should be considered as an important ecological component in the area.

5.10.1.5 Closed Miombo Forest associated with ravines

The ravines in the hill miombo woodland vegetation unit represent small non-perennial drainage channels characterised by a steep slopes on both sides and a tall, dense woody layer that can be classified as forest. While the forest vegetation unit represents a type of miombo woodland, it is distinguished by typical characteristics of natural forests (multi-layered woody structure with overlapping crowns and little or no grasses present in the herbaceous layer). The forests also differ from the surrounding miombo woodland by diagnostic species such as *Parinaria exelsa, Ficus tettensis, Syzigium guineense* and *Mimusops zeyheri*, and indicator species of the moist soil conditions such as fern and moss species occur in the lower herbaceous stratum.

No red data species occur in this vegetation unit, although its value as grazing land during the wet season for game species and its uniqueness in the larger landscape in terms of interconnectivity and as a fauna corridor has high significance.

The cover and height of the floristic components of each of the relevant vegetation units is summarised in Table 10 along with photographs illustrating the typical state of the vegetation. The respective sensitivity of each of the vegetation units is illustrated in Figure 32

Table 10: Summary of Vegetation Types in the study area

Isoberlina angolensis hill miombo woodland		
	Percentage cover	Avgerage Height (m)
Trees	20-25	8-20m
Shrubs	1-2	1-3m
Grass	10-15	1.2 – 2.4m
Forbs	<1	0.5m

Isoberlina angolensis – Uapaca kirkiana eastern footslopes and undulating plains		
	Percentage cover	Avg. Height (m)
Trees	20-25	8-20m
Shrubs	10	1-3m
Grass	70-80	1.2 – 2.4m
Forbs	<1	0.5m

Open Brachystegia boehmii woodland on deep sandy-loam soils		
	Percentage cover	Avg. Height (m)
Trees	10 - 15	3-6m
Shrubs	10	1-2m
Grass	70-80	1.2 – 2.8m
Forbs	<1	0.5m

Loudetia simplex – Tristachya rehmanni moist grassland		
	Percentage cover	Avg. Height (m)
Trees	2-5	3-6m
Shrubs	<1	1-2m
Grass	60-70	0.2- 0.8m
Forbs	<1	0.2m

Closed Miombo Forest associated with ravines		
	Percentage cover	Avg. Height (m)
Trees	20 - 25	3-15m
Shrubs	10 - 15	1-2m
Grass	10 - 15	0.8-1.2m
Forbs	2 - 5	0.2-0.5m

Not surveyed during the dry season

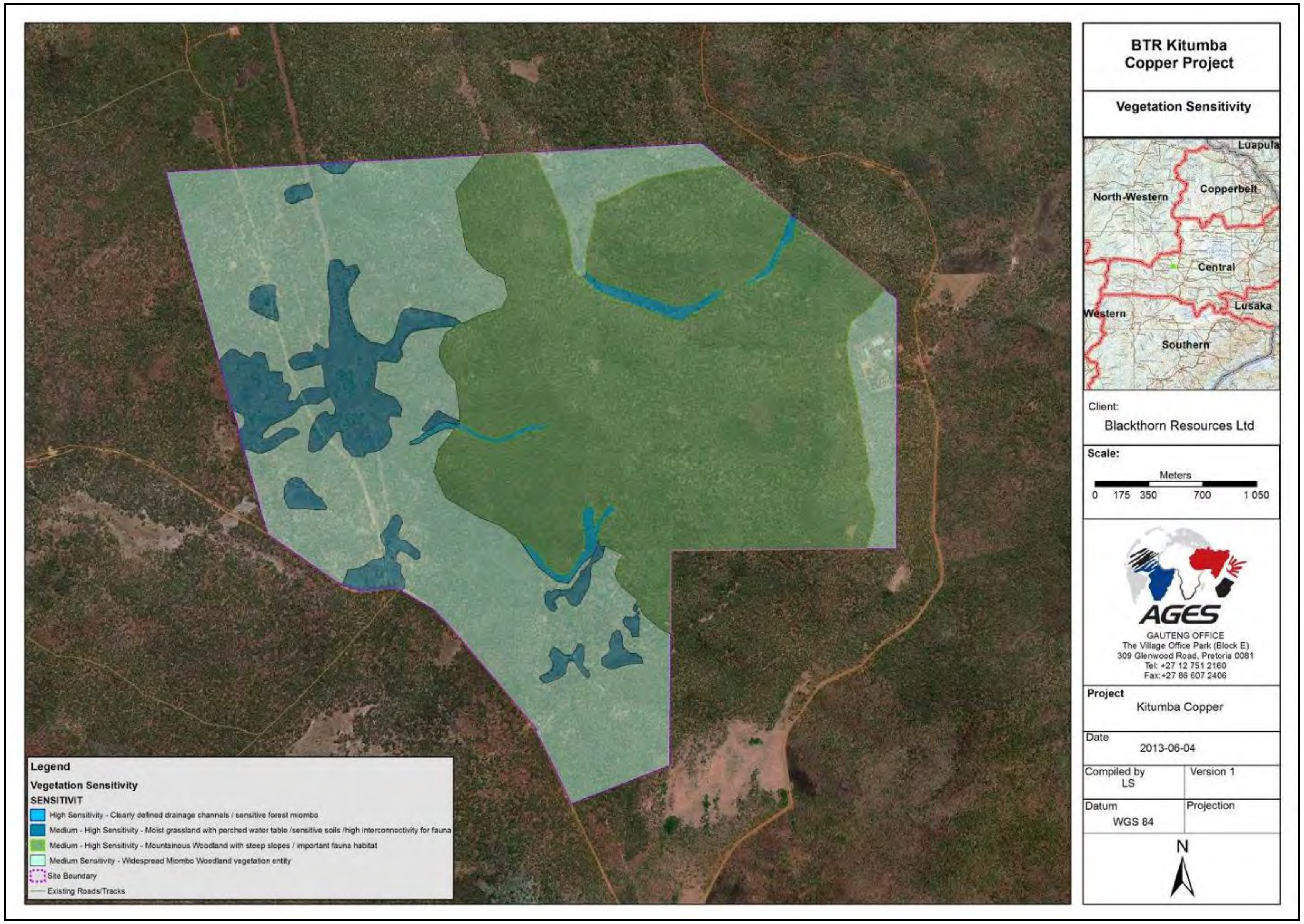

Figure 32: Sensitivity of the vegetation types found on the site

5.10.2 Wetlands of the study area

Swamps, floodplains and dambos are the three major wetland types that occur in Zambia. Of these, only dambo wetlands (which are fairly common on the African plateau) occur in the study area. The word “dambo” is used for a class of complex shallow wetlands in central, southern and eastern Africa, particularly in Zambia and Zimbabwe. They are generally found in higher rainfall flat plateau areas, and have river-like branching forms.

Two major Hydro-Geomorphic (HGM) units were identified that represent wetlands on the proposed development site and direct surroundings, namely “Channel Wetlands” associated with the drainage channels of the Kitumba Hills and “Flat Wetlands” occurring as small pockets of moist grassland.

Channel wetlands associated with the ravines of the Kitumba hills represents non-perennial drainage channels characterised by periodic concentrated flow of water for short periods immediately after and during precipitation events. As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks.

The water does not discharge from these channels and they do not connect to any other river or water source in the larger Kafue River catchment. Water will either flow from the channel onto the plains and quickly drain in the highly permeable sandy soils, or will collect in the low-lying moist grasslands (flat wetlands).

The vegetation structure of the drainage channels can be described as closed forest woodland with little or no grass cover. The diagnostic species associated with the ravines include *Parinaria exelsa, Ficus tettensis, Syzigium guineense* and *Mimusops zeyheri*, while indicator species of the moist soil conditions such as fern and moss species occur in the lower herbaceous stratum.

The pockets of moist grasslands underlain by ferricrete bedrock that creates perched water table conditions are defined as **Flat wetlands**. A flat is defined as a wetland area with little or no relief or gradient. Precipitation represents the primary source of water and dominant hydrodynamics are bidirectional vertical fluctuations, although there may be limited multidirectional horizontal water flow in some cases. Water exits a flat through evaporation and infiltration.

Due to its isolated location in the study area, these flats are considered unique despite their high interconnectivity in terms of its value as grazing “hotspots” for wildlife. The flats in the study area developed as a result of perched water table conditions caused by the underlying hardpan ferricrete. These characteristics encourage poor infiltration of surface flow and high surface run off. The consequence is soil erosion that was observed in the study area. These areas support moist grassland dominated by *Loudetia simplex* and *Tristachya rehmanni*, often with scattered shrubs and trees that have shallow root systems able to cope with temporary waterlogging.

The wetlands present on the project site are illustrated in Figure 33.

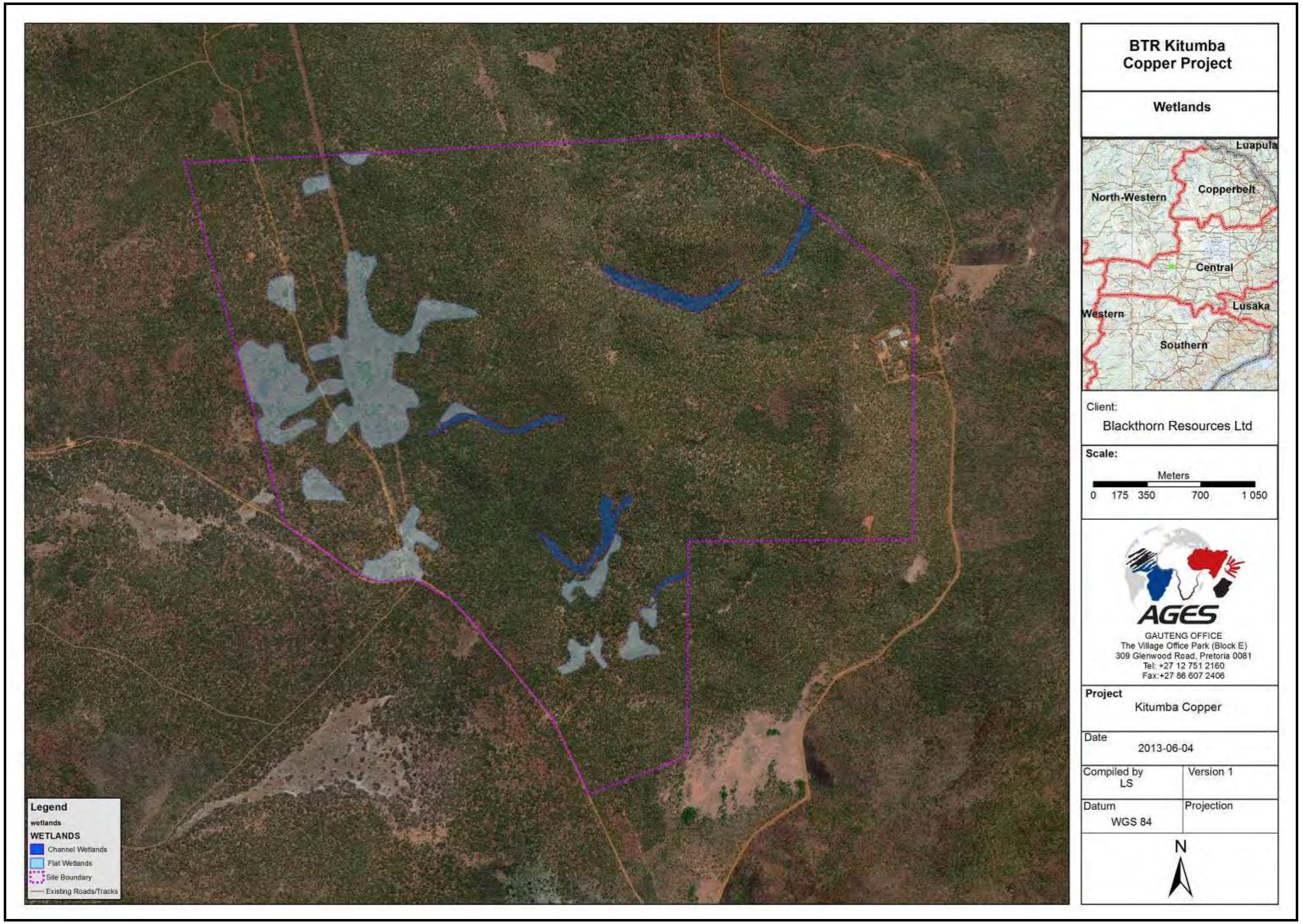

Figure 33: Wetlands of the study area

5.10.3 Fauna

Some 1,234 known species of amphibians, birds, mammals and reptiles occur in Zambia of which 1.5% is endemic[1], and 1.9% is threatened.

During August 2012 and again in March 2013, the study area was surveyed to identify specific faunal habitats and compare these with habitat requirements of fauna recorded in the quarter degree grid. Species were identified by visual sightings, spoor, droppings, burrows or roosting sites. The following section is based on the specialist ecological report by Dr B.J. Henning (Henning B. J., May 2013).

5.10.3.1 Mammals

Mammal diversity in the study area is well represented in terms of species richness and functional roles in the ecosystem. Movement of mammals through the area is largely dependent on water availability, but large mammals (elephant, lion, leopard, wild dog, sable antelope, impala and baboon) periodically utilise the area (especially further away from anthropogenic impacted areas), and these species have in fact been sighted in close proximity to Kitumba Camp in the past.

Herds of up to 30 individuals of Sable Antelope were sighted during the surveys. Conservation of the habitat of this sensitive species should be considered a high priority. A number of medium sized and smaller antelope species were also encountered.

Elephant occasionally migrate to the area during the wetter months, although it would appear as though they prefer cultivated lands (e.g. Kitumba prison area) and sweet Munga woodland areas further south of the proposed mining area.

Predators such as lion, wild dog and leopard occur in the surrounding areas and have extremely large territories. These species are expected to only move through the area when prey becomes scarce in the Mushingashi and KNP. The small ravines and rocky areas associated with the Kitumba Hills represent ideal areas for these predators to raise their young due to the shelter provided in these areas.

The connectivity[2] of the project site is excellent. The site is surrounded by areas with similar veld condition and with no dispersal encumbrances occurring.

5.10.3.2 Avifauna (Bird species)

Zambia's avifauna includes a total of 779 species, one of which is endemic, one has been introduced, 4 are rare or accidental and 11 are globally threatened. Three major bird habitat systems occur in the study area.

---

1 Endemic species are those that occur in one geographic area only and are not found anywhere else in the world.

2 C**onnectivity (habitat connectivity)** - Allowing for the conservation or maintenance of continuous or connected habitats, so as to preserve movements and exchanges associated with the habitat.

They are:

- Miombo associated with valleys and plains;
- Hill Miombo Woodland; and
- Wetland habitats.

The **miombo associated with the valleys and plains** of the project site lies at the centre of the miombo zone of south-central Africa which hosts a greater variety of miombo birds than any of the surrounding areas. Many of the miombo woodland bird species join mixed-species bird parties, which typically contain members of 10 to 20 species of territorial insectivorous birds. Membership changes as the party's route enters and leaves individual territories. Species that usually join such parties include Scimitarbill, Hoopoe, barbets, honeyguides, woodpeckers, pipits, cuckoo shrikes, Miombo Barred Warbler (Endemic), flycatchers, weavers and seed-eaters. Parties are often first noticed when the presence of one of its more conspicuous members such as a Fork-tailed Drongo or Arnot's Chat is detected. More independent birds found here are the Pale-billed Hornbill, Central Bearded Scrub Robin and many of the sunbirds.

The **hill miombo woodland occurring on rocky ground** within the study area (and especially on the resource area itself) represents habitat for a number of somewhat localised birds including Shelley's Francolin, Freckled Rock nightjar, Striped Pipit, Familiar Chat and Rock-loving Cisticola. Though of limited occurrence, rock exposures and precipices hosts specialised bird species such as Black Stork, Augur Buzzard, Black Eagle, Taita and Peregrine Falcons, Mottled, African Black and Little Swifts, African Rock Martin, Mocking Chat, White-necked Raven and Red-winged Starling .

The study are also contains a number of **dambo wetlands** as discussed above. The intermediate levels in typical dambos are permanently spongy and have short grass, representing a habitat which is relatively common in northern Zambia but does not occur in many other parts of Africa. Consequently many of the birds found here have a somewhat localised distribution. They include Blue Quail, Long-toed and Streaky-breasted Flufftails, Black and Rufous Swallow, Yellow-throated, Fulleborn's and Grimwood's Longclaws, Pectoral-patch, Black-tailed and stout Cisticolas, Yellow-mantled and Marsh Whydahs, Fawn-breasted waxbill, Locust Finch and Black-chinned Quailfinch, Croaking Cisticola and red-billed Quelea. On the upper parts of the dambo, close to the woodland edge, scattered trees provide habitat for the White-winged Black Tit. The driest areas of the short grassland are inhabited by Temminck's Courser, Red-capped Lark and the Dessert Cisticola. The dry montane grasslands of the Nyika Plateau have populations of Red-winged Francolin and Common Quail.

A number of avifauna species occur in the study area that are **dependent on mammal** species occurring in the area: The yellow-billed and Red-billed Oxpeckers are dependent on large game animals or on cattle and even donkeys. Hooded, White-backed, Lappet-faced and White-headed Vultures feed at the carcasses of dead animals, including domestic cattle. They are joined by the Marabou Stork. The Cattle Egret and Wattled Starling frequently feed around cattle or game animals. Ground trampled by cattle or other animals may attract the Yellow Wagtail (migrant) or Groundscraper Thrush.

Certain bird species are attracted to **bush fires** by the fleeing or roasted insects and other animals. Almost always present are the Fork-tailed Drongos, often in large numbers. Others often present include Marabou Stork, Yellow-billed Kite (m), Dickinson's Kestrel, Rollers, Hornbills and Swallows.

5.10.3.3 Reptiles and Amphibians

Around 200 reptile species and approximately 90 amphibian species have been recorded in the Zambesian basin, thus knowledge on amphibian and reptile biodiversity in the area is comparatively good. Very few of these species are endemic to the area.

A number of reptiles have been recorded from the study area. Snake species that have been observed in the area include black mamba, African rock python, puff adder, olive grass snake and Mozambique spitting cobra. The flap-neck chameleon has also been observed at the site in the valleys between the hills during day and night. Despite this species being widespread and locally common, the flap-neck chameleon is always a good sign of the integrity of indigenous habitats. Gaboon Viper and Land Monitor Lizard are other important reptiles found in the area.

No threatened reptile species occur in the project area. A number of species are involved in international trade as listed by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), e.g. chameleons and tortoises in the international pet trade, and monitor lizard skin for the leather trade.

Important habitats within the mine area for reptile diversity include rock outcrops, gallery forest and dambo grasslands. The loss of rock outcrops will destroy habitat for reptiles.

Amphibians appear to be poorly represented on the site, which is probably due to the highly permeable soils limiting the formation of pools required by amphibians as breeding habitat. There also appears to be relatively low frog diversity in the hilly areas. Important habitats within the mine area for amphibian diversity include moist grasslands, ravines and temporary pools in Miombo woodland, but no threatened amphibian species occur in the area.

5.10.4 Protected Species

A total of about 505 flora species appear on the Red-Data List (RDL) for Zambia. Of the species assessed, almost half were rated as Data Deficient and as such many changes in the future conservation status of flora species may be expected. No red data flora species (currently listed as such) potentially occurring in the resource area was found during the dry or wet season surveys.

According to the existing databases and field survey, a number of red data fauna species included in the IUCN red data lists can potentially be found in the study area including Elephant (Vulnerable), Lion (Vulnerable), Leopard (Near-Threatened) and African Wild Dog (Endangered). No red data listed herpetofauna occurs in Zambia according to the IUCN database.

5.10.5 Invasive alien species

Invasive alien plants pose a direct threat not only to Zambia's biological diversity, but also to water security, the ecological functioning of natural systems and the productive use of land. They intensify the impact of fires and floods and increase soil erosion.

The most serious invaders in Zambia are from tropical South America and India. They include *Lantana camara, Psidium guajava, Toona ciliata,* and *Solanum hispidum*. Probably the most successful alien is the herb *Ageratum conyzoides*, although it is unlikely to have displaced any indigenous species. *Solanum mauritianum* ("Bugweed") and *Chromolaena odorata* ("Triffid Weed") both occur in disturbed places, but are effectively controlled by periodic droughts.

The only specific alien invader species observed in the area was *Tithonia rotundifolia* (red sunflower) around the fence of Kitumba camp and along roadsides in the study area. This species can be easily controlled mechanically, with chemical follow-ups, if necessary, on seedlings that reappear in cleared areas.

5.10.6 Summary of Ecological Sensitivity

Following ecological surveys, different sensitivity classes and development zones are assigned to specific areas based on the following parameters:

- Presence, density and potential impact of development on rare, endemic and protected flora and fauna species
- Conservation status of vegetation units
- Soil types, soil depth and soil clay content
- Previous land-use
- State of the vegetation in general as indicated by indicator species

The sensitivity of the project area in terms of these criteria is illustrated in Figure 34. The Map also indicates the planned project infrastructure in relation to the site sensitivities identified.

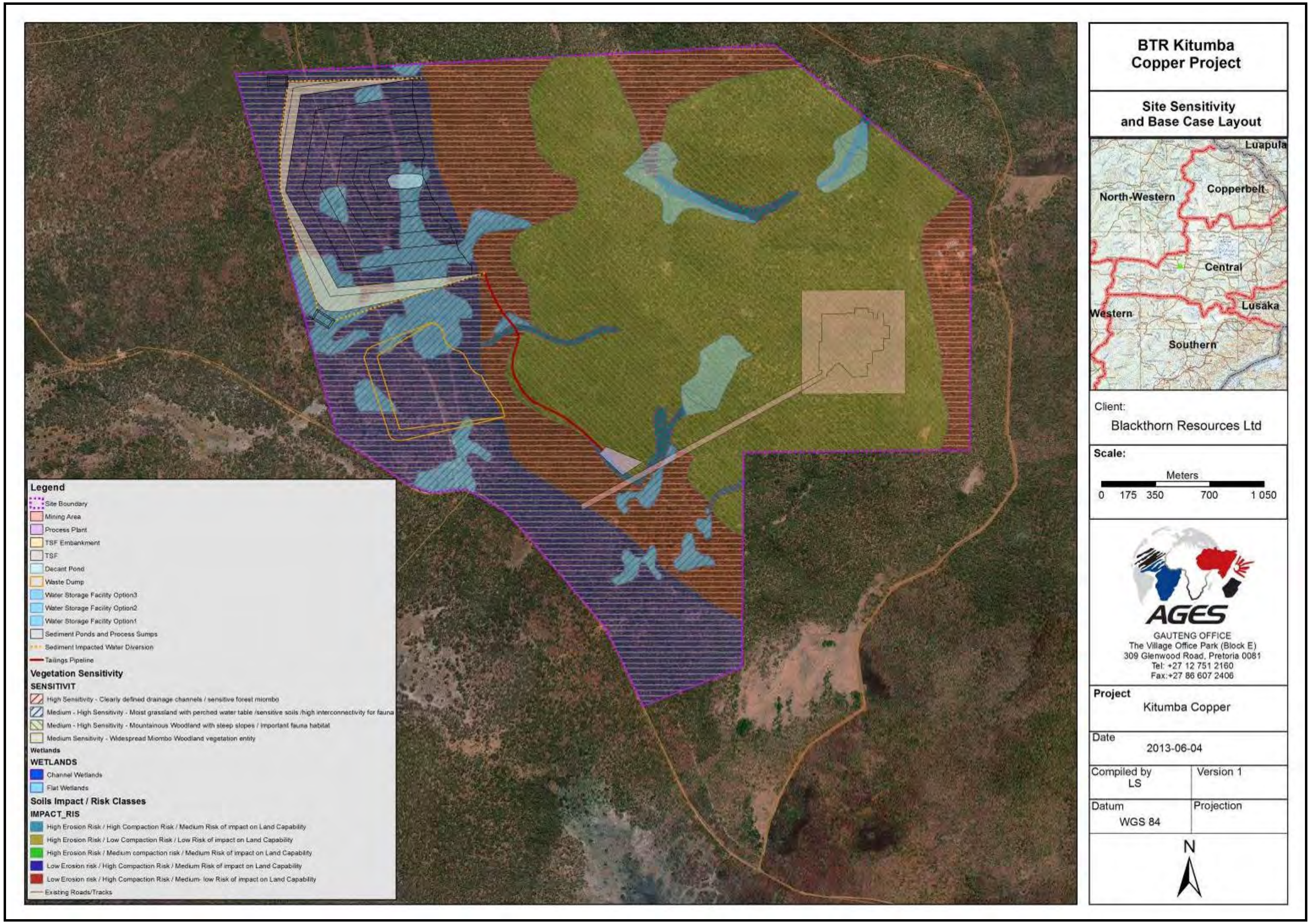

Figure 34: Ecological Sensitivity of the study area

5.11 Archaeological and Cultural Environment (Heritage Resources)

While a large number of academic archaeological and historical studies have been conducted in Zambia, the Kafue region around Mumbwa remains relatively understudied. Available data infer a rich and diverse archaeological landscape, representative of the phases of human and cultural development in south-central Africa and number of areas of archaeological and heritage potential occur in the general surroundings.

During August 2012 and again in March 2013, Mr Neels Kruger conducted surveys of the project site and surrounding landscape in order to identify and evaluate any heritage or archaeological resources which may be affected by the proposed project. The following section is based on his specialist report.

No heritage resources were identified in the proposed mining area and the impact zone for the suggested mine infrastructure. Worth mentioning is that a number of flaked and broken malachite ore rocks were observed on the site, and while the site does not necessarily attest to human activity in the area, considering evidence of historical metallurgy in the larger region, the site might well have been a source of iron and / or copper for metal smiths active in communities bordering the Kitumba hills. The site is probably of limited heritage significance and, since it has been documented no further action is recommended in terms of heritage mitigation or conservation.

Lack of evidence of on-site heritage resources should not exempt the project proponent from conducting the planned activities on site with due cognisance of the larger heritage landscape, and the potential for undiscovered heritage resources occurring on the site. Opportunity exists to become involved in regional heritage conservation, not as an “offset” as such, but to demonstrate respect for the project context.

A number of groups from the surroundings have occupied the region for many generations and have expressed long-term cultural associations with the landscape. These groups thus associate themselves with a number of sites of “Living Heritage” occurring in the areas surrounding the project site. Due cognisance should be taken of these sites of “Living Heritage” in the cultural landscape and the possible associations that communities might have to these. Applicable conservation measures for sacred sites and any other heritage features around the project site should be considered based on the sentiments of traditional guardians, elders and the local communities.

Considering the wealth of heritage occurring in the landscape around the proposed Kitumba mine, as well as the localised nature of heritage remains, a careful watching brief monitoring process is recommended for all stages of the project. Should any subsurface palaeontological, archaeological or historical material or graves be exposed during construction or mining activities, all activities should be suspended and the archaeological specialist should be notified immediately.

Archaeological and heritage resources in the vicinity of the proposed project site are illustrated in Figure 35.

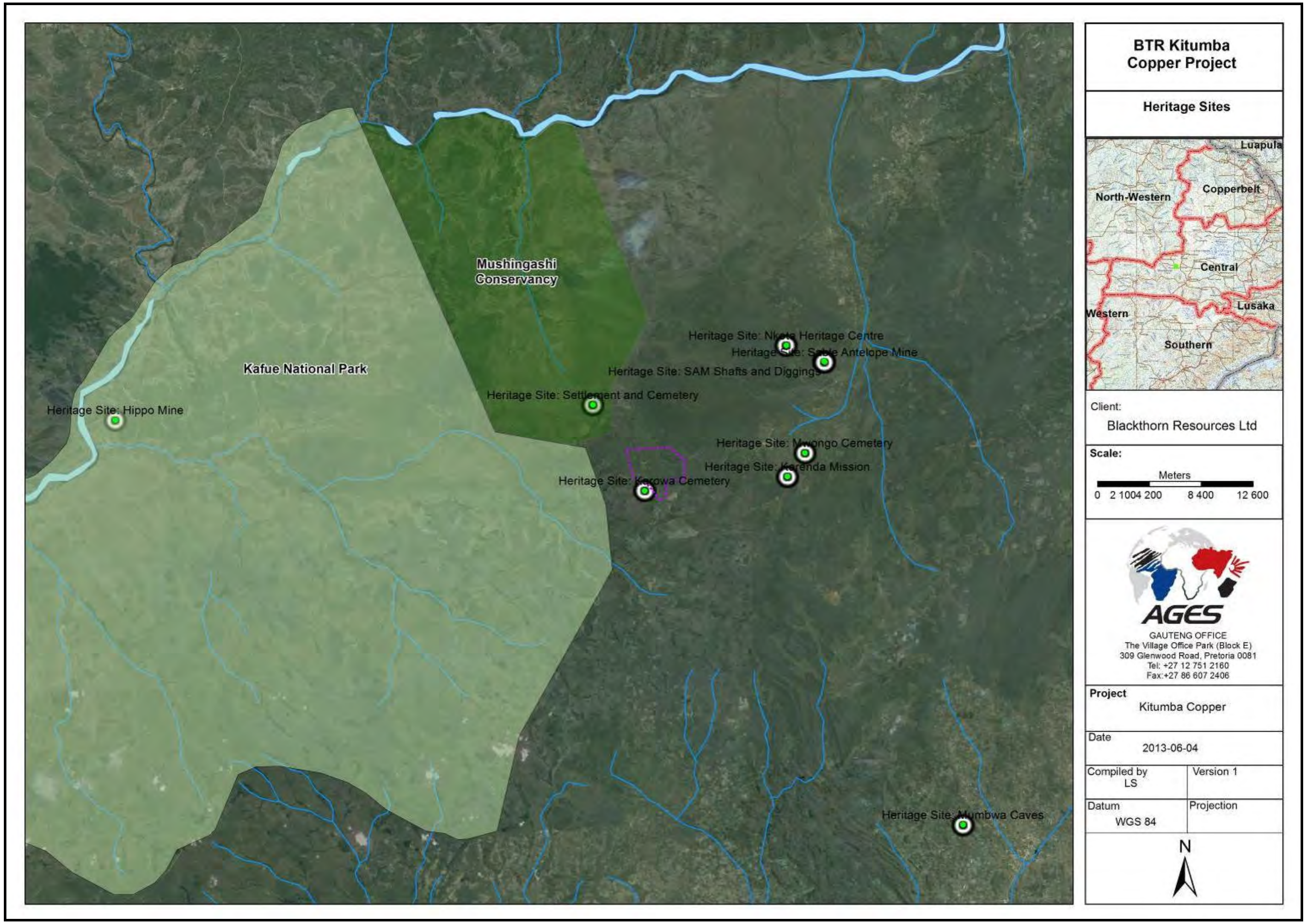

Figure 35: Archaeological and Heritage Resources in the vicinity of the site

5.12 Socio-Cultural and Economic Environment

To understand the possible impacts that a project may have on people one needs to understand their existing, pre-development environment. The following baseline description is derived from the specialist social impact assessment report compiled by Ptersa Environmental Management Consultants (Aucamp S.-M. 2013). The description of the social environment includes the identification and analysis of relevant stakeholders; a description of the area within a national, regional and local context that will focus on the identity and history of the area as well as a description of the population of the area based on a number of demographic, social and economic variables.

Zambia is divided into ten provinces and the provinces are divided into approximately 91 districts of which sixteen were established in 2012. The project site is situated in the Mumbwa District of the Central Province. The project site lies approximately 50 km North West of Mumbwa, the capital of the District. The closest villages to the site are Kafucamo and Mpundu. (Aucamp S.-M., 2013).

5.12.1 Culture and community power structures

Zambia is one of the most urbanised countries in sub-Saharan Africa with 44% of the total population concentrated in a few urban areas. The remaining rural areas, including the project site and surroundings, are sparsely populated.

The country is culturally very diverse, and current historians and linguistic experts can identify at least 16 major cultural groupings and more than 72 different spoken dialects in the country. Contemporary culture is a blend of traditions of more than 70 ethnically diverse tribes, most of who moved into the area in a series of migratory waves a few centuries ago. During the colonial period, the process of industrialisation and urbanisation saw ethnically different people brought together by economic interests. This, as well as the influence of western standards, generated a new culture without conscious effort. Many of the rural inhabitants have however retained their indigenous and traditional customs and values. Zambia is one of the few African countries with very little tribal animosity and the existence of so many tribes has not proved a significant political problem such as what has been seen in many other African states.

The site for the proposed mine is located in an area where the Kaonde people live but there is also a number of Bemba speaking people in the area. The Bemba represents approximately 18% of the population and was historically nomadic hunter-gatherers. When copper mining began in earnest on the Copperbelt, the Bemba speaking people migrated here in search of job opportunities. The Kaonde are the descendants of the famous Luba-Lunda Empire of Zaire and were among the first Zambian tribes to carry out the mining of copper. The communities in the vicinity of the proposed project and the surrounding land are under tribal leadership of Chief Kaindu.

The Chiefdom is divided in seven zones with approximately 300 villages. There are 72 headmen (appointed by the Chief) to assist with the management of the area. Approximately 9 headmen reside in proximity to the project site. There are also a number of councillors active in the surrounding communities. The neighbouring

Chiefdom is ruled by Chief Mumba of the Ile/Kaonde people of Mumbwa.

The community group known as the Kaindu Natural Resource Trust (KNRT) is active in the area and has in the recent past called a meeting with farmers, mining companies and other business stakeholders in the area to determine what their plans were in terms of social responsibility. The Chiefdom also has a committee that deals with community projects, called the Kaindu Project Coordinating Committee (KPCC).

5.12.1.1 Information of the cultural rights and practices in the project area

The project area is adjacent to the area under the leadership of Chief Kaindu. The majority of the people speak Kaonde, but there is also a number of Bemba speaking people in the area.

There is a ceremony called Musaka/Jikubi that usually takes place in September. Religion is very important and the area and there are a number of churches in the surrounding areas. The number of Kingdom Halls of the Jehovah's Witnesses is noticeable. The local communities are conservative with very traditional values, and Lobola is still widely practiced. Houses are often still built from traditional materials.

Leadership structures and rules are still accepted and obeyed by most of the community members.

5.12.2 Population, age, language, religion, education and family life

The total population of Zambia according to the 2010 National Census of Population and Housing was 13,046,508 with an annual growth rate of 2.8% since 2000. The population of the Central province was 1,267,308 while the Mumbwa district had a population of 218,328 and the second-highest population growth rate (3.2%).

Population density nationally, provincially and in the district is 17.3; 13.4 and 10.3 people per km^2 respectively. The average household size in the District is 5.4 people per household and consultations in the area have revealed that local households in the area tend to be large, often with more than six members.

The average age of the population of Zambia is 16.5 years. Life expectancy at birth is approximately 52.57 (Aucamp S.-M. , 2013). 64% of the Zambian population is between 0 – 14 years of age. 25% of the national population rages in age from 15 – 64 years (the economically active age) and 11% are aged over 65 years. 49% of the population of Zambia are male and 51% female. This is also true of the Central Province, but in the Mumbwa district representation is 50/50.

The official language in Zambia is English. The most common languages spoken in the vicinity of the study area are Kaonde and Bemba.

Zambia is officially a Christian nation, but a wide variety of religious traditions exist in the country. In the immediate surroundings of the study area, many churches and Kingdom Halls of Jehovah's Witnesses have been observed. Approximately 1 in 3 Zambians are Jehovah's Witnesses, which is one of the largest percentages worldwide. Locals in the vicinity of the project site place high value on their respective religious practices and expect their customs to be respected.

Education in Zambia consists of Basic education from Grade 1 to 9 and upper secondary education from Grade 10 to 12. Tuition is free up to Grade 7 and the cost of schooling after Grade 7 is out of reach for most rural families. The closest school to the study area which provides tuition up to Grade 12 is in Mumbwa, adding further travelling and accommodation costs to the schooling of rural children in the region. Most children in the area reportedly do not complete secondary schooling. Local educators have indicated that the levels of illiteracy in the area is very high and that it is a great concern that especially girls drop out of school early to get married and then do not finish their education (Aucamp S.-M. , 2013).

Adulthood comes at an early age for rural children and especially for girls. Few children manage to start school before the age of ten and by the age of fifteen they are considered adults with the responsibilities of marriage, child rearing and tending crops. Having a large number of children is still seen as some form of wealth or long-term insurance and females (especially in rural areas such as the study area) will typically have between 6 to 12 children. Men typically marry from the age of about 20 and Lobola is still widely practiced.

Local communities thus appear to be rather conservative with very traditional values. Despite this, divorce is not uncommon or frowned upon, and in certain instances it seems to be an acceptable practice for men to have affairs with other women. This creates a very fertile breeding ground for the transmission of HIV/AIDS and other sexually transmitted diseases.

Unemployment and underemployment in Zambia are serious problems. About 68% of Zambians live below the recognised national poverty line, with rural poverty rates standing at about 78%.

Most rural Zambians are subsistence farmers (traditionally), but with the lure of economic opportunity in the cities, many villages are now dominated by women who have to depend on their own ingenuity to generate cash to support their children and quite often also their elders.

People in the area surrounding the site of the proposed mine are generally poor as there are limited job opportunities in the area and the natural resources are not sufficient to supply in the needs of everyone. Local people busy themselves with subsistence farming (although some of the larger farms also commercialize at least some of their produce), small scale mining, charcoal production, hunting (sometimes poaching) and fishing in communities closer to the Kafue River. Some residents of local towns run shops that they stock from Mumbwa.

5.12.2.1 Illiteracy, emolument and dropout rates of people in the project area.

Most schools in the proximity of the project area are community schools that go up to Grade 7 and in some instances Grade 9. The closest school in the area that offers Grade 12 is in Mumbwa and it is outside the financial reach of most parents to send their children there.

According to educators in the area the levels of illiteracy are very high and it is a great concern that especially girls drop out of school early to get married and then do not finish their education.

Residents have reported that there are five government schools in the area that go up to Grade 9, while the other schools are community schools.

Statistics on illiteracy, emolument and dropout rates specifically for the area are not readily available, if at all. A full inventory of the local schools is also not available. The Kalenda Basic School (which is the closest known school to the site) is approximately 8 km (linear distance) from the project site, although this school is in excess of 20 km from the mine site by road. As statistics are not readily available and current, the following information is supplied (http://www.epdc.org/sites/default/files/documents/Zambia_subnatz_Mumbwa.pdf):

Table 11: 2008 Mumbwa District Profile

	Grade 1 – 9	Grade 10 – 12
Female pupils	26 366	1 165
Male pupils	28 109	1 609
Teachers	822	138
Schools	152	13
Classrooms	663	152
Textbooks	57 018	427

These statistics (though outdated) indicate a pupil-teacher ratio of approximately 1 teacher for every 60 pupils and almost 350 pupils per school.

5.12.3 HIV/AIDS infection rate and preventative measures in the project area

Although the local communities seem to be quite conservative with very traditional values, it seems to be an acceptable practise to have affairs with other women (Aucamp, 2013). Respondents who were consulted with as part of the Social Impact Assessment (See Appendix 3) have indicated belief that having intercourse with a woman while she is pregnant may cause damage to the unborn child, and thus many men have indicated that they would have affairs while their wives are pregnant in order to fulfil their sexual needs in the meantime. This creates a very fertile breeding ground for the transmission of HIV/AIDS and other sexually transmitted diseases (Aucamp, 2013).

Zambia's rate of economic growth cannot support rapid population growth or the strain that HIV/AIDS—related issues place on the economy (Aucamp, 2013). In May 2008 "Estimates put the prevalence of HIV at 15.6% among the 15-49 year old age group in Zambia" (http://www.ghinet.org/downloads/Zambia_GHI_Briefing_Sheet_May08_Final.pdf). Reportedly, significant scale-up of HIV services has occurred throughout Zambia. Between 2004 and 2007 there was a rapid increase in anti-retroviral (ART) coverage, Prevention of Mother to Child Transmission (PMTCT), and Voluntary Counselling and Testing (VCT) services (http://www.ghinet.org/downloads/Zambia_policybrief_hr.pdf). The following statistics are relevant to the Mumbwa district where the proposed project is to be located (http://www.google.co.za/url?sa=t&rct=j&q=&esrc=s&source=web&cd=6&cad=rja&ved=0CIEBEBYwBQ&url=http%3A%2F%2Fwww.ghinet.org%2Fdownloads%2FPoster_PMTCT_Task_sharing%28Final%29.ppt&ei=qMVkUsfgDrOY1AWGrYDQBw&usg=AFQjCNGqW-xl5R-

DoVhI0CKdfPVDZHhMhA&sig2=PDeYLa7rXaT9sIcPLcef6g&bvm=bv.54934254,d.Yms):

	2005	***2007***
PMTCT client numbers	39	2940
Staff numbers delivering PMTCT alone	2	4
Staff numbers delivering PMTCT and other services	22	32
No. of clinical staff (doctors, nurses and clinical officers)	98	91
No. of nurses/midwives	65	68
PMTCT workers as a proportion of all nurses/nurse midwives	37%	53%
PMTCT workers as a proportion of all clinical staff	25%	40%
Ratio of antenatal clinic clients to nurses/midwives	435	413

5.12.4 Industry

The Zambian government is pursuing an economic diversification program to reduce the economy's reliance on the copper industry. Inflation was 30% in 2000 and decreased to 8.9% in 2007. The annual rate of inflation, derived from the revised all items Consumer Price Index (CPI) was recorded at 6.4 per cent in January 2012 (Central Statistical Office, 2012). The following paragraphs briefly discuss the main economic industries in Zambia.

Agriculture is discussed under Section 5.7 of this Report as it is a common Land Use in the vicinity of the study area. Briefly it may be stated that Agriculture is and will continue to be central to the growth of the Zambian economy. Worth mentioning are the activities of Amatheon Agri Zambia Ltd, a local subsidiary of a multinational agricultural production company, in the vicinity of the project site.

Energy sources in Zambia include electricity, petroleum, coal, biomass and renewable energy. Electricity demand has been growing at an approximate average of 3% per annum. Hydro-Power contributes approximately 10% to the national energy supply and is the most important energy source in the country apart from wood fuel.

Zambia imports petroleum, but apart from that is self-sufficient in all its energy sources. Zambia's current proven coal deposits are estimated to be about 80 million tonnes, but there are only two coal mines in the country, and no coal-fired power plants. Utilization of solar and wind energy has remained relatively low.

The **Manufacturing** sector accounts for approximately 11% of the national GDP and growth in this sector is mainly attributed to the agro-processing, textiles and leather subsectors. Secondary processing of metals (including the smelting and refining of copper) is another main activity which has led to the manufacturing of metal products. Manufactured goods contribute an average of 25% of the country's total exports.

Mining has played a key role in the social and economic development of the country and is central to the Zambian economy. Zambia is the largest copper producer in Africa and the country is endowed with substantial mineral wealth including metals such as gold, copper, cobalt, zinc, lead, iron, manganese, nickel and platinum group elements, gemstones, industrial minerals, as well as uranium, coal and hydrocarbons.

Tourism is one of the fastest growing sectors in Zambia and is seen as one of the prime sectors of the economy. The tourism sector contributes approximately 6.5% of the country's GDP. There are 938 tourist accommodation establishments throughout Zambia. About two thirds of visitors to Zambia are from Africa and approximately 20% from Europe.

Zambia offers a wealth of natural tourism assets and wildlife protected areas occupy about 10% of the country's total land area. There are a total of 20 national parks, 34 GMAs and 23 million hectares of land devoted to conservation. Eco-tourism and adventure activities, cultural tourism and movie tourism are regarded as under-explored opportunities.

In the immediate vicinity of the proposed project site lies the Mushingashi Conservancy as well as the KNP (see section 5.7) which are important tourism facilities for the region.

5.12.4.1 Local economic activities in relation to local people's livelihood

People in the area are generally very poor as job opportunities are very limited. People make a livelihood through activities like subsistence farming, small shops, small-scale mining, illegal charcoal making, hunting, poaching and fishing. Economic activities in the area that provide employment opportunities are commercial agriculture, tourism (Kafue National Park as well as private game concessions) and small-scale mining.

There is a farmers' association and a small-scale mining association in the area.

5.12.5 Service Infrastructure

Infrastructure in the vicinity of the study area is generally limited. Local residents source water from boreholes, generally with hand-pumps, and residents walk or cycle in order to have access. Some residents also get water from small streams directly.

There is no sewerage system in the villages of the study area. Several houses have self-constructed pit-latrines outside. It is assumed that the field is used as a toilet by some. Some of the nearby farms and the existing exploration camp have toilet facilities connected to a septic tank system, which are emptied by tankers regularly.

The study area does not have electricity although there are plans to connect to the national electricity grid. Local people use mainly wood or charcoal to supply their current needs. There are also a few diesel generators in the area, including at the exploration camp, the prison farm, and some households and local businesses.

The transport system around the study area is not well developed. The roads are all gravel/dirt roads and generally in a poor condition. The primary mode of transport in the local areas is either by foot or bicycle.

Social Infrastructure (health care, education, recreation etc.) is also mostly insufficient in the project area. The nearest hospital is in Mumbwa, and the clinics in local villages are often incapable of meeting demands. Traditional healers play an important role in local health care. Zambia has a relatively high burden of diseases that require high consumption of pharmaceutical products such as malaria and HIV/AIDS presenting many challenges.

There are approximately five government schools in the vicinity of the project providing tuition up to Grade 9, where after children have to go to Mumbwa for schooling. There are no proper sports fields or other such recreational social infrastructure in the area.

The preceding sections have highlighted a number of existing social conditions prevalent in the areas surrounding the proposed development. It is essential that the local communities be treated with respect and duly consulted about development in their area. Without a “social license to operate” any project runs the risk of significant public opposition.

5.12.6 Transport and Traffic

The M9 is the main regional road in the area. The road is tarred and in good condition. From Mumbwa, this road continues in a westerly direction to the KNP and the road sees some traffic due to tourism activities in the region. This is also the road up to Mumbwa that would typically be used by tourists on their way to Mushingashi.

Existing vehicle traffic volumes on local roads such as the D181 are limited. Traffic through Mumbwa is significantly more prominent than in the surrounding rural areas. Traffic on the outskirts of and through Lusaka is significantly congested although there are rumours of future plans by the Roads Development Agency (RDA) to develop a bypass (Havenga, June 2013). Thus in terms of existing transportation infrastructure, challenges presented to the Project nearer the mine site relate mainly to adequacy of infrastructure (poor road conditions) while closer to Lusaka, the main concern is related to time lost due to traffic congestion.

Local roads through Mumbwa are used to gain site access. These are unpaved roads and are generally in a very poor condition. Street vendors and pedestrians occupy the sides of the street right up to the road, which is not demarcated with clear road signs or pavements. The road from Mumbwa to the project site is a dirt road in poor condition. In some areas, tall grass grows right up to the edge of the road, hampering visibility. During the rainy season, much of the area is not easily negotiable. Local inhabitants use the roads for access mostly by foot or bicycles. Few vehicles were observed.

The road conditions referred to above are illustrated in Figure 36


Vehicle and pedestrian traffic through Lusaka


The M9 west of Lusaka en route to Mumbwa


The traffic circle in Mumbwa


Road just west of the traffic circle in Mumbwa en route to site


Road D181 en route to site


Access to the mine from D181

Figure 36: Existing Road Conditions

6 IMPACTS

The following sub-sections highlight the key environmental, socio-cultural and economic impacts potentially associated with the proposed project. Significance of an impact is a function of the severity of the potential impact (in terms of actual consequence or severity, duration or frequency and spatial scale or extent of the impact, as well as the sensitivity of the element being impacted) and the probability of the impact occurring.

The key issues and potential environmental impacts discussed in this section have been identified through specialist investigations, professional understanding of the project team, and consultation with relevant authorities and a range of stakeholders.

6.1 Stakeholder Engagement and Public Participation

Public Participation is one of the most important aspects of the environmental evaluation and authorization process. This stems from the requirement that people have the right to be informed about potential decisions that may affect them and that they must be afforded an opportunity to influence those decisions. Effective public participation also improves the ability of the competent authority (ZEMA) to make informed decisions as the views of all parties are considered.

The Public Participation Process:

- Provides an opportunity for interested and affected parties (I&APs) to obtain clear, accurate and comprehensive information about the proposed activity, its alternatives or the decisions and the environmental impacts thereof;
- Provides I&APs with an opportunity to indicate their viewpoints, issues and concerns regarding the activity, alternatives and/or the decisions;
- Provides I&APs with the opportunity of suggesting ways of avoiding, reducing or mitigating negative impacts of an activity and for enhancing positive impacts;
- Enables an applicant to incorporate the needs, preferences and values of I&APs into the activity;
- Provides opportunities to avoid and resolve disputes and reconcile conflicting interests;
- Enhances transparency and accountability in decision-making.

6.1.1 Interested and Affected Parties

Every individual potentially affected by this project is a stakeholder in the project. The definition of a stakeholder is:

Any individual, group, or institution who has a vested interest in the social, economic or bio-

physical resources of the project area and/or who potentially will be affected by project activities and have something to gain or lose if conditions change or stay the same (Adapted from WWF, 2005).

Stakeholders who were consulted in the context of the Kitumba project include:

- Chief Kaindu and his tribal council consisting of several headmen
- Teachers at Kaindu Basic School: Danny Dilema, Peter Chisanga, Virginia Mubuyaeta
- Mr. Chabinga at Mpusu Basic School
- Darryl Watt from Mushingashi Game Concession
- Mumbwa Artisinal Mining Association
- Mumbwa Farmer's Association
- Residents of Mpundu Village and Kafucamo Village
- Mumbwa Prison Farm;
- Kafue National Park (Zambia Wildlife Authority – ZAWA)
- Zambia Air Force (ZAF);
- Andy Fleming, CEO of Amatheon Agri Zambia Ltd, who are in the process of developing a new irrigated cropping operation for food production in the Big Concession area adjacent to the proposed project.
- Mr Tandi Kamanga of African Deposits who has certain mining / exploration rights on land in the vicinity of the proposed project.
- The Zambian Roads Development Agency (RDA) (consulted via the traffic engineers).

Please refer to Appendix 2 for details of the consultations that took place as part of the EIS process.

6.1.2 Summary of Consultation / Issues Discussed

Stakeholders who were consulted commented on the following aspects relating to the proposed project: For full details refer to Appendix 2.

- Communities in the area have had bad experiences with mines in the past (promises not kept, unacceptable working conditions, low remuneration for long hours, lack of rehabilitation etc.) – there are trust issues that will have to be overcome.

- In general, communities welcome the mine because of the opportunities that it will bring – unemployment is very high in the area.

- Unemployment is very high in the area and jobs are scarce. There are some skilled people (brick layers, carpenters, drivers, machine operators etc.) in the local villages, but these people often do not have the required paperwork in place. Stakeholders have indicated that they would be willing to obtain the appropriate papers if they were to get the necessary support.

- Environmental aspects of particular concern are increased poaching, water pollution, environmental pollution.

- Impact on tourism activities in the area should be considered (visual, quality of environment, sense of place).

- The Communities have high expectations regarding the mine – care should be taken that the mine does not become a "surrogate government" that supplies things that the government should take care of.

- Consultation with stakeholders is an on-going process and stakeholder engagement should be prioritized throughout the life of the mining operations. Consultation should be expanded to include grassroots communities – not only the leadership, and vulnerable parties such as women, the youth and the elderly should be included in the process.

- They claimed that BHP Billiton tolerated nepotism in such that supervisors appointed friends and family members. They would like it if Blackthorn also engages with the grassroots people, not only with community leaders. It appears as though there are some trust issues with the mining industry.

- There is some concern among local communities that the community representatives (who are regularly consulted) do not always bring the right issues to the table, and that grassroots people need to be consulted as well. The establishment of a community liaison forum with representatives from different groups such as women, youth and the elderly should be investigated — this practice seems to be culturally acceptable and will ensure that the views of all potentially interested and affected parties are considered.

- Some of the women expressed a concern that they see no women employed in the mining arena — they would like to see more opportunities for women

6.2 Impact Assessment Methodology (After Plomp, 2004[3])

An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic environmental system that can be attributed to human activities related to alternatives under study for meeting a project need. The significance of the potential impacts of the proposed project will be rated by using a matrix derived from Plomp (2004) and adapted to fit this specific proposed project. This matrix uses the consequence and the likelihood of the different aspects and associated impacts to determine the significance of the impacts.

The significances of the impacts are determined through a synthesis of the following criteria:

Table 12: Impact Significance Criteria

Probability: This describes the likelihood of the impact actually occurring.		**Weight**
Improbable:	The possibility of the impact occurring is very low, due to the circumstances, design or experience.	**1**
Probable:	There is a probability that the impact will occur to the extent that provision must be made thereof.	**2**
Highly Probable	It is most likely that the impact will occur at some stage of the development.	**4**
Definite:	The impact will take place regardless of any prevention plans, and there can only be relied on mitigatory actions or contingency plans to contain the effect.	**5**
Duration: The lifetime of the impact		**Weight**
Short term:	The impact will either disappear with mitigation or will be mitigated through natural processes in a time span shorter than any of the phases of the project.	1
Medium term:	The impact will last up to the end of the project's phases, where after it will be negated.	3
Long term:	The impact will last for the entire operational phase of the project but will be mitigated by direct human action or by natural processes thereafter.	4
Permanent:	Impact that will be non-transitory. Mitigation either by man or natural processes will not occur in such a way or in such a time span that the impact can be considered transient.	5
Scale: The physical and spatial size of the impact		**Weight**
Footprint:	The impacted area extends only as far as the activity, e.g. footprint	1
Site:	The impact could affect the whole, or a measurable portion of the property.	2
Regional:	The impact could affect the area including the neighbouring residential areas.	3
Magnitude/ Severity: Does the impact destroy the environment, or alter its function.		**Weight**
Low:	The impact alters the affected environment in such a way that natural processes are not affected.	2

3 Plomp, H. 2004. A process for assessing and evaluating environmental management risk and significance in a gold mining company. Conference Papers-Annual National Conference of the International Association for Impact Assessment: South African Affiliate

Medium:	The affected environment is altered, but functions and processes continue in a modified way.	6
High:	Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.	8
Significance:	This is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required.	**Rating**
Significance is equal to the sum of the duration, scale and magnitude of an impact, multiplied by the probability of the impact occurring.		
Negligible:	The impact is non-existent or unsubstantial and is of no or little importance to any stakeholder and can be ignored.	0<20
Low:	The impact is limited in extent, has low to medium intensity; whatever its probability of occurrence is, the impact will not have a material effect on the decision and is likely to require management intervention with increased costs.	20<40
Moderate:	The impact is of importance to one or more stakeholders, and its intensity will be medium or high; therefore, the impact may materially affect the decision to implement, and management intervention will be required.	40<60
High:	The impact could render development options controversial or the project unacceptable if it cannot be reduced to acceptable levels; and/or the cost of management intervention will be a significant factor in mitigation.	>60

For example: If an impact has a high probability of occurrence, of medium term duration and a high magnitude, with site specific scale the significance of that impact is determined in the following way:

Significance = Sum (Duration, Scale, Magnitude) x Probability

= (3 + 2 + 6) x 4 = 44 Therefore Significance is rated as **Moderate**

The significance of each potential impact will be rated without mitigation measures and with mitigation measures.

6.3 Impact Assessment Structure

Impacts on the identified key issues will be assessed according to the following structure:

- The **Source** of the impact: will be identified (e.g. vegetation clearance, vehicles on dirt roads, etc.).
- A **Description** of the impact - the interaction between the activity and the environment, i.e. how and why the impact occurs and how the activity changes the environment.
- **Significance**: an explanation of the significance rating of the impact without mitigation, as above (the impacts are rated again in Section 7 of this report, after Mitigation measures have been applied.
- **Mitigation**: The mitigation measures that can be implemented to eliminate or minimise negative impacts or result in the optimization of positive benefits must, wherever possible be expressed as practical actions – Refer to Section 7 of this report for more details.

6.4 Impact Assessment

Table 13 represents a quantitative assessment of the significance of the various potential impacts which have been identified as per the methodology described above. These impacts are rated **without any mitigation, management or preventative measures in place**. In Section 7 of this report, mitigation measures are identified and the impacts are rated again taking the successful implementation of these measures into account. Please refer to Table 14

The impacts are grouped in terms of the sphere of impact (environmental, socio-cultural or economic) although it must be acknowledged that some impacts will occur simultaneously in more than one of these spheres. The project phase in which the impacts are expected is also indicated.

6.5 Significant Impacts

Following the impact assessment of each of the identified possible environmental impacts, the following potential impacts are deemed to be the most significant (**without implementation of mitigation measures**):

- Air Quality Impacts resulting from All Sources at the operations, causing Incremental PM10 Impact during the operational phase of the mine.
- Lowering of water levels of surrounding (within 3 km radius) water supply boreholes, due to the dewatering radius of influence.
- Inrush of groundwater to mine tunnels and stopes, potentially leading to loss of life.
- Groundwater and surface water contamination by copper, cobalt, cadmium and manganese due to contaminants leaching from mine waste facilities.
- Radioactive contaminants from mine waste facilities, due to uranium being concentrated in the product.
- Groundwater seeping into the underground workings, causing the filling up of the shaft(s) and workings and leading to impacts on operations and mining schedule.
- Negative impacts on surface and groundwater quality due to Migration of TSF and WRD plume (northwest).
- Damage to or destruction of undiscovered heritage or archaeological resources, during construction, operation and decommissioning of the mining project and associated projects (roads, water supply etc.).
- Impacts on Health and social wellbeing: Impacts on physical health due to influx of people putting pressure on infrastructure and resources, increased disease, accidents and injuries.

- Influx of people creating a platform for opportunistic and other criminals: Impacts on Health and social wellbeing: Crime - increased theft, social ills and poaching.
- Shortage of social and physical infrastructure (Impact on quality of the living environment) due to influx of people putting additional pressure on infrastructure (roads, sanitation etc.)
- Habitat fragmentation due to Vegetation clearing and construction, Storage of Tailings; Laydown areas for stockpiles and waste rock, roads as well as in the subsistence zone (depression and cracks caused by SLC).
- Increased soil erosion and sedimentation at the Sidewalls of depression created by SLC mining, causing increased hardened surfaces around infrastructure and exposed areas created alongside the mining area.
- Increased soil erosion and sedimentation due to increased hardened surfaces created at the project site.
- Dust contamination due to exposure of rock, ore and soil to rainfall and wind, stockpiling, Materials handling, vehicle entrainment and windblown dust.
- Light pollution due to construction of mining infrastructure, access roads etc.
- Habitat Destruction in wetlands due to Clearing of vegetation, construction of infrastructure etc., and placement of stockpiles, TSF and WRD on wetlands.
- Dust contamination in wetlands due to movement of construction vehicles, stockpiling, Materials handling, vehicle entrainment and windblown dust, and movement of vehicles on site for rehabilitation.
- Soil Compaction due to regular heavy vehicle movement, and laydown areas.
- Soil Destruction and sterilization due to topsoil stripping and mine construction
- Soil Destruction and sterilization due to the Depression created by SLC operations (will be more severe with opencast mining methods).

Table 13: Impact identification and significance rating WITHOUT MITIGATION

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
1	**Air Quality**								(WOM)
1.1	All construction activities	Increased PM10 and PM 2.5 on and around the project site activities	Construction	Probable	Medium Term	Site	Medium	22	Low
1.2	Earthworks	Decreased air quality due to increased PM10 and PM2.5 and dust	Construction	Probable	Medium Term	Local	Low	12	Negligible
1.3	Site Development	Decreased air quality due to increased PM10 and PM2.5 and dust	Construction	Probable	Medium Term	Local	Low	12	Negligible
1.4	Movement of vehicles and personnel on unpaved roads	Air quality impacts from increased dust	Construction	Probable	Medium Term	Site	Medium	22	Low
1.5	Civil Works	Decreased air quality due to increased PM10 and PM2.5 and dust	Construction	Improbable	Medium Term	Local	Low	6	Negligible
1.6	All Sources of emissions to the atmosphere	Incremental PM2.5 Impact	Operational	Highly Probable	Long Term	Regional	Medium	52	Moderate
1.7	All Sources of emissions to the atmosphere	Incremental PM10 Impact	Operational	Definite	Long Term	Regional	Medium	65	High
1.8	Unpaved Roads	Incremental PM2.5 and PM10 Impact	Operational	Highly Probable	Long Term	Regional	Medium	52	Moderate
1.9	Wind erosion	Incremental PM2.5 and PM10 Impact	Operational	Probable	Long Term	Local	Low	14	Negligible
1.10	Materials handling	Incremental PM2.5 and PM10 Impact	Operational	Probable	Long Term	Local	Low	14	Negligible
1.11	Ventilation shafts	Incremental PM2.5 and PM10	Operational	Improbable	Long Term	Local	Medium	11	Negligible

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
		Impact							
1.12	Crushing	Incremental PM2.5 and PM10 Impact	Operational	Probable	Long Term	Site	Medium	24	Low
1.13	Grading	Incremental PM10 Impact	Operational	Probable	Long Term	Local	Medium	22	Low
1.14	Bulldozing	Incremental PM10 Impact	Operational	Highly Probable	Long Term	Local	Medium	44	Moderate
1.15	Incline Shaft	PM2.5 and PM 10 Impacts	Closure	Improbable	Medium Term	Local	Low	6	Negligible
1.16	Topsoil and waste dumps	PM2.5 and PM 10 Impacts	Closure	Probable	Medium Term	Local	Low	12	Negligible
1.17	Processing Plant	PM2.5 and PM 10 Impacts	Closure	Improbable	Medium Term	Local	Low	6	Negligible
1.18	Admin and HR facilities	PM2.5 and PM 10 Impacts	Closure	Improbable	Medium Term	Local	Low	6	Negligible
1.19	Unpaved Roads	PM2.5 and PM 10 Impacts	Closure	Probable	Medium Term	Local	Low	12	Negligible
1. 20	Blasting	PM2.5 and PM 10 Impacts	Closure	Improbable	Short Term	Local	Low	4	Negligible
2	**Hydrogeology**								
2.1	Establishment of construction camp and sanitation facilities	Negative impacts on Groundwater quality	Pre-construction and Construction	Highly Probable	Short Term	Site	Medium	36	Low
2.2	Use of explosives for decline development	Contribute to nitrates overload to groundwater	Pre-construction and Construction	Highly Probable	Medium Term	Site	Medium	44	Moderate
2.3	Hydrocarbon spillages (construction vehicles)	Negative impacts on Groundwater quality	Pre-construction and Construction	Highly Probable	Short Term	Site	High	44	Moderate
2.4	Surface water	Negative impacts on surface water	Preconstruction	Probable	Short Term	Regional	High	24	Low

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
	contamination	quality	and Construction						
2.5	Anthropogenic activities on site	Negative impacts on surface and groundwater quality	Preconstruction and Construction	Probable	Short Term	Site	High	22	Low
2.6	Dewatering radius of influence	Lowering water levels of surrounding (3km radius) water supply boreholes.		Definite	Long Term	Regional	Medium	65	High
2.7	Inrush of groundwater to mine tunnels and stopes	Loss of Life	Operational	Highly Probable	Permanent	Regional	High	64	High
2.8	Dewatering radius of influence	Lowering water levels of wetlands (3km radius), decrease groundwater head	Operational	Definite	Long Term	Local	Medium	55	Moderate
2.9	Contaminant leaching from mine waste facilities	Groundwater and surface water contamination by copper, cobalt, cadmium and manganese	Operational	Highly Probable	Permanent	Regional	High	64	High
2.1	Uranium concentrated in the product	Radioactive contaminants from mine waste facilities	Operational	Highly Probable	Permanent	Regional	High	64	High
2.11	Chemicals used in mining activities	Contamination of surface and groundwater by point source chemicals	Operational	Highly Probable	Medium Term	Regional	Medium	48	Moderate
2.12	Groundwater seepage to underground workings	Filling up mine shaft negative impact on mine schedule and operations	Operational	Highly Probable	Permanent	Regional	High	64	High
2.13	Increased runoff due to mining activities	increased erosion and silt loading on surface water bodies	Operational	Highly Probable	Long Term	Site	Medium	48	Moderate
2.14	Hydrocarbon spillages (from	Negative impacts on groundwater and surface water quality	Operational	Highly Probable	Medium Term	Site	Medium	44	Moderate

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
	storage facilities or vehicles)								
2.15	Use of explosives	Presence of nitrates in water derived from mine workings (impacts on water quality)	Operational	Highly Probable	Long Term	Regional	Low	36	Low
2.16	Contaminated stormwater runoff from mine workings	Negative impacts on groundwater and surface water quality	Operational	Highly Probable	Long Term	Site	Medium	48	Moderate
2.17	Inrushes of water caused by subsidence and cracking	Negative impacts on production and poses a safety risk	Operational	Definite	Long Term	Local	High	65	High
2.18	Unstable underground conditions due to the effects of subsidence	Negative impacts on production and poses a safety risk	Operational	Highly Probable	Medium Term	Local	High	48	Moderate
2.19	Mine dewatering effects decreasing - post operational rewatering	Rising of water levels and increase in borehole yields for water supply	Closure and Post-Closure	Definite	Permanent	Local	Low	40	Low
2.20	Re-watering radius of influence	Increased water levels of wetlands (3km radius) and increased groundwater head	Closure and Post-Closure	Probable	Long Term	Local	Medium	22	Low
2.21	Leaching of contaminants from mine waste facilities	Contamination of groundwater and surface water by copper, cobalt, cadmium and manganese	Closure and Post-Closure	Highly Probable	Permanent	Regional	High	64	High
2.22	Radioactive contaminants from mine waste facilities	Uranium concentrated in product. Residual concentrations in WRD and TSF (probably low)	Closure and Post-Closure	Highly Probable	Permanent	Site	High	60	Moderate
2.23	Use of explosives	Groundwater contamination by	Closure and	Probable	Medium	Site	Medium	22	Low

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
	causing presence of nitrates	nitrates due to blasting	Post-Closure		Term				
2.24	Post operational void lake acidification caused by oxygen ingress due to subsidence	Negative impacts on groundwater and surface water quality	Closure and Post-Closure	Highly Probable	Permanent	Regional	High	64	High
2.25	Migration of TDF and WRD plume (northwest)	Negative impacts on surface and groundwater quality	Closure and Post-Closure	Definite	Permanent	Site	High	75	High
3	**Noise**								
3.1	All construction, site clearance and preparations	Noise disturbance and nuisance	Construction	Improbable	Medium Term	Local	Low	6	Negligible
3.2	Ventilation shaft, processing plant, underground mining operations, Stockpiling and dumping	Noise disturbance and nuisance	Operational	Improbable	Long Term	Site	High	14	Negligible
3.3	Decommissioning, dismantling, loading, dozing, vehicles	Noise disturbance and nuisance	Closure	Improbable	Medium Term	Site	Medium	11	Negligible
4	**Visual Impact**								
4.1	Presence of construction vehicles, machinery, equipment and personnel	Alteration of key elements, features and characteristics of the baseline visual environment	Construction	Highly Probable	Medium Term	Regional	Medium	48	Moderate

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
4.2	Presence of construction and mining vehicles, machinery, equipment and personnel	Alteration of key elements, features and characteristics of the baseline visual environment	Operational	Highly Probable	Long Term	Regional	Medium	52	Moderate
4.3	Presence of vehicles, machinery, equipment and personnel	Alteration of key elements, features and characteristics of the baseline visual environment	Closure	Highly Probable	Permanent	Regional	Medium	56	Moderate
5	**Impact on Heritage resources**								
5.1	Construction, operation and decommissioning of the mining project and associated projects (roads, water supply etc.).	Damage to or destruction of undiscovered heritage or archaeological resources	Construction, operation and closure	Highly Probable	Permanent	Regional	High	64	High
6	**Social Impacts**								
6.1	Development in the area causing in-migration of foreigners	Change in cultural values and integrity (Impact on Social Dynamics)	Construction	Highly Probable	Permanent	Site	High	60	Moderate
6.2	Influx of people to the surrounding villages due to opportunities	Negative impacts on existing community cohesion (Impact on Social Dynamics)	Construction	Highly Probable	Long Term	Site	High	56	Moderate
6.3	Job-creation for local people and for people from outside, inappropriate procurement policies	Social differentiation and inequity (Impact on Social Dynamics)	Construction	Highly Probable	Long Term	Regional	Medium	52	Moderate

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
6.4	Conflict about available jobs and who should benefit from the project. Cultural change due to influx and economic changes for some.	Social tension and violence (Impact on Social Dynamics)	Construction and operation	Highly Probable	Long Term	Site	High	56	Moderate
6.5	Unrealistically high community expectations of benefits due to project	Aspirations and expectations of community not realized (causing tension and distrust). (Impact on Social Dynamics)	Construction	Highly Probable	Long Term	Regional	High	60	Moderate
6.6	Mine staff residing away from their families	Alterations in Family structures. (Impact on Social Dynamics)	Construction and operation	Highly Probable	Long Term	Regional	High	60	Moderate
6.7	Change in sense of belonging due to influx of people	Community identification and connection (Impact on Social Dynamics)	Construction and operation	Highly Probable	Long Term	Site	Medium	48	Moderate
6.8	Influx of people putting pressure on infrastructure and resources, increased disease, accidents and injuries	Impacts on Health and social wellbeing: Impacts on physical health	Construction and operation	Definite	Permanent	Regional	High	80	High
6.9	Impacts on water quality/availability, increased traffic, unfair labour practices	Impacts on Health and social wellbeing: Impacts on personal safety (physical and psychological)	Construction and operation	Highly Probable	Medium Term	Regional	High	56	Moderate

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
6.10	Influx of people creating a platform for opportunistic and other criminals	Impacts on Health and social wellbeing: Crime - increased theft, social ills and poaching	Construction and operation	Definite	Medium Term	Regional	High	70	High
6.11	Influx of people putting additional pressure on infrastructure (roads, sanitation etc.)	Shortage of social and physical infrastructure (Impact on quality of the living environment)	Construction and operation	Definite	Medium Term	Regional	High	70	High
6.12	presence of mine infrastructure, vehicles, machinery and personnel	Alteration of sense of place / environmental amenity value / aesthetic quality (negative impact on tourism)	Construction and operation	Highly Probable	Permanent	Local	High	56	Moderate
6.13	Animal human interaction and resultant industry conflicts	Conflicting land uses with neighbouring activities (conservation vs. mining)	Construction and operation	Definite	Medium Term	Local	High	60	Moderate
7	**Impacts on Biodiversity**								
7.1	Vegetation clearing and construction	Destruction of habitat	Construction	Definite	Permanent	Local	Medium	60	Moderate
7.2	Storage of Tailings; Laydown areas for stockpiles and waste rock, depression and cracks from SLC Mining method	Direct habitat destruction	Operational	Definite	Long Term	Local	Medium	55	Moderate
7.3	Vegetation clearing and construction	Habitat fragmentation	Construction	Definite	Permanent	Local	High	70	High
7.4	Storage of Tailings; Laydown areas for	Habitat fragmentation	Operational	Definite	Permanent	Local	High	70	High

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
	stockpiles and waste rock, depression and cracks from SLC								
7.5	Rehabilitation of SLC depression (filling and levelling of cracks)	Habitat Fragmentation	Closure	Highly Probable	Permanent	Local	Medium	48	Moderate
7.6	Exposure of rock, ore and soil to rainfall and wind	Soil erosion	Construction	Highly Probable	Long Term	Regional	Medium	52	Moderate
7.7	Sidewalls of SLC depression and Increased hardened surfaces created at the project site	Increased soil erosion and sedimentation	Operational	Definite	Long Term	Regional	High	75	High
7.8	Rehabilitation activities	soil erosion	Closure	Highly Probable	Permanent	Regional	Medium	56	Moderate
7.9	Movement of vehicles on site	Spillages of harmful substances	Construction	Probable	Long Term	Regional	Medium	26	Low
7.10	Domestic and hazardous waste storage and disposal, sewage treatment	Spillages of harmful substances	Operational	Probable	Long Term	Regional	Medium	26	Low
7.11	Movement of vehicles on site	Spillages of harmful substances	Closure	Probable	Long Term	Regional	Medium	26	Low
7.12	Exposure of rock, ore and soil to rainfall and wind	Dust contamination	Construction	Definite	Long Term	Regional	High	75	High

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
7.13	Stockpiling, Materials handling, vehicle entrainment and windblown dust	Dust	Operational	Definite	Long Term	Regional	High	75	High
7.14	Rehabilitation activities	Dust	Closure	Highly Probable	Permanent	Regional	Medium	56	Moderate
7.15	Continued movement of personnel and vehicles on and off site, and deliver of materials	Spread of alien invasive species	Construction	Highly Probable	Permanent	Regional	Medium	56	Moderate
7.16	Transporting of people and equipment	Spread of alien invasive species	Operational	Highly Probable	Permanent	Regional	Medium	56	Moderate
7.17	Movement of vehicles on site	Spread of alien invasive species	Closure	Highly Probable	Permanent	Regional	Medium	56	Moderate
7.18	Construction of infrastructure, roads etc.	Negative impacts of human activities	Construction	Highly Probable	Medium Term	Site	Medium	44	Moderate
7.19	workers accommodation on site	Negative effects of human activities on flora	Operational	Highly Probable	Medium Term	Site	Medium	44	Moderate
7.20	Presence of labourers on site	Negative effects of human activities on flora	Closure	Probable	Long Term	Site	Medium	24	Low
7.21	Continued movement of personnel and vehicles on and off site, and deliver of	Fauna mortality on roads	Construction	Highly Probable	Medium Term	Site	Medium	44	Moderate

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
	materials								
7.22	Movement of vehicles on and off site and delivery of materials	Fauna mortality on roads	Operational	Highly Probable	Medium Term	Regional	High	56	Moderate
7.23	Movement of vehicles on site	Fauna mortality	Closure	Probable	Long Term	Site	Medium	24	Low
7.24	Construction of mining infrastructure, access roads etc.	Light pollution	Construction	Definite	Long Term	Regional	High	75	High
7.25	Mining operations during night time	Light pollution	Operational	Definite	Medium Term	Regional	Medium	60	Moderate
8	**Impacts on Wetlands**								
8.1	Clearing of vegetation, construction of infrastructure etc.	Habitat Destruction	Pre-construction and construction	Definite	Permanent	Local	High	70	High
8.2	Placement of stockpiles, TSF and WRD on wetlands	Direct habitat destruction	Operational	Definite	Long Term	Local	High	65	High
8.3	Increased hardened surfaces and exposed areas	Soil compaction and erosion leading to sedimentation	Pre-construction and construction	Highly Probable	Long Term	Regional	Medium	52	Moderate
8.4	Increased hardened surfaces and exposed areas	Increased soil erosion and sedimentation	Operational	Highly Probable	Long Term	Regional	Medium	52	Moderate
8.5	Rehabilitation activities	Increased soil erosion and sedimentation	Closure and Post-Closure	Highly Probable	Permanent	Regional	Medium	56	Moderate

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
8.6	Exposure of rock, ore and soil to rainfall and wind, and vehicle movement	Water pollution from spillages of harmful substances	Pre-construction and construction	Probable	Long Term	Regional	Medium	26	Low
8.7	Large vehicles - oil and fuel spillages, building waste, batching plants, sewage and domestic waste, topsoil storage	Water pollution from spillages	Operational	Probable	Long Term	Regional	Medium	26	Low
8.8	Movement of vehicles on site for rehabilitation	Water pollution from spillages	Closure and Post-Closure	Probable	Long Term	Regional	Medium	26	Low
8.9	Movement of construction vehicles	Dust contamination	Pre-construction and construction	Definite	Long Term	Regional	High	75	High
8. 10	Stockpiling, Materials handling, vehicle entrainment and windblown dust	Dust contamination	Operational	Definite	Long Term	Regional	High	75	High
8.11	Movement of vehicles on site for rehabilitation	Dust contamination	Closure and Post-Closure	Definite	Long Term	Regional	Medium	65	High
8.12	Movement of personnel and vehicles on and off site and delivery of materials	Spread of alien invasive species in wetland systems	Pre-construction and construction	Highly Probable	Permanent	Regional	Medium	56	Moderate
8.13	Movement of personnel and vehicles on and off	Spread of alien invasive species in wetland systems	Operational	Highly Probable	Permanent	Regional	Medium	56	Moderate

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
	site and delivery of materials								
8.14	Movement of personnel and vehicles on and off site and delivery of materials	Spread of alien invasive species in wetland systems	Closure and Post-Closure	Highly Probable	Permanent	Regional	Medium	56	Moderate
9	**Impacts on Soils, land capability and agricultural potential**								
9.1	Regular heavy vehicle movement, and laydown areas	Soil Compaction	Pre-construction and construction	Definite	Long Term	Local	High	65	High
9.2	Regular heavy vehicle movement, and laydown areas	Soil Compaction	Operational	Definite	Long Term	Local	High	65	High
9.3	Regular heavy vehicle movement for rehabilitation activities	Soil Compaction	Closure and Post-Closure	Highly Probable	Long Term	Local	Medium	44	Moderate
9.4	Vegetation clearance, mine construction and activities leaving soil exposed	Soil erosion	Pre-construction and construction	Highly Probable	Long Term	Regional	Medium	52	Moderate
9.5	Hardened surfaces, slopes of stockpiles and WRD	Soil erosion	Operational	Highly Probable	Long Term	Regional	Medium	52	Moderate
9.6	General rehabilitation activities	Soil erosion	Closure and Post-Closure	Highly Probable	Long Term	Regional	Medium	52	Moderate
9.7	Construction vehicles contributing to oil and fuel	Soil pollution	Pre-construction and construction	Probable	Long Term	Regional	Medium	26	Low

No	Activity/Aspect	Impact	Phase	Probability	Duration	Scale	Magnitude	Significance	
	spillages, building waste, batching plants, sewage and domestic waste								
9.8	Construction vehicles contributing to oil and fuel spillages, building waste, batching plants, sewage and domestic waste	Soil pollution	Operational	Probable	Long Term	Regional	Medium	26	Low
9.9	Oil and fuel leakages from vehicles and machinery for rehabilitation	Soil pollution	Closure and Post-Closure	Probable	Long Term	Regional	Medium	26	Low
9. 10	Topsoil stripping and mine construction	Soil destruction and sterilization	Pre-construction and construction	Definite	Permanent	Local	High	70	High
9.11	Topsoil stripping and mine construction	Soil destruction and sterilization	Operational	Definite	Permanent	Local	High	70	High
9.12	Construction of mine and infrastructure	Loss of land capability	Pre-construction and construction	Definite	Long Term	Local	Medium	55	Moderate
9.13	Dumping of waste rock, mining and stockpiling	Loss of land capability	Operational	Definite	Long Term	Local	Medium	55	Moderate
9.14	Loss of grazing value due to lower grazing capacity after rehabilitation	Loss of land capability	Closure and Post-Closure	Probable	Long Term	Local	Medium	22	Low

7 MITIGATION MEASURES FOR ALL IDENTIFIED IMPACTS

The following paragraphs explain in detail the mitigation measures that have been identified in order to ensure that the impacts identified in Section 6, can be mitigated or managed to acceptable levels, or entirely avoided.

Mitigation is not applicable to all of the identified impacts, either because the impact significance is of such little consequence that mitigation is not warranted, or because the impact cannot be mitigated or avoided.

A summary of the relevant mitigation measures is also provided in the Environmental Management Plan (EMP) contained in Section 9 of this report.

The following paragraphs mention the significant environmental impacts which remain of significance even after the implementation of mitigation measures.

7.1 Significant Environmental Impacts that remain significant after mitigation

The only significant environmental impact which remains significant even after the implementation of mitigation measures is:

- Soil destruction and sterilization due to topsoil stripping and mine construction
- Increased risk of soil erosion and sedimentation due to Sidewalls of SLC depression

7.2 Significant Socio-cultural Impacts that remain significant after mitigation

The only significant impacts on the social environment which remain significant even with the implementation of mitigation measures are:

- Influx of people putting pressure on infrastructure and resources, increased disease, accidents and injuries causing impacts on physical health and social wellbeing.

7.3 Significant Economic Impacts that remain significant after mitigation

There are no negative economic impacts on surrounding communities expected to be associated with the proposed project.

Table 14: Identification of mitigation measures, and impact ratings AFTER mitigation

No	Activity/Aspect	Impact	Phase	WM/ WOM	Significance (WOM)		Mitigation	Significance (WM)	
1	**Air Quality**								
1.1	All construction activities	Increased PM10 and PM 2.5 on and around the project site activities	Construction	WOM WM	22	Low	Water sprays for dust suppression to be applied according to prevailing site specific conditions	6	Negligible
1.4	Movement of vehicles and personnel on unpaved roads	Air quality impacts from increased dust	Construction	WOM WM	22	Low	Water sprays for dust suppression to be applied according to prevailing site specific conditions	6	Negligible
1.6	All Sources	Incremental PM2.5 Impact	Operational	WOM WM	52	Moderate	All mitigation listed for subsequent source groups	48	Moderate
1.7	All Sources	Incremental PM10 Impact	Operational	WOM WM	65	High	All mitigation listed for subsequent source groups	52	Moderate
1.8	Unpaved Roads	Incremental PM2.5 and PM10 Impact	Operational	WOM WM	52	Moderate	75% control efficiency by water sprays on roads	48	Moderate
1.10	Materials handling	Incremental PM2.5 and PM10 Impact	Operational	WOM WM	14	Negligible	50% control efficiency through water sprays	7	Negligible
1.12	Crushing	Incremental PM2.5 and PM10 Impact	Operational	WOM WM	24	Low	50% control efficiency through water sprays	11	Negligible
2	**Hydrogeology**								
2.1	Establishment of construction camp and sanitation facilities	Negative impacts on Groundwater quality	Pre-construction and Construction	WOM WM	36	Low	Chemical sanitary facilities should be used. Facilities to be located away from drainage systems	18	Negligible
2.2	Use of explosives for decline development	Contribute to nitrates overload to groundwater	Pre-construction and	WOM WM	44	Moderate	Monitoring boreholes to monitor and evaluate water quality	36	Low

			Construction						
2.3	Hydrocarbon spillages (construction vehicles)	Negative impacts on Groundwater quality	Pre-construction and Construction	WOM WM	44	Moderate	Store fuels and chemicals in secured and bunded area - prevent spillages and leakages	16	Negligible
2.4	Surface water contamination	Negative impacts on surface water quality	Preconstruction and Construction	WOM WM	24	Low	Limit construction to the dry season where possible	12	Negligible
2.5	Anthropogenic activities on site	Negative impacts on surface and groundwater quality	Preconstruction and Construction	WOM WM	22	Low	Adequate camp management, good housekeeping rules	18	Negligible
2.6	Dewatering radius of influence	Lowering water levels of surrounding (3 km radius) water supply boreholes.	Operational	WOM WM	65	High	Monitor radius of influence (local and regional water level measurements monthly). Provide alternative water to affected parties/ecosystems	60	Moderate
2.7	Inrush of groundwater to mine tunnels and stopes	Loss of Life	Operational	WOM WM	64	High	Dewatering design which covers drilling and pre-dewatering or sealing	9	Negligible
2.8	Dewatering radius of influence	Lowering water levels of wetlands (3 km radius), decrease groundwater head	Operational	WOM WM	55	Moderate	Additional site characterisation to determine wetland mechanism. Monitoring boreholes. Specific discharge into wetlands to maintain biodiversity	30	Low
2.9	Contaminant leaching from mine waste facilities	Groundwater and surface water contamination by copper, cobalt, cadmium and manganese	Operational	WOM WM	64	High	More detailed geochemical investigations. Mixing of lime in plant to neutralize tailings waste and seepage capturing during operational phase	32	Low

2. 10	Uranium concentrated in the product	Radioactive contaminants from mine waste facilities	Operational	WOM WM	64	High	Seepage capturing during operational phase. Bleeding off uranium in process water to prevent build-up. Separate uranium in the plant and develop small norm waste facility, dispose at licensed facility or sell.	16	Negligible
2.11	Chemicals used in mining activities	contamination of surface and groundwater by point source chemicals	Operational	WOM WM	48	Moderate	All materials, fuels and chemicals must be stored in specific secured and bunded area. Spillages and leakages are to be prevented.	26	Low
2.12	Groundwater seepage to underground workings	Filling up mine shaft negative impact on mine schedule and operations	Operational	WOM WM	64	High	Water to be pumped out and re-used in mine circuit (contact water)	16	Negligible
2.13	Increased runoff due to mining activities	increased erosion and silt loading on surface water bodies	Operational	WOM WM	48	Moderate	Erosion control measures and stormwater management plan to be implemented	24	Low
2.14	Hydrocarbon spillages (from storage facilities or vehicles)	Negative impacts on groundwater and surface water quality	Operational	WOM WM	44	Moderate	Maintenance of mine vehicles and machinery. Use spill trays when necessary. Oil separators at workshops	22	Low
2.15	Use of explosives	Presence of nitrates in water derived from mine workings (impacts on water quality)	Operational	WOM WM	36	Low	Groundwater monitoring and treatment if necessary	14	Negligible
2.16	Contaminated stormwater runoff from mine workings	Negative impacts on groundwater and surface water quality	Operational	WOM WM	48	Moderate	A stormwater management plan should be implemented to ensure effective containment. Silt traps to capture sediment load.	24	Low
2.17	Inrushes of water	Negative impacts on	Operational	WOM	65	High	Implementation of emergency	32	Low

	caused by subsistence cracking	production, and poses a safety risk		WM			standby pumping system and procedure		
2.18	Unstable underground conditions due to the effects of subsistence	Negative impacts on production, and poses a safety risk	Operational	WOM WM	48	Moderate	Implementation of early geotechnical detecting warning system	40	Low
2.19	Mine dewatering effects decreasing - post operational rewatering	Rising of water levels and increase in borehole yields for water supply	Closure and Post-Closure	WOM WM	40	Low	Sealing of decline and access tunnels to reduce oxygen ingress. Liming of mine void to neutralise post operational flooding	36	Low
2.20	Re-watering radius of influence	Increased water levels of wetlands (3 km radius) and increased groundwater head	Closure and Post-Closure	WOM WM	22	Low	Channel rehabilitated storm water to wetlands	30	Low
2.21	Leaching of contaminants from mine waste facilities	Contamination of groundwater and surface water by copper, cobalt, cadmium and manganese	Closure and Post-Closure	WOM WM	64	High	Additional geochemical studies to increase understanding of the system. Neutralise waste during operational phase. TSF rehabilitation	16	Negligible
2.22	Radioactive contaminants from mine waste facilities	Uranium concentrated in product. Residual concentrations in WRD and TSF (probably low)	Closure and Post-Closure	WOM WM	60	Moderate	Additional geochemical and radiological studies. Bleeding off uranium in process water to prevent build-up. Separate uranium in plant and develop norm waste facility, dispose at licensed facility or sell.	30	Low
2.23	Use of explosives causing presence of nitrates	Groundwater contamination by nitrates due to	Closure and Post-Closure	WOM WM	22	Low	Nitrates would dissipate as blasting stops	8	Negligible

		blasting							
2.24	Post operational void lake acidification caused by oxygen ingress due to subsistence	Negative impacts on ground water and surface water quality	Closure and Post-Closure	WOM WM	64	High	Altering location of the decline to be situated at a higher elevation or effective sealing of decline to prevent direct decant	32	Low
2.25	Migration of TSF and WRD plume (northwest)	Negative impacts on surface and groundwater quality	Closure and Post-Closure	WOM WM WM	75	High	TSF rehabilitation (and capping) to minimise ingress	52	Moderate
3	**Noise**								
	Noise-related impacts were found to be negligible, even without mitigation (See Table 13) thus no mitigation is required.					Negligible			Negligible
4	**Visual Impacts**								
4.1	Presence of construction vehicles, machinery, equipment and personnel	Alteration of key elements, features and characteristics of the baseline visual environment	Construction	WOM WM	48	Moderate	Retain existing vegetation where possible (especially along site boundary and roads). Implement dust suppression. Concurrent rehabilitation. Strict speed limits. Careful consideration of lighting.	48	Moderate
4.2	Presence of construction and mining vehicles, machinery, equipment and personnel	Alteration of key elements, features and characteristics of the baseline visual environment	Operational	WOM WM	52	Moderate	Dust suppression. Develop sustainable final landform design for TSF, WRD and water storage facilities. Concurrent rehabilitation of TSF and WRD. Strict speed limits. Careful consideration of lighting	52	Moderate
4.3	Presence of vehicles, machinery,	Alteration of key elements, features and characteristics of	Closure	WOM WM	56	Moderate	Dust suppression. Design of TSF, WRD etc. to minimise final heights. Concurrent rehabilitation and	40	Low

	equipment and personnel	the baseline visual environment					monitoring of success of rehab. .		
5	**Impact on Heritage resources**								
5.1	Construction, operation and decommissioning of the mining project and associated projects (roads, water supply etc.).	Damage to or destruction of undiscovered heritage or archaeological resources	Construction, operation and closure	WOM WM	64	High	Environmental awareness training and brief watch monitoring programmes throughout development - know what to look out for. Archaeological surveys on associated projects' sites prior to development. Consultation with local communities (protect living heritage).	16	Negligible
6	**Social Impacts**								
6.1	Development in the area causing in-migration of foreigners	Change in cultural values and integrity (Impact on Social Dynamics)	Construction	WOM WM	60	Moderate	Stakeholders must be capacitated to recognize changes that the project and an influx of people may bring to their communities: Discuss the potential for in-migration with community leaders (political and traditional) and obtain their views on how to manage the process with input from all parties involved; Decide on recruitment policies (especially for unskilled labour) in conjunction with the leadership structures. Ensure policies are fair and equitable (and perceived as such). Communicate the policies as early as possible. A quota system from each affected village in the project area usually works well. Involve schools,	52	Moderate
6.2	Influx of people to the surrounding villages due to opportunities	Negative impacts on existing community cohesion (Impact on Social Dynamics)	Construction	WOM WM	56	Moderate		48	Moderate
6.3	Job-creation for local people and for people from outside, inappropriate procurement policies	Social differentiation and inequity (Impact on Social Dynamics)	Construction	WOM WM	52	Moderate		48	Moderate
6.4	Conflict about available jobs and who should benefit	Social tension and violence (Impact on Social Dynamics)	Construction and operation	WOM	56	Moderate		48	Moderate

	from the project. Cultural change due to influx and economic changes for some.			WM			churches and clinics to assist with awareness creation through pamphlets, lectures and posters about potential social ills e.g. drugs, alcohol and teenage pregnancy. Implement a community relations plan that includes all relevant stakeholders and was compiled with input of all the affected stakeholders. Establish a community liaison forum (CLF) with representatives from all the stakeholders (including in-migrants, woman, the youth and the elderly). Involve religious, security and cultural groups in stakeholder forums. Participate in community events such as sport days, national days and other celebrations. Make communication the responsibility of one person to ensure representatives of the mine do not contradict each other. It is important to consider that the mine will need the input from government (local and traditional) and a number of community institutions to successfully manage this process. The change cannot be avoided, but must be managed.		
6.5	Unrealistically high community expectations of benefits due to project	Aspirations and expectations of community not realized (causing tension and distrust). (Impact on Social Dynamics)	Construction	WOM WM	60	Moderate		56	Moderate
6.6	Mine staff residing away from their families	Alterations in Family structures. (Impact on Social Dynamics)	Construction and operation	WOM WM	60	Moderate		56	Moderate
6.7	Change in sense of belonging due to influx of people	Community identification and connection (Impact on Social Dynamics)	Construction and operation	WOM WM	48	Moderate		44	Moderate

6.8	Influx of people putting pressure on infrastructure and resources, increased disease, accidents and injuries	Impacts on Health and social wellbeing: Impacts on physical health	Construction and operation	WOM			Cooperate with existing health services and engage with the Health Department. Support and align with existing community health programmes. Rotation of district health personnel through the site clinic for skills enhancement and training. Monitor air and water quality. Ensure that there are no standing pools of water that can act as a breeding ground for mosquitoes. Community outreach programmes to improve knowledge, attitudes, practices, and beliefs surrounding malaria. Ensure all buildings created by the project are mosquito proof. Establish and maintain road safety signage, along project roadways. Collaborate with local authorities and local law enforcement (prevent speeding, reckless driving; enforce seat belt usage, accident response etc.). Provide health care services to workers. Abide by VPSHR. Deploy two guards in critical locations. Deploy guards on the borders of the mining property and involve them in anti-poaching activities. Educate the work force about poaching. Support anti-poaching		
				WM	80	High		70	High
6.9	Impacts on water quality/availability, increased traffic, unfair labour practices	Impacts on Health and social wellbeing: Impacts on personal safety (physical and psychological)	Construction and operation	WOM					
				WM	56	Moderate		36	Low
6. 10	Influx of people creating a platform for opportunistic and other criminals	Impacts on Health and social wellbeing: Crime - increased theft, social ills and poaching	Construction and operation	WOM					
				WM	70	High		48	Moderate

							initiatives initiated by neighbouring properties and ZAWA.		
6.11	Influx of people putting additional pressure on infrastructure (roads, sanitation etc.)	Shortage of social and physical infrastructure (Impact on quality of the living environment)	Construction and operation	WOM			Input from different role players is essential: adhere to the mitigation in other specialist studies. Utilise the existing exploration camp to house construction workers. Put workers from similar areas in the same shift and provide transport to and from these areas. Engage with the government about upgrade of infrastructure (mutually beneficial to project and surrounding communities). Include upgrade of social or physical infrastructure in CSI initiatives. Develop a “code of conduct” to guide staff interaction with local communities and include guidelines on interaction with conservation areas. Make provision for a buffer zone around the physical footprint of the project and erect a fence around the buffer zone. Interact with conservation parties about how to elephant-proof water structures and how to scavenger-proof waste areas. Include animal-human interaction procedures in health and safety procedures of the operations.		
				WM	70	High		48	Moderate
6.12	presence of mine infrastructure, vehicles, machinery and personnel	Alteration of sense of place / environmental amenity value / aesthetic quality (negative impact on tourism)	Construction and operation	WOM					
				WM	56	Moderate		48	Moderate
6.13	Animal human interaction and resultant industry conflicts	Conflicting land uses with neighbouring activities (conservation vs. mining)	Construction and operation	WOM					
				WM	60	Moderate		50	Moderate
7	**Impacts on Biodiversity**								

7.1	Vegetation clearing and construction	Destruction of habitat	Construction	WOM			Retain vegetation where possible. Construction should preferably take place in winter (reduce disturbance to breeding fauna and flowering flora). Relocate plants of ecological significance; Do not clear the entire footprint simultaneously; Clearly demarcate the entire development footprint and prevent creep; Implement monitoring to ensure minimal impacts; Regular environmental training should be provided; Trenches should be adequately cordoned off and constant excavating and backfilling of trenches should occur. Poisons for the control of rats, mice or other vermin should only be used after approval from an ecologist.		
				WM	60	Moderate		40	Low
7.2	Storage of Tailings; Laydown areas for stockpiles and waste rock	Direct habitat destruction	Operational	WOM					
				WM	55	Moderate		35	Low
7.3	Vegetation clearing and construction	Habitat fragmentation	Construction	WOM			Use existing facilities as far as possible. Ensure as little disturbance as possible to the sensitive habitats such as ravines and moist grassland pockets. Establish protective buffers to exclude unintentional disturbance to sensitive areas. Construction activities must remain within defined construction areas and the road servitudes. Unnecessary driving around or bulldozing natural habitat must not take		
				WM	70	High		60	Moderate
7.4	Storage of Tailings; Laydown areas for stockpiles and waste rock, depression and cracks of SLC mining method	Habitat fragmentation	Operational	WOM					
				WM	70	High		60	Moderate

							place. No disturbance will occur outside demarcated areas.		
7.5	Exposure of rock, ore and soil to rainfall and wind	Soil erosion	Construction	WOM WM	52	Moderate	Topsoil stripping and excavation should be scheduled for the dry season where possible; Ensure that the exposed areas are minimal at any specific time – construction and rehabilitation should occur concurrently; Cover disturbed soils; Control runoff to move water safely off site after removal of sediment without destructive gully formation; Install sediment control devices (Grass filter strips, Sediment filters, Sediment traps, Drop inlet filters). Implement stringent erosion and dust control practices. Institute a storm water management plan. Do not let surface water or storm water to be concentrated, Design storm water discharge points to prevent erosion; Repair all erosion damage as soon as possible; Gravel roads must be well drained in order to limit soil erosion.	36	Low
7.6	Sidewalls of SLC depression, and Increased hardened surfaces created at the project site	Increased soil erosion and sedimentation	Operational	WOM WM	75	High		65	Moderate
7.7	Rehabilitation activities	soil erosion	Closure	WOM WM	56	Moderate		36	Low
7.8	Movement of vehicles on site	Spillages of harmful substances	Construction	WOM WM	26	Low	Contain polluted water. Excess or waste material or chemicals should be discarded in an environmental friendly way. Hazardous chemicals	18	Negligible

7.9	Domestic and hazardous waste storage and disposal, sewage treatment	Spillages of harmful substances	Operational	WOM			to be stored on an impervious surface protected from rainfall and storm water; Ensure refuelling stations are constructed to prevent spillages. Ensure that accidental spillages are contained and cleaned up promptly; treat sewage in a suitable plant or remove from site for treatment elsewhere; Spill kits should be on-hand to deal with spills immediately; Inspect all vehicles regularly for oil and fuel leaks. Vehicle maintenance should be done in a designated facility and drip trays should be used. Drip trays should be emptied into a holding tank and returned to the supplier.		
				WM	26	Low		18	Negligible
7. 10	Movement of vehicles on site	Spillages of harmful substances	Closure	WOM					
				WM	26	Moderate		18	Low
7.11	Exposure of rock, ore and soil to rainfall and wind	Dust contamination	Construction	WOM			Undertake dust suppression and a dust monitoring programme. Implement the air quality management programme, and monitor regularly to ascertain the dust load and emission rates and particle size distribution; Implement standard dust control measures, including periodic spraying and chemical dust suppression and monitor efficiency. Implement strict speed limits to reduce dust formation.		
				WM	75	High		45	Moderate
7.12	Stockpiling, Materials handling, vehicle entrainment and windblown dust	Dust	Operational	WOM					
				WM	75	High		45	Moderate
7.13	Rehabilitation activities	Dust	Closure	WOM					
				WM	56	Moderate		36	Low
7.14	Continued movement of	Spread of alien invasive species	Construction	WOM	56	Moderate	Kill the alien invasive plants present, the seedlings which	36	Low

	personnel and vehicles on and off site, and deliver of materials			WM			emerge, and establish an alternative plant cover to limit re-growth and re-invasion; Institute strict control over materials brought onto site, inspect for seeds of noxious plants and eradicate before transport to site. Routinely fumigate or spray with appropriate herbicides; Rehabilitate disturbed areas as quickly as possible; Institute a monitoring programme to detect alien invasive species early; Institute an eradication/control programme for early intervention if invasive species are detected; A detailed plan should be developed for control of noxious weeds and invasive plants..		
7.15	Transporting of people and equipment	Spread of alien invasive species	Operational	WOM					
				WM	56	Moderate		36	Low
7.16	Movement of vehicles on site	Spread of alien invasive species	Closure	WOM					
				WM	56	Moderate		36	Low
7.17	Construction of infrastructure, roads etc.	Negative impacts of human activities	Construction	WOM			Staff should preferably be accommodated on site to reduce impacts such as dust and ensure a safe working environment; Staff accommodation should be fenced to prevent movement of people and animals into 'no-go' areas. Adequate rubbish bins and sanitation facilities should be provided; Maintain proper firebreaks around entire development footprint. Educate construction workers regarding risks and correct disposal of		
				WM	44	Moderate		28	Low
7.18	workers accommodation on site	Negative effects of human activities on flora	Operational	WOM					
				WM	44	Moderate		28	Low
7.19	Presence of labourers on site	Negative effects of human activities on flora	Closure	WOM					
				WM	56	Moderate		36	Low

							cigarettes and other waste materials.		
7.2	Continued movement of personnel and vehicles on and off site, and deliver of materials	Fauna mortality on roads	Construction	WOM WM	44	Moderate		28	Low
7.21	Movement of vehicles on and off site and delivery of materials	Fauna mortality on roads	Operational	WOM WM	56	Moderate	Enforce a speed limit no more than 40 km/hour. Install speed bumps in sections where the speed limit tends to be disobeyed. Avoid travelling at night. Lights should be positioned 5 m from the roads or paved areas.	32	Low
7.22	Movement of vehicles on site	Fauna mortality	Closure	WOM WM	56	Moderate		36	Low
7.23	Construction of mining infrastructure, access roads etc.	Light pollution	Construction	WOM WM	75	High	Eliminate as much external lighting as possible; Use recommended light sources and fittings; Wherever possible long-wavelength light sources should be used. Fluorescent lights should not be used outdoors. External light sources should be directed inward; Lights should be positioned 5 m from roads or paved areas; Internal lighting should be shielded.	18	Negligible
7.24	Mining operations during night time	Light pollution	Operational	WOM WM	60	Moderate		40	Low
8	**Impacts on Wetlands**								
8.1	Clearing of vegetation, construction of infrastructure etc.	Habitat Destruction	Pre-construction and construction	WOM WM	70	High	Prevent impact by applying recommended buffer zones altering the base case layout plans to fall outside of these wetlands	16	Negligible

				WOM			and buffer zones; Limit development activities including storage areas to demarcated appropriate areas. Adapt layouts to fit natural patterns rather than imposing rigid geometries; Regular environmental training should be provided to construction workers to ensure the protection of the wetland habitat; The removal of indigenous plants associated with the wetlands and riparian areas should be prohibited; Limit and control pesticide use; Implement environmental monitoring to ensure that minimal wetland impact; Work in rivers, streams and wetlands should preferably be avoided, but if necessary should be done during the dry season; Pipelines or roads constructed across drainage channels should be guided by a rehabilitation plan. Cross drainage channels at a 90 degree angle to prevent erosion. Minimize changes to natural drainage patterns and crossings to drainages. Perform scheduled maintenance to be prepared for storms. Ensure culverts are cleaned, and that channels are free of debris. Keep cut and fill slopes as flat as possible and stabilized to		
8.2	Placement of stockpiles, TSF and WRD on wetlands	Direct habitat destruction	Operational	WM	65	High		14	Negligible

							minimize slumping and surface erosion. In-stream diversions at constructions in drainages must avoid damming). No construction of new channels. Appropriate measures must be taken to manage storm water run-off and potential flooding		
8.3	Increased hardened surfaces and exposed areas	Soil compaction and erosion leading to sedimentation	Pre-construction and construction	WOM WM	52	Moderate	Minimize the amount of land disturbance; Topsoil stripping and excavation activities should be scheduled for the dry season if possible; Ensure that the exposed areas prone to erosion are minimal at any specific time; Cover disturbed soils as completely as possible; Move runoff water safely off the site without destructive gully formation, trap the sediment before releasing the run-off water off site; Sediment control devices need to be installed to capture mobilised sediment. Implement stringent erosion and dust control practices. Install temporary drains and minimize concentrated water. Control stormwater velocity where necessary and divert run-off around disturbed areas. Institute a storm water management plan; Have both temporary (during construction) and permanent erosion control plans; Protect areas	36	Low
8.4	Increased hardened surfaces and exposed areas	Increased soil erosion and sedimentation	Operational	WOM WM	52	Moderate		36	Low
8.5	Rehabilitation activities	Increased soil erosion and sedimentation	Closure and Post-Closure	WOM WM	56	Moderate		18	Negligible

							susceptible to erosion and repair all erosion damage as soon as possible; Gravel roads must be well drained in order to limit soil erosion;		
8.6	Exposure of rock, ore and soil to rainfall and wind, and vehicle movement	Water pollution from spillages of harmful substances	Pre-construction and construction	WOM WM	26	Low	Treat water emerging from the mine and water that accumulates in the backfilled and rehabilitated voids; Water falling on areas polluted with hazardous substances must be contained. Any excess or waste material or chemicals should be removed from the site and discarded in an environmental friendly way; Inspect construction vehicles for oil and fuel leaks regularly, service vehicles regularly. Situate maintenance yards away from drainage lines; Construct refuelling stations to prevent spillage of fuel or oil and implement measures to deal with accidental spills. Fit temporary inlet pit filters near wash-down areas to prevent pollutant entry into the drainage system; Sewage should either be treated in a suitable plant or removed from the site for treatment elsewhere; Maintain a good standard of housekeeping. Store all litter carefully so it cannot contaminate stormwater drainage	18	Negligible
8.7	Large vehicles - oil and fuel spillages, building waste, batching plants, sewage and domestic waste, topsoil storage	Water pollution from spillages	Operational	WOM WM	26	Low		18	Negligible
8.8	Movement of vehicles on site for rehabilitation	Water pollution from spillages	Closure and Post-Closure	WOM WM	26	Low		18	Negligible

							systems; Provide (scavenger proof) bins at appropriate locations, particularly where food is prepared and consumed. Avoid poisons for the control of problem animals where possible.		
8.9	Movement of construction vehicles	Dust contamination	Pre-construction and construction	WOM			Implement dust suppression and monitoring. Implement and monitor the air quality management programme. Mine health and safety requirements for the use of dust masks must be adhered to and compliance audited regularly; Implement standard dust control measures, including chemical dust suppressants where appropriate and periodic spraying; Soil dumps may be covered if necessary; A speed limit (no more than 60 km/hour) should be enforced on dirt roads;		
				WM	75	High		45	Moderate
8.10	Stockpiling, Materials handling, vehicle entrainment and windblown dust	Dust contamination	Operational	WOM					
				WM	75	High		45	Moderate
8.11	Movement of vehicles on site for rehabilitation	Dust contamination	Closure and Post-Closure	WOM					
				WM	65	High		45	Moderate
8.12	Movement of personnel and vehicles on and off site and delivery of materials	Spread of alien invasive species in wetland systems	Pre-construction and construction	WOM			Kill the alien plants present and seedlings which emerge, and establish alternative plant cover. The control of AIS at the site should commence prior to construction. Prevent AIS from establishing, detect AIS that do establish early, eradicate AIS that establish or control population is eradication is not feasible. Develop and implement a detailed AIS eradication and monitoring plan.		
				WM	56	Moderate		36	Low
8.13	Movement of personnel and vehicles on and off site and delivery of materials	Spread of alien invasive species in wetland systems	Operational	WOM					
				WM	56	Moderate		36	Low
8.14	Movement of personnel and	Spread of alien invasive species in	Closure and Post-Closure	WOM	56	Moderate		18	Negligible

	vehicles on and off site and delivery of materials	wetland systems		WM					
9	**Impacts on Soils, land capability and agricultural potential**								
9.1	Regular heavy vehicle movement, and laydown areas	Soil Compaction	Pre-construction and construction	WOM WM	65	High	Soil should be handled when dry to reduce the risk of compaction; Vegetation is to be stripped together with topsoil; Avoid soils with risk of compaction wherever possible. Unnecessary driving around in the veld or bulldozing natural habitat must not take place. Vehicles should also stick to haul roads when dumping of waste rock and topsoil are done. Existing roads and tracks are to be utilized as far as this is possible. Rip and/or scarify compacted areas on a continuous basis. Do not rip and/or scarify areas under wet conditions. Soil should be sampled and analysed prior to replacement during rehabilitation. If necessary, and under advisement from a suitably qualified restoration ecologist, supplemental fertilisation may be necessary.	40	Low
9.2	Regular heavy vehicle movement, and laydown areas	Soil Compaction	Operational	WOM WM	65	High		20	Negligible
9.3	Regular heavy vehicle movement for rehabilitation activities	Soil Compaction	Closure and Post-Closure	WOM WM	44	Moderate		28	Low
9.4	Vegetation clearance, mine construction and activities leaving soil exposed	Soil erosion	Pre-construction and construction	WOM WM	52	Moderate	Schedule topsoil stripping and excavation in the dry season where possible; Clearance and excavation activities should occur concurrently with construction and	36	Low

9.5	Hardened surfaces, slopes of stockpiles and WRD	Soil erosion	Operational	WOM WM	52	Moderate	rehabilitation activities; keep exposed surfaces at a minimum. Cover disturbed soils as completely as possible; Control the flow of runoff to avoid gully formation; Sediment control devices need to be installed to capture mobilised sediment. Implement stringent erosion and dust control practices. Control dust using water-sprayers or chemical dust suppressants to prevailing site conditions; Institute storm water management plans (temporary and permanent); Protect all areas susceptible to erosion and repair all erosion damage as soon as possible; Gravel roads must be well drained in order to limit soil erosion; Implement erosion monitoring procedures; Re-vegetate or stabilise all disturbed areas as soon as possible. Monitor vegetative cover on stockpiles to maintain a high basal cover. Conservation of topsoil should be prioritized; Plant species that have been rescued or removed and relocated to the temporary nursery could be used in replanting rehabilitation areas to prevent erosion	36	Low
9.6	General rehabilitation activities	Soil erosion	Closure and Post-Closure	WOM WM	52	Moderate		36	Low
9.7	Construction vehicles	Soil pollution	Pre-construction	WOM	26	Low	Store hazardous chemicals on an impervious bunded area protected	18	Negligible

	contributing to oil and fuel spillages, building waste, batching plants, sewage and domestic waste		and construction	WM			from rainfall and stormwater run-off; Construct refuelling stations to prevent spillages, and implement measures contain and clean up accidental spillages; Sewage should either be treated in a suitable plant or removed from the site for treatment elsewhere; Spill kits should be on-hand to deal with spills immediately and employees should be trained in the use of spill kits; Spillages or leakages must be treated according to an applicable procedure as determined by a plan of action for the specific type of disturbance; Drains and intercept drains should be maintained to ensure that they continue to redirect clean water away from the polluted areas.		
9.8	Construction vehicles contributing to oil and fuel spillages, building waste, batching plants, sewage and domestic waste	Soil pollution	Operational	WOM WM	 26	Low		18	Negligible
9.9	Oil and fuel leakages from vehicles and machinery for rehabilitation	Soil pollution	Closure and Post-Closure	WOM WM	 26	Low	All vehicles should be regularly maintained to prevent leakages and inspected. Vehicle maintenance should be done in a designated facility and drip trays should be used to capture any spills. Drip trays should be emptied into a holding tank and returned to the supplier.	18	Negligible
9. 10	Topsoil stripping and mine construction	Soil destruction and sterilization	Pre-construction and construction	WOM WM	 70	High	Continually rehabilitate the soils to the best possible state. Refer to the specialist reports on soil rehabilitation	70	High

9.11	Topsoil stripping and mine construction	Soil destruction and sterilization	Operational	WOM					
				WM	70	High		70	High
9.12	Construction of mine and infrastructure	Loss of land capability	Pre-construction and construction	WOM			Ensure that disturbance and clearing is confined to the footprint areas of the mine; Only a small area of the land should be disturbed at a time. Rehabilitation should take place on a continuous basis where after the land would become partially available again as grazing. Once mining activities have ceased, disturbed areas should be rehabilitated and the grazing capacity restored as far as possible. The rehabilitation of the soils and re-vegetation is discussed in the specialist report.		
				WM	55	Moderate		35	Low
9.13	Dumping of waste rock, mining and stockpiling	Loss of land capability	Operational	WOM					
				WM	55	Moderate		35	Low
9.14	Loss of grazing value due to lower grazing capacity after rehabilitation	Loss of land capability	Closure and Post-Closure	WOM	22	Low		14	Negligible

8 PROJECT ALTERNATIVES

The purpose of identifying and evaluating feasible alternatives in terms of a development proposal is to find the most effective way of meeting the project needs, either through enhancing the environmental benefits of the proposed activity, and / or through reducing or avoiding negative impacts (DEAT, 2004). Any environmental investigation needs to consider feasible alternative options.

Feasible alternatives have been identified through discussions with authorities, discussions with relevant stakeholders, reviewing of existing environmental data, specialist inputs/studies and discussions with the project proponent.

Methods for comparing alternatives range from descriptive and non-quantitative methods, through methods based on varying levels of quantification to a full quantitative comparison, in which all impacts may be expressed in monetary terms. Possible alternatives in terms of the proposed project have been identified as described in sections 8.2 to 8.7 below.

Alternatives are essentially evaluated in order to improve a project's environmental performance. The section below discusses potential opportunities and benefits associated with the proposed project.

8.1 Opportunities and Benefits

Mining by nature is associated with a certain extent of ecological impacts. This does not, however, imply that mining and biodiversity conservation and socio-economic upliftment cannot co-exist. The aim of mines today is to be good stewards of the environment and strive to leave the communities in which they work better than they found them (Henning B. J., May 2013).

Mines have significant conservation potential, as they are in control of large amounts of land and only utilise a small portion for mining operations. It is therefore at the local level that mining and conservation can be integrated.

The proposed project presents various environmental opportunities and benefits, specifically within the socio-economic environment. These are discussed below:

8.1.1.1 Biodiversity opportunities:

Various opportunities for biodiversity improvements and conservation could be utilized through the development of the project, these include amongst other:

8.1.1.1.1 Biodiversity off-set areas and contribution to conservation management:

The large-scale prospecting license (reference number 8589-HQ-LPL) borders the Kafue National Park and the Mushingashi Conservancy. There are no fences around these conservation areas and wildlife is allowed free movement. The management of an ecological offset area presents an opportunity for the project proponent to compensate for biodiversity loss in the mining area by contributing to biodiversity conservation and management at the conservation areas around the site.

Biodiversity offsets are "intended to compensate for the residual, unavoidable harm to biodiversity caused by development projects, so as to ensure a situation where there is "no net loss" of biodiversity" (Henning B. J., May 2013:102). The Conservation sector and the mining industry can both benefit from biodiversity offsets:

For the mining industry, the potential benefits of biodiversity offset strategies include (but are not limited to) the following:

- An offset commitment may enhance a mine's social license to operate.
- The implementation of an offset can be used to demonstrate environmental responsibility, compliance and environmental performance.
- Ethical environmental stewardship: by demonstrating corporate responsibility, a company will have better relationships with government departments, the community around its operations and its own employees. This will likely improve the image of the company (and potentially improve business opportunities), and improve relationships with government departments due to mutual trust.

Biodiversity offsets could include a number of different strategies or types of offset contributions such as conservation management contributions at existing conservation facilities in the surroundings: It was confirmed during on-site consultations that some of the Mushingashi employees are currently contracted out to Blackthorn by prior agreement (such as guards and Professional Hunters) when required, and that the relationship between the Mushingashi Conservancy and Blackthorn has mostly been, and can remain a relationship of mutual benefit. The existing relationship can be expanded to include contributions to fire control and poaching management in order for Blackthorn to "offset" ecological damage caused by mining with positive contributions to conservation management.

Potential also exists to create a biodiversity offset in terms of physical contribution of land between the mining site and the Mushingashi conservancy or the KNP (land on which Blackthorn is currently authorized to prospect). Areas in the immediate vicinity could have the following positive attributes as an offset:

- The area should represent 'like for like' habitat and constitute a pristine area suitable for a biodiversity offset considering that the offset area has to have similar biodiversity characteristics to the proposed mining area;
- The offset area should link to the Mushingashi Conservancy (or KNP) and form a buffer between the mining area and the Conservation Area(s).

Access to the suggested offset area will have to be negotiated with the relevant local and government authorities. Additional information and suggestions pertaining to biodiversity offsets are discussed in the Specialist Ecological Report (Henning B. J., May 2013).

8.1.1.1.2 Charcoal community project:

As part of site clearing for the construction of the proposed project infrastructure a number of trees will be removed from the development footprint. The potential exists to involve local communities in a charcoal project to address energy demands and generate temporary income. The feasibility of such a project should be investigated further and community-related projects should be approached in such a way that communities are consulted and their needs put first.

8.1.1.2 Heritage conservation:

While the proposed project may not directly affect any heritage resources, potential exists to become involved in regional heritage conservation due to the rich archaeological history of the region and to improve relationships with local communities. Sites such as the Nkoto Heritage Centre and other contemporary features such as meeting places, initiation sites, ceremonial graves and places of ancestor reverence are of local social value and are sensitive in terms of intangible heritage attributes (Kruger, 2013). If the project proponent can become involved in the preservation and management of such sites, it would not only contribute to the conservation of Zambian heritage resources, but is also likely to be seen favourably by the local communities who attach value to these sites. Such projects could include (Kruger, 2012):

- Mumbwa cave conservation.
- Maintenance of Sable Mine Centre.
- Heritage offsets (formal conservation of heritage resources similar to any which may be affected by the project or associated development such as road upgrades and re-alignments. Such impacts on heritage resources will have to be managed under appropriate licenses from the heritage resources authorities).

The opportunities related to biological diversity and heritage conservation mentioned above can potentially also contribute positively to the socio-economic environment by presenting associated job-opportunities at these facilities, and contributing to the local tourism sector.

8.1.2 Socio-economic benefits and investment:

The proposed project is expected to bring about improvement in the local standards of living through job creation and other economic opportunities. Some blame existing deviant social behaviour experienced in the community such as crime (often resulting from boredom or extreme poverty) and excessive alcohol consumption, on the lack of employment and economic opportunities in the area (Aucamp S.-M. , 2013).

Additionally, the rapid growth of a young adult population unable to find employment or to make a living (as is experienced in almost all African countries to some extent) can lead to political unrest. The project will undoubtedly impact on such existing social dynamics.

The project should be associated with and guided by a Social and Labour Plan (SLP) or similar documented procedural guideline, which is to include details of recruitment procedures and stipulate a certain percentage of employment associated with the project to be sourced from local communities. It is acknowledged that some more specialized work will have to be conducted by employees or subcontractors from outside the local area. Training opportunities for skills development in local communities are significant and should be incorporated into the SLP.

The project will lead to improvements in local road conditions (whether the improvements are directly affected by the project proponent, or in consultation with government), and could potentially improve other local infrastructure as well through community based projects. Surrounding communities may also benefit from infrastructure development in the area such as electricity and water supply to the project.

Corporate Social Investment (CSI) projects will be associated with the project, and identification of these projects will be done through a continuous consultative process with representative members of the community in order to ensure that projects meet community needs and truly add value to the area. Consultation with communities to date has identified possibilities as described in Table 15:

The project will also generate additional opportunities for entrepreneurs especially in associated services industries such as small scale traders and service providers especially during the construction phase, but they may remain during the operations phase if there are still opportunities (Aucamp S.-M. 2013).

Table 15: Summary of Social Opportunities in response to Social Issues

Stakeholder and description	Community Issue	Opportunity
Kitumba Prison Farm: (Interviewed Assistant Superintendent SM Kazembe in August 2012). Farms with maize, soya beans and cabbage. Also vegetable gardens for own use. No electricity – currently using generator. Have waterborne toilets, but they are not connected – use pit latrines	Want to go more commercial with vegetable production, but they do not have enough water. Plan reservoir for vegetable garden. Main Challenges: transport and health care facilities (nearest clinic 17 km). No shops close nearby. Concerns about dust & water quality (mining). Elephants raid their maize fields.	Buy vegetables from Prison for canteen
Community members (interviewed August 2012) Males living in the area, working at the exploration camp	High levels of unemployment and poverty. Most schools in area only go up to Grade 7, a few go up to Grade 9. Must go to Mumbwa for Grade 12 – most don't have the means to travel to Mumbwa to complete their education. Many community schools in area – parents have to pay for teachers. Clinics in area often don't have the medicine required – patient has to travel to Mumbwa to get medicine. Mumbwa experiencing social problems like HIV/AIDS, unplanned pregnancies, street children, excessive drinking, prostitution, etc. Workers have been exploited previously by Chinese and Indian miners (also huge infringements on human rights!)	Procurement from local communities. Worker education programmes and skills development
Chief Kaindu and his headmen (Interviewed March 2013) No electricity Get water from boreholes, wells – some also use ground water Pit toilets – some don't have toilets Transport – by feet / bicycle. Poor road infrastructure High levels of unemployment Very expensive to go to Mumbwa	Expect community to benefit from Blackthorn activities. BHP Billiton made verbal promises, but did not deliver. Benefits must be local (within Chiefdom). Distances between clinics are quite big. Problem especially when there is a problem with childbirth. Kaindu Project Coordinating Committee is looking at community projects. Suggested that committee is introduced to consultants. Projects lined up include community schools; distance between Government Schools; Health Care (distances); clean drinking water. Local labour should be given preference at the mine. Concerns about working conditions of workers. Concerns about male mine workers and HIV, as well as "stealing" wives/girlfriends – leave women and babies behind when they leave.	Meet and liaise with Kaindu Project Coordinating Committee to identify potential projects across the area.

Stakeholder and description	**Community Issue**	**Opportunity**
Kaindu Basic School: (Interviewed March 2013 – Mr Danny Dilema, Mr Peter Chisanga and Mrs Virginia Mubuyaeta) AND Mpusu School: (Interviewed March 2013 – Mr Chabinga) No electricity. Classes very full and large Almost 70% don't go to secondary school – financial constraints Have one social worker Water and sanitation is a problem. Few water points/boreholes Many children come to school hungry Many children come from far (approx. 14 km)	Quality of education – high illiteracy levels. Getting books and study material is a challenge. Need additional classrooms. School does not have any computers – not computer literate. Shortage of teaching staff. There are enough trained teachers, but the Government is unable to put up accommodation for them. Community forced to employ community teachers (untrained). Need equipment for their feeding programme (pots, etc.) Parents marry off children for financial gain. Girls drop out of school – vulnerable, marry young. High numbers of unemployed youth – revert to crime when they don't have anything to do. Alcohol abuse is a challenge. Need recreational activities in community. People fear that they will be displaced and loose property as a result of mining. Malaria big problem in area.	Assist with providing accommodation for teachers. Road and electricity infrastructure
Mpundu Village: (Interviewed March 2013). High levels of unemployment: Have skilled people in community – carpentry, driving, brick layers, and operators. Make a living from small-scale farming Mobile phones charged with solar power, communicate via word-of-mouth or mobile phone	Investors come with own labour – few locals benefit. Need services like health care (also antenatal care – mothers have to walk far) and schools (some schools three grades in a class). Get water from hand pump – far distances (4-5 times per day).	Repair some of the broken water pumps
Kafucamo Village: (interviewed March 2013) Make a living from subsistence farming and piece work	Issues similar to Mpundu Village Employment seems to be for men only – don't see women being employed	
Mumbwa Farmers Association: (Interviewed March 2013) Maize, soya beans, cattle, paprika. Wells for water	Small-scale farmers do not have means to use service providers (e.g. for ploughing or spraying crops). Concern that big mine will lead to loss of casual labour. Disease control – cattle die in large numbers. Concern whether mine will have impact on productivity of farm, water pollution etc.	
Small Scale Mining (Interviewed March 2013) Mainly copper	Challenges in accessing small scale mining licenses – meeting requirements and financial constraints. Problems with regulations of small-scale mining – need policy. Can't afford mining equipment. Don't have access to resources such as geological experts. Selling their copper is a challenge – transport costs, roads to mining areas very bad – increase transport costs Concerns related to mining: health issues, water pollution, loss of casual labour Mines can assist small scale miners with developing their skills.	

8.2 Process / Mining Method Alternatives

The PFS base case involves an underground mining operation involving sub-level caving as described in Section 4. Conventional underground mining as well as an open cast mine have also been considered as alternative mining methods. In terms of potential environmental impacts, technology alternatives for conventional underground copper mining would be comparable to one another as they would all be associated with similar inputs and outputs (wastes). The consideration of an open-cast mining method, however, would have a significant effect on the expected environmental impacts of the project.

Sub-level caving is associated with a subsistence zone above the underground operations, which is not the case with conventional supported underground operations.

Open-cast mining would necessitate the complete destruction of vast areas of natural vegetation, is associated with increased visual impacts, and is generally associated with increased pollution impacts. From an environmental perspective, underground mining is without a doubt the preferred mining method. Table 16 contains a comparison of the environmental effects associated with opencast and underground mining respectively.

Table 16: Comparative assessment - Opencast Underground and Cave mining

Environmental Aspect	Base Case – Sub-Level Caving	Alternative 1 Underground Mining (Base Case)	Alternative 2 Opencast Mining
Surface Water	Storm water management post-closure in the depression may prove more difficult to manage	Storm water management measures to separate dirty and clean storm water will still have to be implemented throughout the site.	Impacts associated with storm water inside an open pit may be more difficult to manage. Increased disturbed area increases risk of erosion and siltation.
Groundwater (dewatering)	Maximum dewatering volume 82 L/s	Maximum dewatering volume 48 L/s	Maximum dewatering volume 100 L/s
Groundwater (radius of influence)	Radius of influence for the LOM maximum 3.6 km	Radius of influence for the LOM maximum 1.80 km	Radius of influence for the LOM maximum 3.7 km
Groundwater (rewatering time)	Rewatering simulations as part of the feasibility phase	100 years	100 – 300 years
Groundwater (water quality)	Water quality affected by AMD caused by oxygen ingress due to subsidence zone	Absence of oxygen ingress reduces the risk of AMD even further	Water quality may be affected by AMD caused by oxidation
Soils and Soil Potential	The area does not contain high potential agricultural land but some areas do provide valuable wildlife grazing potential. Some grazing may be affected post closure in the depression area	The area does not contain high potential agricultural land but some areas do provide valuable wildlife grazing potential. The smaller footprint area associated with underground mining will disturb less grazing land post-closure.	The opencast mine will leave a permanent scar on the landscape in the area of the open pit, likely negatively impacting on grazing potential of this land in the long term.
Flora Impacts	The footprint areas of the SLC mine will have a lower impact on the ecosystem compared to opencast mining, but may still impact on the depression / subsistence zone. The impact on the flora and fauna will therefore be lower compared to opencast alternative	The footprint areas of the underground mine will have a significantly lower impact on the ecosystem compared to opencast mining. The impact on the flora and fauna will therefore be lower compared to opencast alternative.	The opencast mine will have a significant negative impact, not only on the fauna and flora through the destruction and fragmentation of habitat, but also on the landscape since the Kitumba Hill will be completely removed during the mining process, while the WRD and TSF will have significantly larger footprints in the mountainous area.
Fauna Impacts	Some fauna may be permanently displaced in the subsidence zone, but this area is comparatively very small when compared to opencast operations	Clearing of vegetation on the smaller footprint area will still displace some of the fauna, but not necessarily all. Fauna and avifauna are still affected by noise and vibrations, but less so than with opencast operations.	Removal of all vegetation thereby also displacing fauna from the entire project area. Noise and vibrations due to blasting and operation of the machines drive away animals and birds.
Wetland Impacts	The base case will have less of a potential for dewatering of the wetlands on-site.	Less of a potential for dewatering of the wetlands on-site.	The open pit will cause a limit dewatering impact on the surrounding wetlands.

Archaeological Impacts	Some undiscovered resources may be affected in the subsistence zone, but none have been identified.	No archaeological impacts are expected, however the likelihood for impacts on unidentified archaeology is significantly less for the underground option.	Opencast option has greater potential to permanently destroy unidentified heritage resources at the area of the open pit
Air Quality Impacts	Any mining activity, including the underground option will be associated with increased emissions compared to the existing air quality environment, but these would be less compared to an opencast scenario.	Any mining activity, including the underground option will be associated with increased emissions compared to the existing air quality environment, but these would be less compared to an opencast scenario.	Open cast mining would be associated additional in-pit roads resulting in increased unpaved road emissions, and increased materials handling emissions
Noise Impacts	The current location and layout of the Kitumba Copper Project relative to noise-sensitive receptors in the area is acceptable and there are no adverse noise impact consequences of concern.	The current location and layout of the Kitumba Copper Project relative to noise-sensitive receptors in the area is acceptable and there are no adverse noise impact consequences of concern.	Opencast mining will result in higher overall noise emissions and a larger noise footprint compared to underground mining. The larger noise footprint of opencast mining will encroach on a larger zone of wilderness area which may be a concern for eco-tourism.
Noise Impacts	Because the processing plant with its large noise output is a common component in the alternatives, and due to the large distances between the mine and the nearest communities, none of the alternatives are expected to have a significant impact on the nearest communities.		
Visual Impacts	No open pit but intrusion from subsistence zone and higher TDF height due to no past backfill occurring. WRD smaller. Impact comparable to underground option.	The underground option has significantly less of a visual impact due to the absence of the visually intrusive open pit. Visual impacts associated with other mine infrastructure would be the same for both options.	Visual landscape is completely altered by the presence of the open pit (semi-permanent) as well as mining infrastructure (for the duration of mining operations).
Socio-economic	Impacts on neighbouring communities (nuisance, dust, noise etc.) are minimized and increased employment opportunities make SLC the preferred option in terms of economic growth	An underground mine is the preferred option as it will minimise the impacts on neighbouring properties from a sense of place perspective. There will also be less nuisance impacts like dust and noise, whether it is actual or perceptual. All other impacts on the social environment will take place irrespective of the mining method.	Opencast mining would be associated with increased noise, dust and visual intrusion in turn impacting negatively on the social environment (whether actual or perceived).
Closure and Rehabilitation	Due to the smaller exposed footprint (no open pit) rehabilitation (such as re-vegetation of disturbed areas) is expected to be less than the opencast option. However, rehabilitation of the subsistence zone could prove challenging depending on geotechnical stability and further study is warranted.	Due to the smaller exposed footprint (no open pit) rehabilitation (such as re-vegetation of disturbed areas) is expected to be less.	Rehabilitation of opencast pits may be significantly more costly and rehabilitation to viable land use may prove more challenging.

8.3 Layout Alternatives

The nature of mining activities restricts the consideration of location alternatives to a large degree, due to the fixed nature of the identified mineral resource. Alternative site layouts may however be considered. The positioning of project-related infrastructure should be practical from a project process perspective and should also take the site-specific environmental conditions into consideration.

8.3.1 Main Site Infrastructure

The Main site infrastructure includes three primary components namely:

1) the processing plant,
2) administrative facilities such as offices, parking, workshops, fuel farm and refuelling area, storage areas for machinery and equipment etc., and
3) employee housing and associated facilities such as ablutions, kitchen facilities, emergency medical facilities etc.

Any preferred site(s) for the main site infrastructure should consider the following:

- Relatively flat area to minimise cut / fill earthworks.
- Process Plant should be located so as to minimise the length of roads, but still taking safety measures into account). Access from the plant to transport routes, and access to proposed future location of power and water sources should also be considered.
- Favourable topography enabling minimal water management issues.
- Minimal site sensitivities in terms of ecological and/or heritage features.
- Maximum distance from sensitive receptors, or no line-of-sight to receptors.

It would be advisable to locate on-site housing and associated facilities at the existing exploration camp. Mine administration facilities are not currently indicated on the base case proposed layout, but the existing exploration camp would also likely be a suitable location. The proposed position for the processing plant (See Figure 38) is deemed moderately appropriate as the location meets the majority of the abovementioned criteria (Table 17). The optimal location for the plant from an environmental management point of view would however be further west of its currently planned location, so as to avoid the high sensitivity drainage channel at its current location.

Table 17: Evaluation of base case process plant location

Criteria	Criteria Met?	Comment
Minimal cut / fill earthworks required	Yes	Area relatively flat
Length of roads minimised	Yes	Close to Mine Access
Minimal water management issues expected	Yes	No drainage lines
No ecologically sensitive features or heritage resources affected	No	Partially located on area of high ecological sensitivity
Distance and Line of Sight to receptors	No	Visibility from road used by tourists (vegetation may screen)

8.3.2 Tailings Dam Facility Alternatives

The preferred site for the tailings dam facility (TSF) is usually largely influenced by existing topography, as appropriately locating the TSF in response to existing topographic features may have significant cost-saving potential. Unfortunately, such "ideal" TSF sites are usually associated with drainage lines, thus impacting on natural drainage patterns.

Alternative locations have been evaluated against ecological considerations, storm water management plans, visual considerations and economics (proximity and elevation in relation to the mining area and process plant). Tenement is also a distinguishing factor in evaluating layout options as some ideal locations for a TSF may not be within the Blackthorn mining licence or surface rights area.

Access between on-site infrastructure is also a determining factor as minimizing the length of haul roads is known to minimise dust impacts at mining operations and is also associated with economic benefit. Thus the detail mine design should follow a holistic approach, equally determined by environmental and economic considerations.

The base case TSF site is situated on the road leading to the Mushingashi conservancy. If the TSF is to be located here, alternative access to Mushingashi will have to be devised by Blackthorn. The base case TSF location with a TSF height expected at approximately 31 meters is also expected to have significant impacts on the visual landscape. The TSF is also currently planned on sensitive wetland areas and this presents ecological as well as technical concerns as constructing the TSF on areas with perched water table conditions could prove less than ideal. Alternative TSF locations should be identified. One possibility is to move the TSF to the "dome" area inside the Kitumba Hills as this location will most likely reduce visual impact, negate the necessity for road relocation and will also be associated with lower ecological impacts.

A comparative assessment of the Base Case (Figure 38: Base Case and Alternative 1 underground site layout) TSF Location and the Opencast Alternative TSF location (Figure 39: Alternative 2 Opencast site layout) is presented in Table 18.

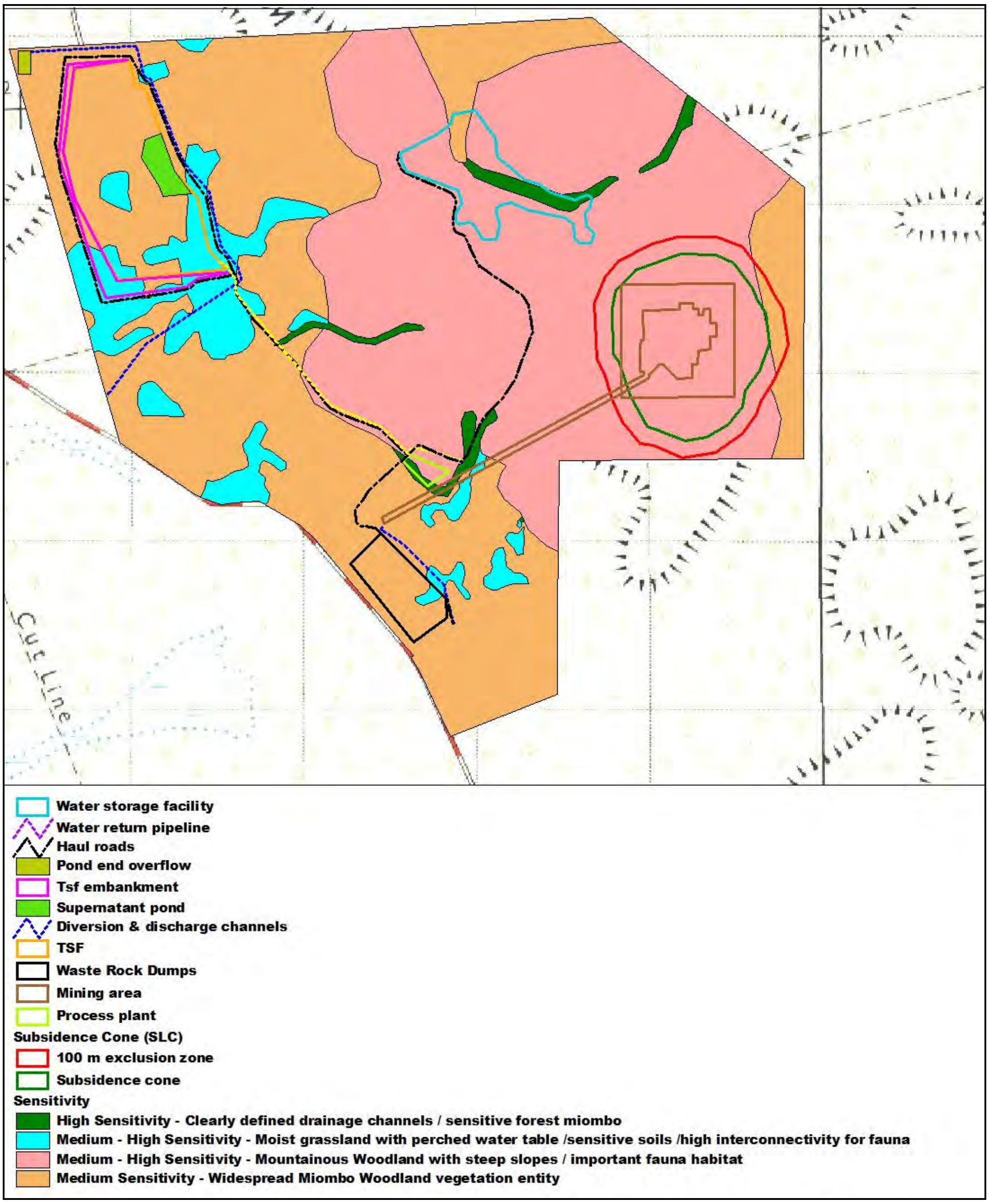

Figure 37: Base Case SLC mine Layout and ecological sensitivity

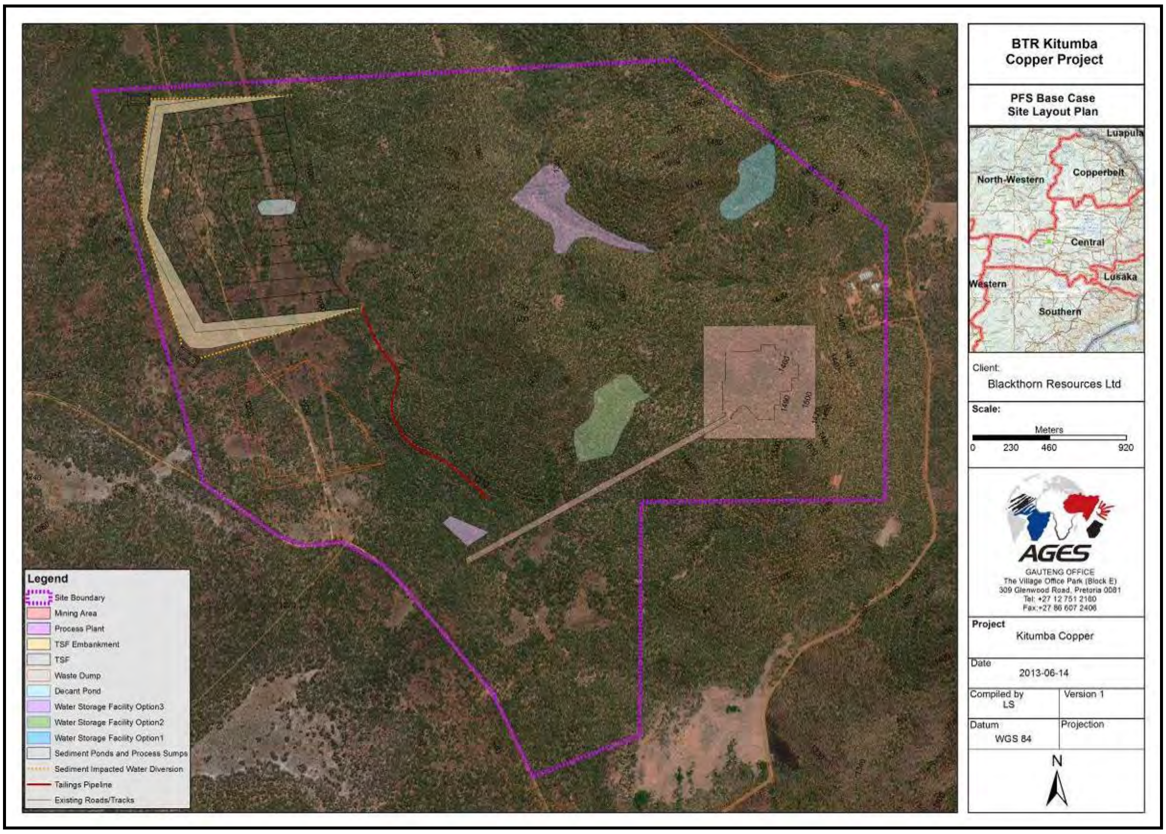

Figure 38: Base Case and Alternative 1 underground site layout

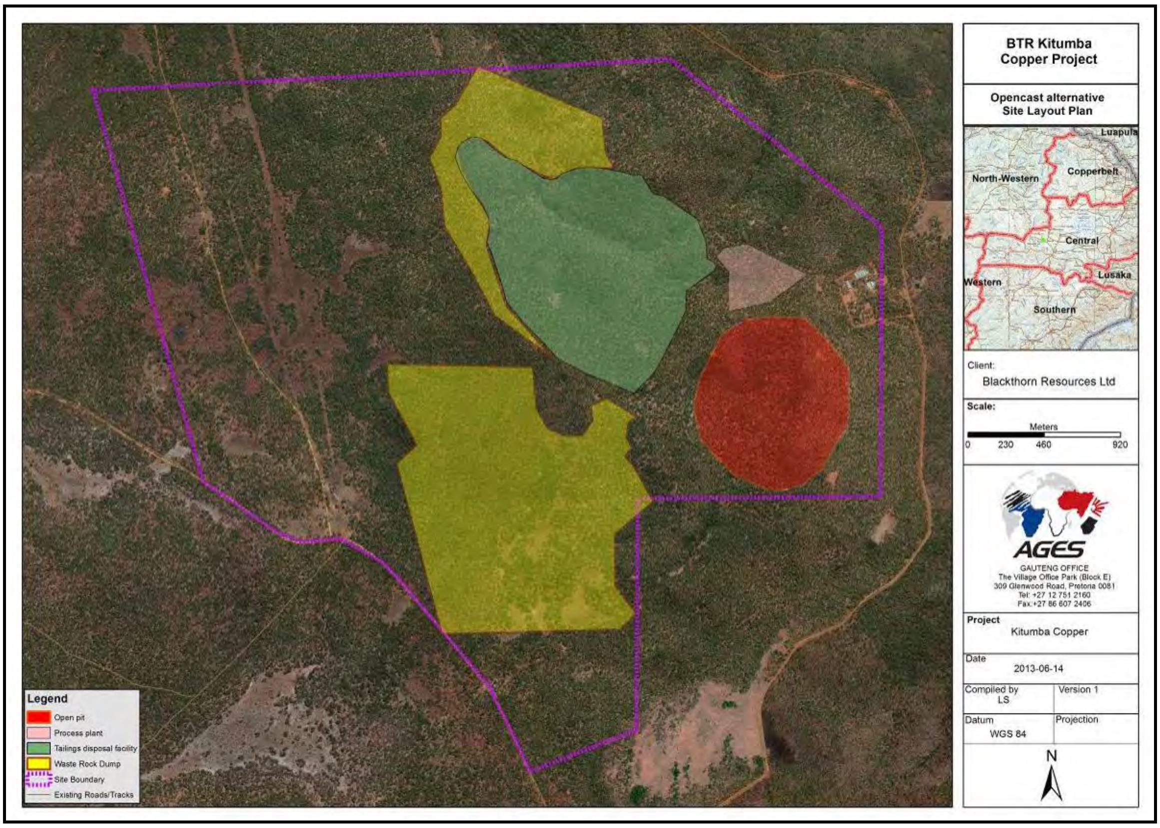

Figure 39: Alternative 2 Opencast site layout

Table 18: Comparative Assessment: TSF Base Case (Alt 1) vs. Alternative 2

Environmental Aspect	Base Case and Alternative 1 TSF for underground operations	Alternative 2 TSF for open cast operation.
Surface Water	TSF on area associated with perched water table – could pose a risk to wetlands.	TSF affects a portion of ravine (high wetland sensitivity). Storm water more difficult to manage in these steep areas.
Groundwater	Both scenarios will have to be modelled in detail to determine the potential impacts of each from a ground water management perspective.	
Soils and Soil Potential	TSF located on area with high erosion risk, high compaction risk and medium risk of impact on land capability.	TSF mostly impacting on areas of high erosion risk, but medium compaction risk and low risk of impact on land capability.
Flora Impacts	The location of the TSF for the underground mine will impact on moist grass land and miombo woodland (medium sensitivity).	The TSF will have significantly large footprint in the mountainous area in comparison with the base case and impact on high sensitivity drainage channels.
Fauna Impacts	Smaller development footprint should imply less displacement of fauna, although fauna will still be displaced and habitats fragmented and destroyed.	Larger TSF footprint in the mountainous regions is expected to have a more significant impact on fauna habitats.
Wetland Impacts	TSF location will impact negatively on medium-high sensitivity moist grassland with perched water table.	TSF location will impact on some areas (small and already somewhat impacted area) of high sensitivity drainage channel in sensitive forest miombo.
Archaeological Impacts	No archaeological impacts are expected, however the likelihood for impacts on unidentified archaeology is significantly less for the underground option.	
Air Quality Impacts	The base case TSF will be more exposed to wind in the low lying valley.	The alternative TSF will be located in the mountains and more protected from wind.
Noise Impacts	NA	NA
Visual Impacts	The TSF location is expected to be highly visible from the proposed location.	The mountainous terrain has the potential to hide the visual intrusion of the TSF to some extent.
Socio-economic	NA	NA
Closure and Rehabilitation	The base case TSF has a significant smaller footprint and will result in a lower rehabilitation and closure cost.	The TSF for the opencast requires a significantly larger footprint due to overburden storage/stripping.

8.3.3 Waste Dump Location

The Alternative 1 location for the waste dump is to the immediate south of the TSF and also obstructs the existing Mushingashi road. Additionally the waste dump is expected to impact significantly on the existing visual landscape in this location. Portions of the waste dump are also located on areas with perched water table conditions associated with ecological sensitivity.

The location is relatively flat and not associated with specific heritage or ecological resources apart from the perched water table "flat wetland" areas mentioned. Alternative locations should be considered. The Base Case (SLC mining option) is associated with a significant decrease in the WRD footprint (see Figure 37 which also impacts on fewer ecologically sensitive areas. If this waste dump is to be relocated slightly more to the north-west impact on sensitive ecological features can be avoided entirely.

If the current base case layout is to be implemented, the re-alignment of the Mushingashi road will be the responsibility of the project proponent. A suggested routing is provided in Figure 40.

8.3.4 Water Storage Facility Options

The base case layout has identified three possible options for water storage (Figure 38) which are all in response to existing topography with the aim of minimizing construction effort. These alternatives are identified as options only and are not based on the project's water requirements. Of these, alternative 3 is deemed to be most appropriate from a visual impact perspective, as well as from an ecological perspective as the affected drainage channel in question is already somewhat modified.

The three alternatives have relevance in terms of ecological impacts and visual impacts. For all the other aspects the three alternatives are expected to present the same impacts and risks.

It is recommended that the project continue with consideration of either the base case SLC or the alternative underground mining option, but that the locations of the WRD, TSF and plant be re-considered in subsequent development phases. Water storage option 3 is deemed the most appropriate option from an environmental impact management point of view.

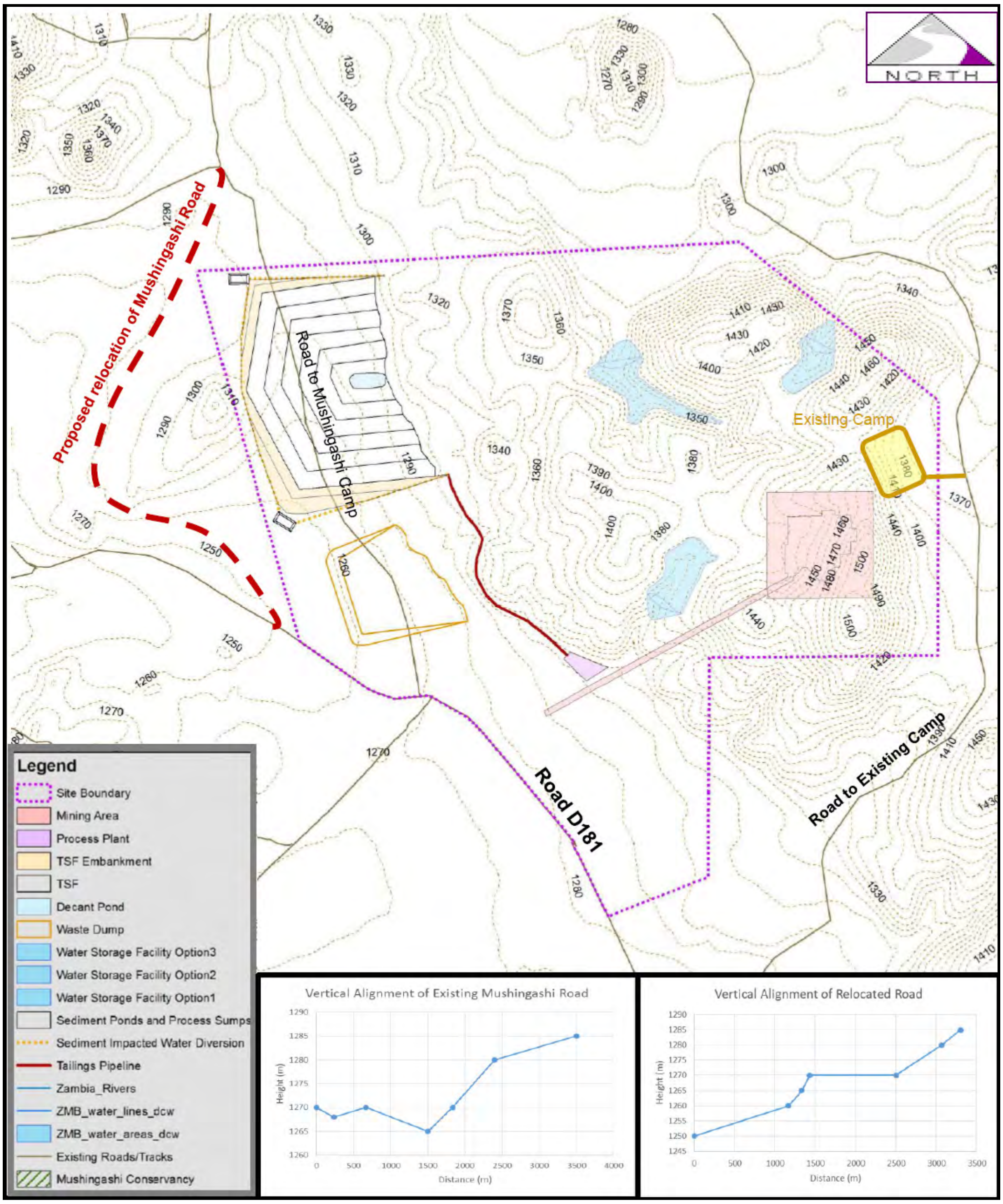

Figure 40: Suggested route for re-alignment of Mushingashi Road

8.4 Route Alternatives

Consideration of alternative routes generally applies to linear developments such as power lines, transport and pipeline routes, all of which are infrastructure associated with the proposed development. The alternatives include consideration of alternative routes and methods of transport of materials to site, transport of products and waste from the site (and its final destination in terms of the "cradle to grave" principles) and transport of personnel to and from the site.

The exact routes of potential pipelines and electricity and water supply infrastructure have not yet been determined and the alignment of this infrastructure during future project phases and detail project design should consider environmental considerations.

Community safety has been flagged as a project risk and will play a significant role in the finalization of the transportation route option. The current road conditions from the site to Mumbwa and through Mumbwa would likely present significant safety risks to pedestrians if mine trucks are to utilize these roads for product transport. Increased heavy traffic on these roads is likely to cause further road deterioration and dust impacts.

The Regional Manager of the Central Province Road Development Agency (RDA) revealed during on-site consultations that the RDA is planning to construct Road D181 between Mumbwa and Road M8 towards the end of 2014. This would include the section of the D181 between Mumbwa and the mine access. This planned construction is essential to the future of this project.

One of the route alternatives from the site to Lusaka is via the M20 (approximately 116 km) and the T2 Road (approximately 67 km).

The first 60 km of Road M20 from Mumbwa was recently constructed (surfaced with surfaced shoulders) and is in a very good condition. The rest of Road M20 is currently almost impassable. The RDA has confirmed that the contract to complete the remaining section of Road M20 has already been signed and that construction should commence on this section imminently.

The project will produce approximately 33,000 tonnes per annum of copper cathode and approximately 24,000 tonnes per annum of wet copper sulphide concentrate, to be shipped from site by road truck. This would amount to trip generation to and from the mine as depicted in Table 19.

Table 19: Expected daily trip generation (external transport during production)

	Directional split	Total trips	New trips in	New trips out
Consumables	50:50	14	7	7
General Trips	50:50	70	35	35
Product	50:50	12	6	6
Total trips		**96**	**48**	**48**

The current assumption is that the concentrates will be placed with local Zambian smelters on the Copperbelt, while the cathodes will be transported to an appropriate port such as Dar es Salaam (Tanzania) or Durban (South Africa) for export. From Mumbwa, either the M9 highway or the T2 road via the M20 can be used to reach Lusaka. These alternatives are discussed in the traffic impact assessment (Havenga, June 2013). For economic reasons the shortest route and best road conditions (M9) is preferred.

8.5 Services Alternatives

The proposed mining operation will be associated with a number of support service infrastructure including water supply (process water, fire water, potable water etc.), power supply, waste management infrastructure and housing and transport infrastructure. These are briefly investigated below:

8.5.1 Water Supply Options

The project's make-up water requirements of 4,177m^3/d (48 ℓ/s) could be obtained from a number of alternative sources. The water supply alternatives investigated are discussed in detail in the Water Supply Option Analysis conducted by Vivier & Mostert (June 2013), and summarised below:

8.5.1.1 Groundwater

Eight high potential groundwater zones were identified for the potential development of well fields. The aquifers were mapped and possible water bearing features examined using remote sensing, drainage catchments, geological information and aerial photo interpretation. Targets were prioritised based on catchment size and groundwater recharge and areas with regional fault zones and dolomitic formations to the north of the project site were targeted.

It was found that groundwater resources within a 10 km radius of the site should be able to supply the mine water demand, although only limited site characterisation boreholes were drilled to confirm this.

The proposed development of an agricultural irrigation scheme for food crop production in the Big Concession farming block approximately 10 km to the north-east of the mine could pose a risk to regional groundwater development.

8.5.1.1.1 Regional Groundwater

The groundwater supply potential of each delineated groundwater zone (see Figure 41) was quantified through a regional groundwater balance evaluation. Groundwater recharge is primarily determined by rainfall although factors such as topography and soil type also play a role. The MAP of the area is 819 mm/a. Thus with a conservative recharge of 5 % of rainfall, an area of 70 km^2 or 5 km radius is required to provide sufficient recharge for the mine water demand (48 ℓ/s) at a 95% assurance level. The number of boreholes required to abstract the requisite volumes of water and the yields of the respective boreholes should be further investigated through a field investigation with borehole drilling and testing, although conservative assumptions were made in this regard. Water from a combination of the identified groundwater units can be sourced to make-up the total required water supply.

8.5.1.1.2 Underground fissure water from mine dewatering

There is an interaction between mine water supply and dewatering. The mine water supply will be required for the ramp up phase while water will be generated from dewatering after one year of the underground mining operations. Pre-dewatering could be done to also supply water to the mine.

The mine water demand (4 883 m^3/d (57 ℓ/s) could partially be met by dewatering, although the required dewatering to supply the demand would only be reached after several years of mining while the water supply to the mine plant will be required during the ramp up phase. The timing difference could be bridged by development of a well field either at the mine area or in the areas identified and discussed above.

Due to the fact that the groundwater at the underground mine is not yet a proven resource, a conservative assumption is made that at least 50% of the low dewatering scenario 2 376 m^3/d (28 ℓ/s) would be available for water supply. The shortfall of 2 376m^3/d (28 ℓ/s) must be obtained from development of groundwater resources in the area via Piped River Water.

The option to abstract water from the Kafue River approximately 30 km north of the site and pipe the water to the mine operations was also considered. The exact pipeline route and specifications for pipeline material and pumping stations, should this option be pursued, are yet to be determined. Water quality is not foreseen to present challenges, however the option is associated with considerably higher capital expense.

The monetary cost of constructing such a water supply system to the mine is not the only concern associated with this water supply option: Additional environmental impact assessments over the entire pipeline route, water intake structure area, pump station locations and the Kafue River itself will have to be conducted to determine the environmental acceptability of this proposal. It is expected that such a pipeline would traverse sections of the Mushingashi Conservancy and thus also meet with resistance due to potential impacts on the local tourism sector.

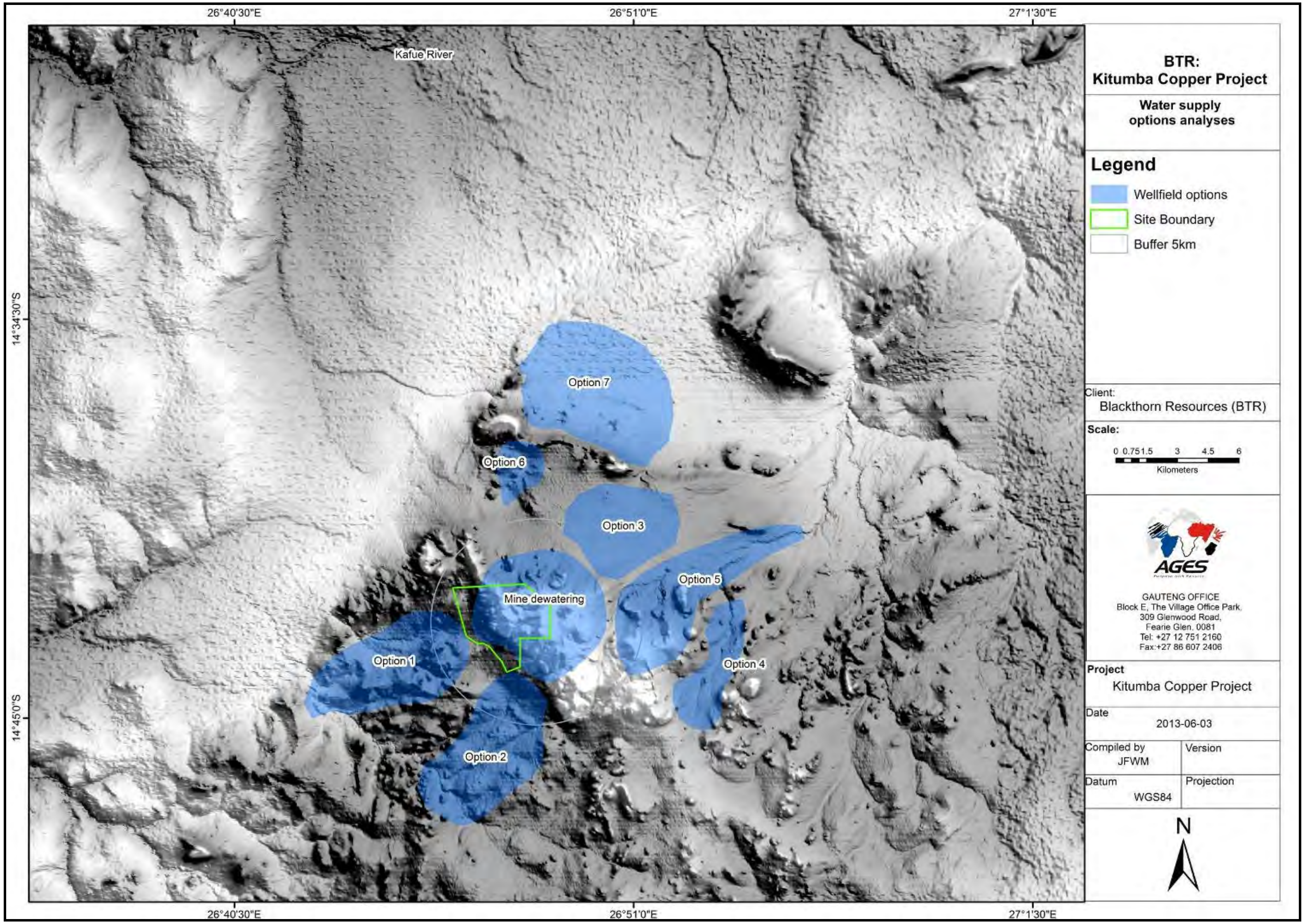

Figure 41: Water supply option – Groundwater

8.5.2 Power supply options

Two power supply options have been identified, namely in-situ generation using diesel generator sets (gensets); or connecting to the ZESCO electricity grid. Consideration could also be given to supplementary solar or wind power, to a lesser extent.

Blackthorn is currently negotiating with ZESCO for supply of electric power to the project and it is likely that emergency power back-ups will be incorporated into the detail project design during DFS.

Care must be taken that over-head power lines do not pose a threat to animal (especially avifauna) safety and the visual impacts of electrical power supply to the project have also not been accounted for in this PFS study. It is however expected that the majority of visual receptors (local residents) will welcome electrical power infrastructure in the area, and that the only sensitive visual receptors who may be negatively affected by the presence of power supply infrastructure would be tourists travelling through the area to Mushingashi and KNP.

8.5.3 Waste management options

Processing and technology alternatives will possibly give rise to different types of waste with different management options, and a detailed waste management plan should be compiled once more project detail becomes available. Such a waste management plan should, as a minimum:

- identify all types of wastes and quantities of wastes associated with the project and associated activities,
- quantify the abovementioned waste types throughout the lifespan of the project in different phases,
- identify appropriate waste storage options on the site, and waste transport options from the site, and implement plans to ensure safe and legal disposal / treatment / re-use,
- identify and implement procedures to avoid or minimise the generation of waste, encourage or enforce the re-use and recycling of waste, and as a last resort to dispose of waste (waste hierarchy).

Waste management could include disposal to landfill in which case the landfill will have to be identified and the impacts of such disposal (including transport of waste from the site to the landfill) must be evaluated. Recycling options should also be assessed.

Domestic waste from the site (papers, wrappers, cans etc.) and office waste is not expected to be hazardous and disposal of these wastes should consider recycling options – there are a number of companies in Zambia (mostly based in Lusaka) capable of recycling domestic waste.

Sewage disposal / treatment options have to be investigated fully in subsequent project phases. It is anticipated that, due to the remote location of the mine site, sewage effluent may be treated on site through package sewerage treatment plants (http://www.wpl.co.uk/), or that domestic sewage will have to be removed by specialist waste contractors on a regular basis. This second option will be associated with increased traffic and associated dust impacts, while on-site sewage treatment is associated with its own risks which should be evaluated as part of the EIA and considered in the compilation of the waste management plan.

Hazardous waste which may be associated with the project include (but is not limited to) various hydrocarbons, oily solids and liquids, medical waste, batteries and electronic waste, flammable substances and explosives. Some of these may have treatment and/or disposal options within Zambia, but some may have to be transported elsewhere in order to ensure safe disposal.

Zambia has formally agreed to the Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (Basel Convention) which aims to protect human health and the environment against the adverse effects resulting from the generation, management, movement and disposal of hazardous waste. Additionally, many countries to whom hazardous waste may be sent have ratified the Basel Convention and the provisions thereof will have to be heeded in the waste management practices of the project.

Zambia has also signed the 1991 Convention on the Ban of the Import into Africa and the Control of Trans-boundary Movement of Hazardous Wastes within Africa (Bamako Convention) although the ratification has yet to be finalised. The convention is supplementary to the Basel Convention and covers movement of hazardous waste into or between signatory African countries. The provisions of the convention will have to be considered in the preparation of the waste management plan.

Trans-boundary movements of hazardous wastes are generally approved if the country of export does not have the capability of managing or disposing of the waste in an environmentally sound manner and the receiving country has appropriate, environmentally sound facilities, and agrees to accept the waste.

8.5.4 Employee housing options

Employee housing options will directly influence transport options, waste management scope, and will also potentially affect the surrounding social environment, especially if employees are to be housed in surrounding villages. Housing employees on the site is associated with its own set of challenges in terms of social considerations and service provision to name but a few.

Movement of personnel between the mine site and the surrounding environment could present significant potential for animal-human interaction, which will have to be managed carefully.

The current estimate is for a peak construction work force of 500 and accommodation camp for operations of 400 people. These figures are likely to be refined as the project progresses. Accommodation facilities on site will be provided at the site of the existing exploration camp. Employees will be bussed to the site from Mumbwa.

8.6 Scheduling Alternatives

The proposed project comprises a number of activities and components which can be scheduled in a different order or at different times (of the day or of the year in different seasons) and as such produce different impacts. For example, conducting earth-works during construction in the dry season would significantly reduce the risk of erosion, but may give rise to higher dust impacts; blasting activities scheduled during the day-time will have a less significant perceived noise impact than blasting activities at night; and operational hours of the mining and processing operations can also alter its visual and noise impacts.

Usually, scheduling of mining operations is driven by economic rather than ecological considerations. Scheduling alternatives should be considered in more detail as part of the DFS project planning.

8.7 The No-Go Alternative

The No-Development Option assumes that the activity does not go ahead, implying a continuation of the current situation or the status quo. The baseline descriptions provided in Section 5 of this report will therefore remain as is, but the potential benefits arising from the implementation of the project will not be realized.

Thus from a purely ecological point of view, the no-go option may be preferred as the project is located in a pristine environment. However, if the project does not go ahead, the conservation potential discussed in Section 8.1 will not be realized, and the socio-economic opportunities that the proposed project presents to local people and to the Zambian economy will not materialize.

It is therefore stated that the potential benefits of the proposed project outweigh the potential negative impacts associated with project, assuming that appropriate management measures are implemented throughout all project phases in order to minimise project impacts and enhance project benefits.

9 ENVIRONMENTAL MANAGEMENT PLAN

The costs referred to for any monitoring or mitigation costs are indicative and will be finalized as part of the Feasibility Study.

Table 20: Environmental Management Plan

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
1	**Air Quality**						
1.1	All construction activities	Increased PM10 and PM 2.5 on and around the project site activities	Water sprays for dust suppression to be applied according to prevailing site specific conditions	Continuous throughout all project phases	Dust fallout rates should not exceed 350 $mg/m^2/day$	Refer to the Air Quality Impact Assessment (Liebenberg-Enslin & Gresse, 2013 - Appendix 3.1) Section 6: Figure 6-1 indicates the proposed monitoring network for the project.	As per Appendix 5
1.6	All Sources	Incremental PM2.5 and PM10 Impact	All mitigation listed for subsequent source groups				
1.4	Movement of vehicles and personnel on unpaved roads	Air quality impacts from increased dust	Water sprays for dust suppression to be applied according to prevailing site specific conditions. Consideration of conveyor use wherever possible.		Dust fallout @ road perimeter < 1 200 $mg/m^2/day$, within mine boundary < 600 $mg/m^2/day$ and < 350 $mg/m^2/day$ at the sensitive receptors.		
1. 10	Materials handling and Crushing	Incremental PM2.5 and PM10 Impact	50% control efficiency through water sprays or dust extraction. Reduce drop heights where possible. Increase moisture content (above 4%) of material entering crusher if possible.				
1.8	Unpaved Roads	Incremental PM2.5 and PM10 Impact	75% control efficiency by water sprays on roads		No visible dust.		
2	**Hydrogeology**						
2.1	Establishment of construction camp and sanitation facilities	Negative impacts on Groundwater quality	Use chemical sanitary facilities placed away from drainages. Frequent maintenance by specialist contractor for removal without	Throughout construction Phase	No spillages from chemical sanitary facilities. No uncontrolled discharges (separation of	The mine environmental manager is charged with	Cost dependant on responsible party (on-site

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
2.2	Use of explosives for decline development	Contribute to nitrates overload to groundwater	spillages. Schedule construction during the dry season if possible. No uncontrolled discharges from the construction camp shall be permitted; Good housekeeping rules to be implemented at site. The use of all materials, fuels and chemicals must be controlled and these must be stored in a specific secured and bunded area to prevent pollution from spillages and leakages; Construction vehicles and machines must be maintained properly to ensure that oil spillages are kept at a minimum; Re-fuelling of construction vehicles should be done in designated re-fuelling, bunded areas which must be impermeable with sumps capturing any waste water; Monitoring according to the monitoring protocol should commence before construction starts, preferable at least a sampling run in the winter and summer before construction commences.		clean and dirty water systems). No visible waste, litter on site. All fuels, chemicals etc. stored in designated and secured areas designed for purpose (with impervious floors, bunded to 110% capacity of storage vessel, protected from precipitation and wind). Regular maintenance of vehicles and machinery as per manufacturer's specification. No visible oil or fuel leaks from vehicles/machinery or anywhere on site. Use of explosives to be controlled (only used by qualified designated persons).	monitoring and reporting on non-compliances with legislation, spillages or any other environmental incidents on site. The proponent may consider appointing a designated environmental control officer for these purposes. Explosive storage, handling and use - specialist and mine Health and Safety officer.	environmental manager or additional Environmental Control Officer). To be determined, but expected to be in keeping with mine operational costs. Appendix 5
2.3	Hydrocarbon spillages (construction vehicles)	Negative impacts on Groundwater quality					
2.4	Surface water contamination	Negative impacts on surface water quality					
2.5	Anthropogenic activities on site	Negative impacts on surface and groundwater quality					

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
2.6	Dewatering radius of influence	Lowering water levels of surrounding (3 km radius) water supply boreholes.	Monitor radius of influence (local and regional water level measurements monthly). Provide alternative water to affected parties/ecosystems	Throughout operational phase	Measurement of local and regional water levels (monthly). Provision of alternative water if and as needed.	Monthly by Mine environmental manager	As per Appendix 5
2.7	Inrush of groundwater to mine tunnels and stopes	Loss of Life	Dewatering design which covers drilling and pre-dewatering or sealing		No loss of life or injury to occur as inrush of water is to be prevented.	Mine Health and Safety Officer	Only determinable after additional studies.
2.8	Dewatering radius of influence	Lowering water levels of wetlands (3 km radius), decrease groundwater head	Additional site characterisation to determine wetland mechanism. Monitoring boreholes. Specific discharge into wetlands to maintain biodiversity		No nett decrease in minimum wetland water levels.	Monthly by Mine environmental manager	Drilling of Additional monitoring boreholes – Appendix 5
2.9	Contaminant leaching from mine waste facilities	Groundwater and surface water contamination by copper, cobalt, cadmium and manganese	More detailed geochemical investigations. Mixing of lime in plant to neutralize tailings waste and seepage capturing during operational phase		Chemical levels not to exceed accepted standards (neutral mine waste)	Monthly by Mine environmental manager	Indicative cost for additional Geochemical AnalysisR250 000
2.10	Uranium concentrated in the product	Radioactive contaminants from mine waste facilities	Seepage capturing during operational phase. Bleeding off uranium in process water to prevent build-up. Separate uranium in the plant and develop small norm waste facility, dispose at licensed facility or sell.		No unacceptable levels of radiation in mine waste	Every 3 months by Mine environmental manager	Radiological Source Characterization Indicative budget of R118 000

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
2.11	Chemicals used in mining activities	Contamination of surface and groundwater by point source chemicals	All materials, fuels and chemicals must be stored in specific secured and bunded area. Spillages and leakages are to be prevented.		No leakages or spillages	Mine Environmental Manager	Water Monitoring costs included in Appendix 5 will be sufficient.-
2.12	Groundwater seepage to underground workings	Filling up mine shaft negative impact on mine schedule and operations	Water to be pumped out and re-used in mine circuit (contact water)		No unmanageable seepage of groundwater to underground workings	Mine Health and Safety Officer	As per engineering operational costs.
2.13	Increased runoff due to mining activities	Increased erosion and silt loading on surface water bodies	Erosion control measures and stormwater management plan to be implemented		Effective implementation of storm water management plan.	Mine Environmental Manager	Stormwater Management Plan – Approx. R140 000
2.14	Hydrocarbon spillages (from storage facilities or vehicles)	Negative impacts on groundwater and surface water quality	Maintenance of mine vehicles and machinery. Use spill trays when necessary. Oil separators at workshops		Maintenance according to manufacturer specification. No visible spills on site.	Mine Environmental Manager	Water Monitoring as per Appendix 5.
2.15	Use of explosives	Presence of nitrates in water derived from mine workings (impacts on water quality)	Groundwater monitoring and treatment if necessary		Use of explosives controlled (qualified persons). Only acceptable nitrate concentrations in groundwater.	Mine Environmental Manager	Water Monitoring- As per Appendix 5
2.16	Contaminated stormwater runoff from mine workings	Negative impacts on groundwater and surface water quality	A stormwater management plan should be implemented to ensure effective containment. Silt traps to capture sediment load.		Effective implementation of storm water management plan.	Mine Environmental Manager	Stormwater Management Plan – Approx. R140 000
2.17	Mine dewatering effects decreasing -	Rising of water levels and increase in	Sealing of decline and access tunnels to reduce oxygen ingress. Liming of	mmis sionin g and	Monitoring rise of water levels to verify	Mine Environment	Mine Closure and

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
	post operational rewatering	borehole yields for water supply	mine void to neutralise post operational flooding			al Manager	Rehabilitation – Appendix 3
2.18	Re-watering radius of influence	Increased water levels of wetlands (3 km radius) and increased groundwater head	Channel rehabilitated storm water to wetlands		No decrease in wetland water levels	Mine Environmental Manager	As per Appendix 5
2.19	Leaching of contaminants from mine waste facilities	Contamination of groundwater and surface water by copper, cobalt, cadmium and manganese	Additional geochemical studies to increase understanding of the system. Neutralise waste during operational phase. TSF rehabilitation		Contaminants in groundwater remain at acceptable levels. TSF rehabilitation according to specialist rehab plan	Mine Environmental Manager	Only determinable after detailed Rehabilitation plan has been compiled.
2.2	Radioactive contaminants from mine waste facilities	Uranium concentrated in product. Residual concentrations in WRD and TSF (probably low)	Additional geochemical and radiological studies. Bleeding off uranium in process water to prevent build-up. Separate uranium in plant and develop norm waste facility, dispose at licensed facility or sell.		No unacceptable levels of radiation in mine waste	Mine Environmental Manager	As per Appendix 5
2.21	Use of explosives causing presence of nitrates	Groundwater contamination by nitrates due to blasting	Nitrates would dissipate as blasting stops		Nitrate concentrations in groundwater at acceptable level and decreasing	Mine Environmental Manager	As per Appendix 5
2.22	Migration of TSF and WRD plume (northwest)	Negative impacts on surface and groundwater quality	TSF rehabilitation (and capping) to minimise ingress		Monitor groundwater quality to northwest to verify migration as expected.	Mine Environmental Manager	Mine Closure and Rehabilitation – Appendix 3
4	**Visual Impacts**						

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
4.1	Presence of construction vehicles, machinery, equipment and personnel	Alteration of key elements, features and characteristics of the baseline visual environment	Retain existing vegetation where possible (especially along site boundary and roads). Implement dust suppression. Concurrent rehabilitation. Strict speed limits. Careful consideration of lighting.	Throughout all project phases	Vegetation retained, no visible dust, no unnecessary light spillage	Mine Environmental Manager	-
4.2	Presence of construction and mining vehicles, machinery, equipment and personnel	Alteration of key elements, features and characteristics of the baseline visual environment	Dust suppression. Develop sustainable final landform design for TSF, WRD and water storage facilities. Concurrent rehabilitation of TSF and WRD. Strict speed limits. Careful consideration of lighting		No visible dust. Concurrent rehabilitation to satisfaction of rehabilitation plan.	Landscape architect, ecologist or similar and Mine environmental manager	Concurrent rehabilitation as per Appendix 3
4.3	Presence of vehicles, machinery, equipment and personnel	Alteration of key elements, features and characteristics of the baseline visual environment	Dust suppression. Design of TSF, WRD etc. to minimise final heights. Concurrent rehabilitation and monitoring of success of rehab.		Monitor success of rehabilitation as per rehabilitation plan.	Mine Environmental Manager	Only determinable after compilation of site specific rehabilitation plan
	Security and other lighting at the project site.	Alteration of visual environment by Light pollution	Minimise light pollution: Security lighting should only be used where absolutely necessary and carefully directed. Reduce light "spillage" beyond the immediate surrounds of the project. Avoid white light. Light pathways and roads with 'bollard' type lights. Avoid pole top lighting.		No complaints from surrounding tourist lodges regarding light pollution.	Complaints record keeping by Mine environmental manager - continuous.	-
5	**Impact on Heritage resources**						

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
5.1	Construction, operation and decommissioning of the mining project and associated projects (roads, water supply etc.).	Damage to or destruction of undiscovered heritage or archaeological resources	Environmental awareness training and brief watch monitoring programmes throughout development - know what to look out for. Archaeological surveys on associated projects' sites prior to development. Consultation with local communities (protect living heritage).	Throughout all project phases	No damage to heritage resources	Mine Environmental Manager	Mine Closure and Rehabilitation – Appendix 3.
6	**Social Impacts**						
6.1	Development in the area causing in-migration of foreigners	Change in cultural values and integrity (Impact on Social Dynamics)	Discuss potential for in-migration with community leaders (political and traditional) and obtain their views on management options; Decide on recruitment policies in conjunction with the leadership structures. Ensure policies are fair and equitable (and perceived as such). Communicate the policies as early as possible. Implement a quota system from each affected village. Create awareness of potential social ills (pamphlets, lectures, posters). Implement a community relations plan (include all relevant	commence prior to project (procedures etc. to be in place before project commences). Community Liaison and consultation is an	Social impacts associated with the project directly impact a contingency of the projects' work force. Internal and external complaints register is to be kept - performance indicated by no complaints received and reaction to complaints received. Monitor community water levels and quality - no deterioration in quality will be accepted. If water	The mine should consider the appointment of a community liaison officer for the duration of the project. A complaints register (both internal for employees	No specific cost associated with monitoring and management of social impacts apart from: appointment of Community Liaison Officer and Community
6.2	Influx of people to the surrounding villages due to opportunities	Negative impacts on existing community cohesion (Impact on Social Dynamics)					
6.3	Job-creation for local people and for people from outside, inappropriate procurement policies	Social differentiation and inequity (Impact on Social Dynamics)					

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
6.4	Conflict about available jobs and who should benefit from the project. Cultural change due to influx and economic changes for some.	Social tension and violence (Impact on Social Dynamics)	stakeholders). Establish a community liaison forum (CLF) with representatives from all the stakeholders (including in-migrants, woman, the youth and the elderly). Participate in community events. Ensure consistent communication. The mine will need the input from government (local and traditional) and a number of community institutions to successfully manage this process. The change cannot be avoided, but must be managed.		levels drop alternative potable water has to be supplied to the communities. Performance of Social impact management measures should also be evaluated from within local communities - the results / minutes of the community forum meetings and feedback from a community liaison officer will indicate whether the project is socially acceptable.	etc. and external for members of the public) should be kept continuously. Communication between the mine, communities, government departments and other stakeholders should be a continuous process throughout all of the phases of the project.	Forum administration as well as the Mine environmental Officer.
6.5	Unrealistically high community expectations of benefits due to project	Aspirations and expectations of community not realized (causing tension and distrust). (Impact on Social Dynamics)					
6.6	Mine staff residing away from their families	Alterations in Family structures. (Impact on Social Dynamics)					
6.7	Change in sense of belonging due to influx of people	Community identification and connection (Impact on Social Dynamics)					
6.8	Influx of people putting pressure on infrastructure and resources, increased disease, accidents and injuries	Impacts on Health and social wellbeing: Impacts on physical health	Cooperate and align with existing health services and programs and engage with Health Department. Skills enhancement and training through site clinic. Avoid standing pools of water on site (breeding ground for mosquitoes). Community				

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
6.9	Impacts on water quality/availability, increased traffic, unfair labour practices	Impacts on Health and social wellbeing: Impacts on personal safety (physical and psychological)	outreach programmes to address malaria. Buildings to be mosquito proof. Road safety signage. Collaborate with local authorities and law enforcement (prevent speeding, reckless driving; enforce seat belt usage, accident response etc.). Provide health care services to workers. Abide by VPSHR. Deploy two guards in critical locations. Involve guards in anti-poaching activities and support anti-poaching programs. Educate the work force about poaching.				
6. 10	Influx of people creating a platform for opportunistic and other criminals	Impacts on Health and social wellbeing: Crime - increased theft, social ills and poaching					
6.11	Influx of people putting additional pressure on infrastructure (roads, sanitation etc.)	Shortage of social and physical infrastructure (Impact on quality of the living environment)	Get input from all role players. Utilise existing exploration camp for housing. Provide worker transport. Engage with government for infrastructure upgrades. Include upgrade of social infrastructure in CSI initiatives. Guide staff interaction with local communities and conservation areas. Provide a buffer zone around the physical footprint of the project and fence off. Elephant-proof water structures and scavenger-proof waste areas. Include animal-human interaction procedures in health and safety procedures.				
6.12	presence of mine infrastructure, vehicles, machinery and personnel	Alteration of sense of place / environmental amenity value / aesthetic quality (negative impact on tourism)					
6.13	Animal human interaction and resultant industry conflicts	Conflicting land uses with neighbouring activities (conservation vs. mining)					

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
7	**Impacts on Biodiversity**						
7.1	Vegetation clearing and construction	Destruction of habitat	Retain vegetation where possible. Reduce disturbance to breeding fauna and blooming flora). Relocate plants of ecological significance; Do not clear the entire footprint simultaneously; Clearly demarcate the entire development footprint and prevent creep; Implement monitoring to ensure minimal impacts; Provide environmental training; Cordon off and continually excavate and backfill trenches. Only use poison for vermin after approval from an ecologist. Concurrent rehabilitation and detailed rehabilitation of subsistence zone and cracks – Geotechnical Specialist to advise.	Throughout all project phases	Successful environmental training to all employees. No activities beyond demarcated mine area, and vegetation also retained within mine area where possible. Rehabilitation of subsistence zone as per geotechnical specialist recommendations, to compile detailed rehabilitation plant in consultation with an ecologist / landscape architect.	Mine Environmental Manager	No cost associated with retention of vegetation. Training costs to be determined if not conducted in-house.
7.2	Storage of Tailings; Laydown areas for stockpiles and waste rock	Direct habitat destruction					
7.3	Vegetation clearing and construction	Habitat fragmentation	Use existing facilities as far as possible. Ensure as little disturbance as possible (especially to ravines and moist grassland pockets). Establish protective buffers around sensitive areas. Remain within defined construction areas and servitudes. Unnecessary driving around or bulldozing natural habitat must not take place. No disturbance will occur outside demarcated areas.	Throughout all project phases	Adequate fenced buffer zones; no activities beyond fenced boundaries; effective conservation/avoidance of ravines and moist grassland pockets.	Project design should consider avoidance of sensitive habitats.	To be determined by project engineering team
7.4	Storage of Tailings; Laydown areas for stockpiles and waste rock	Habitat fragmentation				Mine Environmental Manager to monitor	-

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
						and report.	
7.5	Exposure of rock, ore and soil to rainfall and wind	Soil erosion	Schedule topsoil stripping and excavation for the dry season where possible; Ensure minimal exposed areas – concurrent construction and rehabilitation; Cover disturbed soils; Control runoff: move water without gulley formation; Install sediment control devices. Implement stringent erosion and dust control practices. Institute a storm water management plan. Do not let surface water or storm water be concentrated, Design storm water discharge points to prevent erosion; Repair all erosion damage as soon as possible; Gravel roads must be well drained in order to limit soil erosion.	Throughout all project phases	Minimal disturbances and concurrent rehabilitation. Implementation of storm water management measures. No visible erosion or gully formation	Mine environmental manager	-
7.6	Increased hardened surfaces created at the project site	Increased soil erosion and sedimentation					
7.7	Rehabilitation activities	soil erosion					
7.8	Movement of vehicles on site	Spillages of harmful substances	Contain polluted water. Discard excess, waste or chemicals in an environmental friendly way. Store	Througho ut all project phases	Adherence to the provisions of the detailed waste management plan	Mine environmental manager	-Air and Water Monitoring as

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
7.9	Domestic and hazardous waste storage and disposal, sewage treatment	Spillages of harmful substances	hazardous chemicals on an impervious surface protected from storm water; Construct refuelling stations to prevent spillages. Contain accidental spillages and clean up promptly; treat sewage in a suitable plant or remove from site for treatment elsewhere; Spill kits should be on-hand to deal with spills immediately; Inspect all vehicles regularly for oil and fuel leaks. Vehicle maintenance should be done in a designated facility and drip trays should be used. Drip trays should be emptied into a holding tank and returned to the supplier.		(to be compiled) and principles of the waste hierarchy. No spillages at refuelling stations or storage areas and no leaks from vehicles or machinery. Sewage treatment as per specification. Spill kits present and employees know how to use them. Appropriate vehicle maintenance facility.		per Appendix 5
7. 10	Movement of vehicles on site	Spillages of harmful substances					
7.11	Exposure of rock, ore and soil to rainfall and wind	Dust contamination	Undertake dust suppression and a dust monitoring programme. Implement the air quality management programme, and monitor regularly to ascertain the dust load and emission rates and particle size distribution; Implement standard dust control measures, including periodic spraying and chemical dust suppression and monitor efficiency. Implement strict speed limits to reduce dust formation.	Throughout all project phases	No visible dust and no exceedance of acceptable emissions standards according to the air quality management programme.	Mine environment al manager	Air Quality Monitoring As per Appendix 5
7.12	Stockpiling, Materials handling, vehicle entrainment and windblown dust	Dust					
7.13	Rehabilitation activities	Dust					

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
7.14	Continued movement of personnel and vehicles on and off site, and deliver of materials	Spread of alien invasive species	Kill the alien invasive plants and seedlings and establish an alternative plant cover to limit re-growth; Institute strict control over materials brought onto site. Routinely fumigate with appropriate herbicides; Rehabilitate disturbed areas as quickly as possible; Institute a monitoring programme to detect alien invasive species early, and an eradication/control programme for early intervention if invasive species are detected; A detailed plan should be developed for control of noxious weeds and invasive plants..	Throughout all project phases	No alien invasive plants present on the project site.	Mine environmental manager	Biodiversity Monitoring as per Mine Closure and Rehabilitation – Appendix 3
7.15	Transporting of people and equipment	Spread of alien invasive species					
7.16	Movement of vehicles on site	Spread of alien invasive species					
7.17	Construction of infrastructure, roads etc.	Negative impacts of human activities	Accommodate staff on site. Fence area to prevent movement into 'no-go' areas. Provide adequate rubbish bins and sanitation facilities; Maintain firebreaks around development footprint. Educate construction workers regarding risks and correct disposal of waste materials.	Throughout all project phases	No movement into no-go areas. Good housekeeping practices implemented (no litter etc.). Firebreaks adequate.	Mine environmental manager	-
7.18	workers accommodation on site	Negative effects of human activities on flora					
7.19	Presence of labourers on site	Negative effects of human activities on flora					
7.2	Continued movement of personnel and vehicles on and off site, and deliver of materials	Fauna mortality on roads	Enforce a speed limit no more than 40 km/hour. Install speed bumps in sections where the speed limit tends to be disobeyed. Avoid travelling at night. Lights should be positioned 5 m from the roads or paved areas.	Throughout all project phases	No exceedences of speed limits. No night travelling. Appropriate lighting (no / little insect activity). No or little observed fauna mortality on roads. No	Mine environmental manager	-

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
7.21	Movement of vehicles on and off site and delivery of materials	Fauna mortality on roads			incidents involving animal-human interaction.		
7.22	Movement of vehicles on site	Fauna mortality					
7.23	Construction of mining infrastructure, access roads etc.	Light pollution	Limit construction to day-time; minimise external lighting; long-wavelength light sources should be used. Do not use Fluorescent lights outdoors. Direct external light sources inward; Internal lighting should be shielded.	Throughout all construction phases	No or little light spillages at night beyond project site boundary.	Mine environment al manager	-
7.24	Mining operations during night time	Light pollution					
8	**Impacts on Wetlands**						
8.1	Clearing of vegetation, construction of infrastructure etc.	Habitat Destruction	Alter base case layout to fall outside of wetlands; Limit development activities to appropriate areas. Avoid rigid geometries; Provide regular environmental training; Do not remove indigenous plants from wetlands or riparian areas; Control pesticide use; monitor wetland water	Throughout all construction phases	If the base case layout is altered to avoid the wetland areas, the impact is avoided and no further measures are necessary.	Project team	-

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
8.2	Placement of stockpiles, TSF and WRD on wetlands	Direct habitat destruction	levels; Avoid work in rivers, streams and wetlands or limit to dry season. Implement a rehabilitation plan. Cross drainage channels at 90 degrees. Minimize changes to natural drainage patterns and crossings to drainages. Perform scheduled maintenance to be prepared for storms. In-stream diversions at constructions in drainages must avoid damming. No construction of new channels. Manage storm water run-off and potential flooding.		Surface water monitoring as per monitoring protocol.	Mine environmental manager.	As per Appendix 5
8.3	Increased hardened surfaces and exposed areas	Soil compaction and erosion leading to sedimentation	Minimize land disturbance; Schedule topsoil stripping and excavation for winter if possible; Minimise exposed areas; Cover disturbed soils; Move runoff water without gully formation, trap sediment before discharge. Implement erosion and dust control practices. Minimize concentrated water. Control stormwater velocity and divert run-off around disturbed areas. Institute a storm water management plan; Have temporary and permanent erosion control plans; Protect areas susceptible to erosion and repair erosion damage as soon as possible;	Construction and operational phases	Surface water monitoring as per monitoring protocol.	Mine environmental manager.	As per Appendix 5
8.4	Increased hardened surfaces and exposed areas	Increased soil erosion and sedimentation					
8.5	Rehabilitation activities	Increased soil erosion and sedimentation					

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
			Gravel roads must be well drained in order to limit soil erosion;				
8.6	Exposure of rock, ore and soil to rainfall and wind, and vehicle movement	Water pollution from spillages of harmful substances	Treatment and containment of dirty water; remove excess, waste material or chemicals from site and discard in an environmental friendly way; Inspect construction vehicles for oil and fuel leaks, service regularly. Situate maintenance yards away from drainage lines; Construct refuelling stations to prevent spillages and be prepared for accidental spills. Prevent pollutant entry into the drainage system; Treat sewage in a suitable plant or remove from the site for treatment elsewhere; Maintain a good standard of housekeeping. Store all litter so it cannot contaminate drainage systems; Provide (scavenger proof) bins. Avoid poisons for the control of problem animals.	Construction and operational phases	Surface water monitoring as per monitoring protocol.	Mine environment al manager.	As per Appendix 5 and Stormwater Management Plant
8.7	Large vehicles - oil and fuel spillages, building waste, batching plants, sewage and domestic waste, topsoil storage	Water pollution from spillages					
8.8	Movement of vehicles on site for rehabilitation	Water pollution from spillages					
8.9	Movement of construction vehicles	Dust contamination	Implement dust suppression and monitoring. Implement air quality management programme. Use dust	Through out all project phases	Surface water monitoring as per monitoring protocol.	Mine environment al manager.	As per Appendix 5

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
8. 10	Stockpiling, Materials handling, vehicle entrainment and windblown dust	Dust contamination	masks as per the Mine health and safety requirements; Implement standard dust control measures, Soil dumps may be covered if necessary; A speed limit (no more than 60 km/hour) should be enforced on dirt roads;				
8.11	Movement of vehicles on site for rehabilitation	Dust contamination					
8.12	Movement of personnel and vehicles on and off site and delivery of materials for construction	Spread of alien invasive species in wetland systems	Kill the alien plants present and seedlings which emerge, and establish alternative plant cover. The control of AIS at the site should commence prior to construction. Prevent AIS from establishing, detect AIS that do establish early, eradicate AIS that establish or control population is eradication is not feasible. Develop and implement a detailed AIS eradication and monitoring plan.	Throughout all project phases	As per the alien-invasive plants management procedure to be compiled as part of the mine's procedures and guidelines.	Mine environmental manager.	Biodiversity Monitoring as per Mine Closure and Rehabilitation – Appendix 3.
8.13	Movement of personnel and vehicles on and off site and delivery of materials for mining operation and maintenance	Spread of alien invasive species in wetland systems					
8.14	Movement of personnel and vehicles on and off site and delivery of materials for rehabilitation	Spread of alien invasive species in wetland systems					
9	**Impacts on Soils, land capability and agricultural potential**						

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
9.1	Regular heavy vehicle movement, and laydown areas for construction	Soil Compaction	Only handle soils when dry to reduce compaction risk; Strip vegetation with topsoil; Avoid soils with risk of compaction wherever possible. Unnecessary driving around or bulldozing natural habitat must not take place. Stick to haul roads. Use existing roads and tracks as far as possible. Rip and/or scarify compacted areas on a continuous basis. Do not rip and/or scarify areas under wet conditions. Sample and analyse soil prior to rehabilitation. Under advisement from a suitably qualified restoration ecologist, supplemental fertilisation may be necessary.	Construction	Minimal compacted soils. No impacts beyond development footprint. Existing facilities are used where possible. Soil quality prior to rehabilitation is acceptable. Ensure that Geotechnical specialist is appointed to advise, especially on stability and rehabilitation of the subsistence zone.	Mine environmental manager.	-
9.2	Regular heavy vehicle movement, and laydown areas during mining	Soil Compaction		Operation			
9.3	Regular heavy vehicle movement for rehabilitation activities	Soil Compaction		Closure			
9.4	Vegetation clearance, mine construction and activities leaving soil exposed	Soil erosion	Schedule topsoil stripping and excavation in the dry season if possible; Schedule clearance & excavation concurrently with construction & rehabilitation; keep exposed surfaces at a minimum. Cover disturbed soils; Avoid gully formation by runoff; Install sediment control devices. Control dust using water-sprayers or chemical dust suppressants; Institute storm water	Construction	Minimal exposed surfaces; no visible erosion or gully formation; susceptible areas are protected from erosion; vegetative cover is adequate.	Mine environmental manager.	-
9.5	Hardened surfaces, slopes of stockpiles and WRD	Soil erosion		All phases			

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
9.6	General rehabilitation activities	Soil erosion	management plans (temporary and permanent); Repair erosion damage as soon as possible; Implement erosion monitoring procedures; Re-vegetate disturbed areas as soon as possible. Monitor vegetative cover on stockpiles to maintain a high basal cover. Conserve topsoil for use in rehabilitation	Closure and rehabilitation			
9.7	Construction vehicles contributing to oil and fuel spillages, building waste, batching plants, sewage and domestic waste	Soil pollution	Store hazardous chemicals in impervious bunded area protected from stormwater; Construct refuelling stations to prevent spillages, and implement measures to contain and clean up accidental spillages; Treat sewage in a suitable plant or remove from site for treatment elsewhere; Spill kits should be on-hand to deal with spills immediately and employees should be trained in their use; Implement procedures to deal with spillages or leakages; Maintain stormwater management system to ensure clean and dirty water separation. Maintain vehicles regularly to prevent leakages. Conduct vehicle maintenance in a designated facility and use drip trays. Empty drip trays into a holding tank and return to the	Throughout all project phases	No visible leakages from vehicles or machinery or on the site. Appropriate storage of hazardous materials. Appropriate maintenance and refuelling facilities (no spillages visible and emergency response procedures in place).	Mine environmental manager.	-
9.8	Construction vehicles contributing to oil and fuel spillages, building waste, batching plants, sewage and domestic waste	Soil pollution					
9.9	Oil and fuel leakages from vehicles and machinery for rehabilitation	Soil pollution					

No	Activity/Aspect	Impact	Mitigation	Time Frame	Performance indicator	Monitoring and reporting	Cost
			supplier.				
9. 10	Topsoil stripping and mine construction	Soil destruction and sterilization	Continually rehabilitate the soils to the best possible state. Refer to the specialist reports on soil rehabilitation	Throughout all project phases	Minimal areas disturbed. Effective rehabilitation and monitoring efficiency of rehabilitation	Mine environmental manager	-
9.11	Topsoil stripping and mine construction	Soil destruction and sterilization					
9.12	Construction of mine and infrastructure	Loss of land capability	Confine disturbance and clearing to the footprint areas of the mine; Only disturb small areas of land at a time. Rehabilitation should take place on a continuous basis where after the land would become partially available again as grazing. Once mining activities have ceased, disturbed areas should be rehabilitated and the grazing capacity restored as far as possible. The rehabilitation of the soils and re-vegetation is discussed in the specialist report.	Throughout all project phases	Post-closure monitoring of the success of rehabilitation of the area to viable grazing land.	Mine environmental manager.	-
9.13	Dumping of waste rock, mining and stockpiling	Loss of land capability					
9.14	Loss of grazing value due to lower grazing capacity after rehabilitation	Loss of land capability					

10 DECOMMISSIONING AND REHABILITATION

The Mines and Minerals Development Act, 2008 (MMDA) provides in Section 116 that

> *(1) The conditions subject to which the mining right is granted or renewed shall include such conditions as may be prescribed by the Minister, by statutory instrument, or as the Minister may, in a particular case, otherwise determine, in relation to*
>
> *(c) the rehabilitation, levelling, re grassing, re foresting or contouring of such part of the land over which the right or licence has effect as may have been damaged or adversely affected by prospecting operations, mining operations or mineral processing operations; and*
>
> *(d) the filling in, sealing or fencing off of excavations, shafts and tunnels.*

The Act also states (section 123) that the holder of a mining right shall be held liable for the cost of remedial and rehabilitative measures in relation to the mining right area after cessation of mining activity.

The stipulations of the MMDA are in line with the IFC and World Bank Standards as well as other international best practice requirements related to mining projects. It is thus essential that the proposed development be designed with closure in mind and that financial provision for rehabilitation and closure of the development be determined and planned for in order to ensure that the project leaves behind a positive legacy.

To this end, a mine closure plan and estimate for financial provision was prepared by REDE Engineering and Management Services (Pty) Ltd (REDE) dated September 2013. This report was based on the information available at the time of the study and should be updated periodically throughout subsequent project phases.

10.1 Closure plan objectives

The closure plan has aimed to:

- rehabilitate all disturbed land to a state that is suitable for its post closure use;
- ensure that affected areas are safe and secure for both human and animal activities;
- ensure that the physical and chemical stability of the remaining structures are such that risk to the environment through naturally occurring forces is eliminated;
- rehabilitate all disturbed land to a state where limited or preferably no post closure management is required;
- rehabilitate all disturbed land to a state that facilitates compliance with current environmental quality objectives (air and water quality); and

- limit the impact on personnel whose positions may become redundant on decommissioning of the mine

Based on the findings of the closure plan, it is recommended that the following actions be taken immediately in order to ensure adherence to the closure plan objectives mentioned above:

- A geotechnical investigation focussing on the determination of the stability of the subsistence zone has to be conducted in order to define which rehabilitation options for the subsistence zone could be feasible in order to meet the closure objectives;

- All uncertainties must be resolved and included in the report as soon as the information becomes available. These factors will have an influence on the final financial provision figures;

- Progressive rehabilitation has been included in the closure plan and the mine must ensure that provision for progressive rehabilitation is incorporated in the Project's business-case.

10.2 Closure activities

The final rehabilitation, closure and aftercare plan will be associated with the following primary activities. Where practical, some of these rehabilitation may occur during the operational phase of the mining project. Wherever possible, progressive rehabilitation should be implemented:

- Dismantling of the processing plant, administrative facilities, workshops and other buildings, which will involve the removal of all equipment for salvage or re-sale. Items with no salvage value to the mine, but which might have value to individuals will be sold. Any fixed assets that can be profitably removed, will also be removed for salvage or resale. All remaining items will be treated as waste and disposed of in a designated waste disposal area.

- All rubble and waste from the dismantling of the processing plant will be disposed of in a designated waste disposal area. This excludes any tailings or slurry dam materials;

- All structures are to be demolished or dismantled, and foundations to be removed to a minimum of 500 mm below the natural ground level. All excavations will be filled with 350 mm waste rock from the stockpiled waste material and 150 mm topsoil. Terraced areas will be cut back to a slope incline of no more than 18º; and the entire disturbed area will be ripped to a depth of 500 mm, covered with topsoil and vegetated.

- Roads will be ripped, reshaped, covered with 150 mm topsoil and vegetated. Access portals to decline shafts will be sealed with a double-layered reinforced brick wall with concrete foundation. A 1Q thick reinforced concrete plug will be used to seal ventilation shafts. All structures and ventilation equipment are to be demolished, with all terracing and foundations to be removed to a minimum of 500 mm below the natural ground level. All excavation will be filled with 400 mm waste rock and the entire rehabilitated area will be covered with 100 mm topsoil. This applies to the area where the ventilation infrastructure has been removed. Any other disturbed areas will be ripped to a depth of 500 mm, covered with 100 mm topsoil and vegetated.

- The waste dumps will remain post-closure, but all dump slopes will be reshaped from 24° to an 18 ° incline angle. Run-off control benches will be constructed on dump slopes at 35 m intervals to prevent storm water damage on the dump slope;

- The entire dump slope surface will be covered with a minimum of 100 mm topsoil and vegetated. This will serve as both a rainwater penetration cover and a dust fallout prevention measure. Paddocks will be constructed on the dump top surface to assist with evaporation and ensure the prevention of rainwater overtopping;

- Surface water diversions around the WRD footprint will be left in place during and post the mining operations as part of the general operational mining infrastructure;

- The TSF will remain post-closure, and if not constructed as such, the TSF walls will be reshaped to a slope incline of 18°. Run-off control benches will be constructed at 25 m intervals to prevent storm water damage on the dump slope;

- The entire TSF wall surface will be covered with 100 mm topsoil and vegetated to serve as an evaporative cover and prevent dust-fallout. Paddocks will be constructed on the top surface to assist with evaporation and ensure the prevention of rainwater overtopping;

- Surface water diversions around the TSF footprints will be left in place; and any associated equipment will be removed and disposed of.

- General surface rehabilitation will involve the reshaping of terraced land to a maximum 18° incline angle and to resemble the natural topography. All disturbed areas not covered specifically in the details of the closure and rehabilitation plan will at least be ripped to a depth of 500 mm, covered with 150 mm topsoil and vegetated.

- Fencing which has become redundant will be dismantled and removed for salvage. Where fencing is to be installed for post-closure safety, dismantled fencing will be used first. All concrete fence foundations will be demolished to 500 mm below original ground level. All fence lines are to be ripped to a depth of 500 mm, covered with 150 mm topsoil and vegetated where required.

- Water related infrastructure will remain post closure and be transferred to a suitable authority/owner.

- It is recommended that a geotechnical study be done to determine the stability of the depression which will inform the rehabilitation of the cone of subsidence. Depending on the geotechnical findings it is proposed that either:

    - The area be fenced off and handled as an open pit, if considered too unstable to rehabilitate. The sustainability of a fence is not beyond a decade, therefore

- A waste rock berm that would limit access by livestock such as cattle and especially people should be developed around the depression. This is however expected to be costly and needs to be assessed during feasibility phase. For example the waste rock could be dumped closer to the area of depression in order to be available post-closure.
- If stability allows standard rehabilitation measures could be implemented such as the area being ripped, levelled, covered with topsoil and vegetated thereafter but it is currently thought to be unlikely that stability would allow for this and further geotechnical investigation is warranted. .

10.3 Financial Provision

Estimates of financial provision for closure and rehabilitation, including the calculation for an end of year 1 (‘lights-out’ scenario) as well as provision for concurrent rehabilitation has been developed and will be refined as the project develops. Financial provision should be guaranteed and updated regularly (yearly) to ensure the feasibility of effective rehabilitation of the site concurrently with mining, after closure of the project, the rehabilitation of infrastructure and the post-closure maintenance and monitoring.

Please refer to Appendix 3-5 for a copy of the mine closure and rehabilitation plan and estimate of financial provision. Kindly also refer to Appendix 5 which contains indicative costs related to the recommended environmental monitoring

11 CONCLUSION

The purpose of this Report and the specialist studies associated therewith is to evaluate the existing socio-economic and biophysical baseline environments of the proposed project site in order to determine the potential environmental impacts of the proposed project on the receiving environment and to identify possible mitigation measures which should form part of project implementation in order to ensure that the identified potential environmental impacts are avoided or minimised to acceptable levels, and that potential positive impacts are enhanced.

11.1 Regulatory summary and way forward

There are a number of regulatory requirements pertaining to environmental management to which the proposed development will have to conform. Licenses and permits that have thus far been identified in terms of environmental management legislation that are required in terms of the development of the proposed project are:

- Environmental Authorisation (ZEMA)
- Mining Right (ZEMA and the MMDA)
- Water Use Authorisation (ZEMA and the Water Board and/or WUA)

This report is the environmental impact statement compiled in accordance with the abovementioned legislation and international best practice principles.

Additional authorisations may be required for project related infrastructure required off-site for the project to continue, such as access road construction, power supply and water supply. Should it come to light that Blackthorn would become the responsible party to construct or upgrade roads in the area (currently planned by the Roads Development Agency) or provide electricity supply infrastructure (currently planned by ZESCO), the need for additional environmental impact assessments and approvals will have to be determined.

Two primary water supply options have been identified for the proposed project. Favourable groundwater units were delineated towards the north of the project area and it is plausible that the project may source the required make-up water demand (4 1177m3/d or 48 ℓ/s) from here through a network of boreholes and associated pipe network to the project site. Alternatively it was investigated to abstract water from the Kafue river and convey abstracted water to the site via a pipeline. No environmental fatal flaws have been identified in this study, however, a number of factors have been identified which require further investigation, consideration and/or incorporation into the current project design. These are discussed in this report and the specialist reports appended hereto.

11.2 Conclusion

This EIS report was prepared by Africa Geo Environmental Services Gauteng (Pty) Ltd (AGES) and is submitted to the Zambian Environmental Management Agency (ZEMA) and other relevant authorities in Zambia for consideration of the project and the relevant way forward from an environmental impact management perspective.

This report is in support of applications for environmental authorization, water use permissions and a mining right for the project on behalf of Blackthorn, and has been prepared in accordance with Zambian law.

From an environmental management point of view, the finalization and submission of the EIS report following additional consultation with relevant stakeholders, is the next step in the environmental permitting and licensing aspect of the AGES scope of work. AGES will liaise with ZEMA in this regard should ZEMA so require.

No fatal flaws have been identified in terms of environmental management considerations, a number of follow-up and additional studies need to be conducted as part of future project phases have been recommended in this report, and it is therefore recommended that the project progresses from an environmental management point of view.

12 APPENDICES

Appendix 1: Consultations with ZEMA

Appendix 2: Public Participation

Appendix 3: Copies of Specialist Studies

Appendix 4: Details of the EIA Team

Appendix 5: Costs associated with monitoring and mitigation discussed in Section 9

13 REFERENCES

Aucamp, S. (2012). Proposed Kitumba Copper Mine: Social Baseline Study. Pretoria: Ptersa Environmental Management Consultants.

Aucamp, S.-M. (2013). Proposed Kitumba Copper Mine: Social Impact Assessment. Pretoria: Ptersa Environmental Management Consultants.

Central Statistical Office - Republic of Zambia. (February 2011). Zambia 2010 Census of Population and Housing - Preliminary population figures. Lusaka: Republic of Zambia - Central Statistical Office.

Central Statistical Office. (2012). Inflation: The Revised Consumer Price Index records January 2012. The Monthly, 106.

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

Chapman, K., & Walmsley, B. (2003). Zambia. In P. Tarr, Environmental impact assessment in southern Africa - A SAIEA publication. Windhoek: Southern African Institute for Environmental Assessment (SAIEA).

Cilliers, M., & Young, G. (June 2013). Visual Impact Assessment for the proposed Kitumba Copper-Gold Project, Central Province, Zambia. Gauteng: Newtown Landscape Architects.

DEAT. (2004). Criteria for determining Alternatives in EIA, Integrated Environmental Management, Information Series 11. Pretoria: Department of Environmental Affairs and Tourism (DEAT).

Gerritsen, T. (19 June 2013). Kitumba Copper Project - Water Management. Ref: BR301-00458 M TLG13007. Queensland: Knight Piesold Consulting.

Havenga, C. (June 2013). Traffic Impact Assessment: Kitumba Copper-Gold Project. Gauteng: Corli Havenga Transportation Engineers.

Henning, B. (2012). Draft Environmental Baseline Report on the Soils, Agricultural Potential and Land Capability for the proposed Kitumba Copper-Gold Project, Mumbwa District, Central Province, Zambia. Polokwane: AGES.

Henning, B. (2012). Environmental Report on the Ecology (Flora and Fauna) and Wetlands for the proposed Kitumba Copper-Gold Project, Central Province, Zambia. Polokwane: AGES.

Henning, B. J. (May 2013). An Environmental Specialist Report on the Biodiversity for the Proposed Kitumba Copper-Gold Project, Mumbwa District, Central Province, Zambia. Gauteng: AGES.

Kruger, N. (2012). Baseline Heritage Study / Sensitivity Analysis: Kitumba Copper-Gold Project, Mumbwa District, Central Province, Zambia. Gauteng: AGES.

Kruger, N. (May 2013). Heritage Impact Assessment for the Kitumba Copper-Gold Project, Mumbwa District, Central Province, Zambia. Gauteng: AGES .

Liebenberg-Enslin, H., & Gresse, N. (2013). Air Quality Impact Assessment for the proposed Kitumba Copper-Gold Project in Mumbwa District, Central Province, Zambia. Gauteng: Airshed Planning Professionals (Pty) Ltd.

Lungu, J. (2009). The Politics of Reforming Zambia's Mining Tax Regime. Resource Insight(No 8), 1 - 27.

Minarco MineConsult. (2012). Blackthorn Resources Limited: Kitumba Copper Project, Zambia - Mine Scoping Study.

Mndaweni, S., Vermeulen, D., & Rowland, A. (November 2009). BHP Billiton, Zambia Mumbwa Copper-Gold Project Hydrogeological Investigation Mumbwa Water Supply. Rivonia: Knight Piesold Consulting.

Mostert, J., & Vivier, J. (2012). MSA Kitumba Copper Project: Geohydrological Baseline Study. Gauteng: AGES.

Republic of Zambia, C. (2012, January). Selected Socio-Economic Indicators. The Monthly, 106, 15 - 23.

Robertson, M., Hall, M., & Gallant, L. (July 2012). JORC Competent Persons Report - Kitumba Mineral Resource Estimate. The MSA Group.

Rowles, T. (18 June 2013). Kitumba Copper Project - Review of AGES Report G12-113-2013-05-23. Queensland: Knight Piesold Consulting.

The World Bank. (2011, July). worldbank.org. Retrieved August 6, 2012, from The World Bank: http://siteresources.worldbank.org/INTZAMBIA/Resources/copper-mining-summary-note(online-copy).pdf

Van Zyl, B. (May 2013). Kitumba Copper Project in the Mumbwa District, Central Province, Zambia: Noise Study for Environmental Impact Assessment. Gauteng: Acusolv.

Vivier, J., & Mostert, F. (June 2013). Hydro-Geological Impact Assessment for the proposed Kitumba Copper Project. Gauteng: AGES Gauteng Pty Ltd.

Walmsley, B., & Tshipala, K. E. (2007). Handbook on Environmental Assessment Legislation in the SADC Region. Midrand: The Development Bank of South Africa in collaboration with the South African Institute for Environmental Assessment.