SECTION XIV: INDEPENDENT TECHNICAL REPORTS

SUB-SECTION D: MOPANI REPORT

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04 May 2011

GLENCORE INTERNATIONAL PLC

Mopani Copper Mines Plc

REPORT

Submitted to:
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MINERAL EXPERT'S REPORT: MOPANI COPPER MINES Plc

Dear Sirs

PURPOSE OF REPORT

Golder Associates Africa (Pty) Ltd ("GAA") has been commissioned by Glencore International AG ("Glencore"), to prepare a Mineral Expert's Report ("MER") in respect of the mining assets owned by and operated by Mopani Copper Mines Plc ("MCM") (the "Material Assets") a company in which Glencore has an interest. Glencore International plc is expected to be the ultimate parent company of the group.

The Material Assets of MCM comprise of the following:

- Mining assets:
  - Nkana underground mines: the Central Shaft, the South Ore Body, the Mindola Sub-vertical and the Mindola North Shaft; and
  - Nkana open pit mines (Area A, Area D and Area J) (together the "Nkana Mine");
  - Mufulira underground mine; and
  - Mufulira East and West portals (together the "Mufulira Mine").
- Processing assets:
  - a sulphide copper-cobalt concentrator at Nkana ("Nkana concentrator");
  - an oxide copper agitation leach-solvent extraction plant at Nkana ("Nkana Leach' Plant");
  - a cobalt plant which incorporates a copper solvent extraction and an Electro-Winning ("EW") tank house ("Cobalt Plant");

- a sulphide copper concentrator at Mufulira ("Mufulira concentrator");
- an oxide copper agitation leach-solvent extraction plant at Mufulira ("Mufulira Leach Plant");
- an IsaSmelt smelter and refinery at Mufulira.

This MER has been prepared by a team of Competent Persons ("CPs") with each team member possessing the appropriate technical and professional qualifications.

This report, which summarises the findings of GAA's review, accords with the requirements set out in the United Kingdom Financial Services Authority's Prospectus Rules ("Prospectus Rules") and has been prepared having regard to the recommendations for the consistent implementation of the European Commission's Regulation on Prospectuses No. 890/2004 (the European Securities and Markets Authority ("ESMA") recommendations) published by the Committee of European Securities Regulators (now the ESMA, as updated on 23 March 2011 following the publication of a consultation paper in April 2010 in relation to content of prospectuses regarding mineral companies) and Chapter 18 of the Hong Kong Listing Rules.

GAA understands that this MER will be included as part of the prospectus (the "Prospectus") to be published in connection with a global offering of shares and the admission of the ordinary shares of Glencore International plc to the Official List of the United Kingdom Financial Services Authority ("FSA") and the admission of such shares to trading on the London Stock Exchange plc's ("LSE") market for listed securities and the main board of the Hong Kong Stock Exchange Limited (together, "Admission").

This MER provides an audit of the mineral resource estimates, classification of resources and reserves (to the extent applicable) and evaluation of the Material Assets.

The practices and estimation methods undertaken by GAA are in accordance with the criteria for internationally recognised reserve and resource categories of the "Australasian Code for Reporting Mineral Resources and Ore Reserves" (2004) published by the Joint Ore Reserves Committee ("JORC") of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and the Minerals Council of Australia (the "JORC Code").

In addition, GAA is of the opinion that such practices and estimations accord with the requirements set out in the FSA's Prospectus Rules in conjunction with the ESMA recommendations (including proposed amendments thereto). In this report, all reserves and resources estimates, initially prepared by MCM in accordance with the JORC Classification, have been substantiated by evidence obtained from GAA's site visits, interviews, own data collection, analysis and modelling. Where appropriate, GAA has relied on previous work done on MCM by other experts.

CAPABILITY AND INDEPENDENCE

GAA has 50 years of mining and engineering expertise built up on 6 continents. GAA operates as an independent technical consultant providing resource evaluation, mining engineering and mine valuation services to clients. GAA has received, and will receive, professional fees for its preparation of this report. However, neither GAA nor any of its directors, staff or sub-consultants who contributed to this report has any interest in:

- The Company, Glencore, MCM or any of their subsidiaries; or
- The Material Assets reviewed.

Drafts of this report were provided to the Company and MCM, but only for the purpose of confirming both the accuracy of factual material and the reasonableness of assumptions relied upon in the report.

For the purposes of Prospectus Rule 5.5.3R(2)(f), GAA is responsible for this report as part of the Prospectus and declares that it has taken all reasonable care to ensure that the information contained in this report is, to the best of its knowledge, in accordance with the facts and contains no omission likely to affect its import. This declaration is included in the Prospectus in compliance with item 1.2 of Annex I and item 1.2 of Annex III of the Prospectus Directive Regulation.

This MER has been prepared based on a technical and economic review by a team of consultants and associates sourced from the GAA's Johannesburg offices. Details of the qualifications and experience of the consultants who carried out the work are included in the Report.

METHODOLOGY

The methodology used to compile this report consists of the following:

- Site visits conducted by GAA representatives between October and December 2010 to inspect the mine site (open pits and underground workings), plant and processing facilities, waste dumps and tailings facilities in order to audit technical content of previous technical teports and studies conducted for and on behalf of MCM and where necessary for GAA staff to evaluate current requirements and future developments;
- Interviews with various senior MCM managers;
- GAAs own data analysis, engineering, financial, resource, mining and resource modelling; and
- Reliance on previous technical studies and experts reports.

The information contained in this report is current and effective from 1 January 2011, unless otherwise indicated. The results of GAA evaluation are as set out in this MER.

All opinions, findings and conclusions expressed in this report are those of GAA and its sub-consultants.

DECLARATIONS

GAA will receive a fee for the preparation of this MER in accordance with normal professional consulting practice. This fee is not contingent on the outcome of Admission and GAA will receive no other benefit for the preparation of this report. GAA does not have any pecuniary or other interests that could reasonably be regarded as capable of affecting its ability to provide an unbiased opinion in relation to the mineral resources, ore reserves and the valuation of Material Assets.

GAA does not have, at the date of this report, and has not previously had any shareholding in or other relationship with the Company, Glencore or MCM and consequently considers itself to be independent of the Company, Glencore and MCM.

The results of the technical and economic reviews are summarised herein.

GLOSSARY OF TERMS

Defined and technical terms used in this report are set out in Appendix A of the MER.

QUALIFICATIONS OF CONSULTANTS

The individuals listed in the table below, have provided input to this MER are Qualified/ Competent persons as defined in the JORC Code, United Kingdom Financial Services Authority's Prospectus Rule, European Commissions Regulation on Prospectus No. 890/2004, and Chapter 18 of the Hong Kong Listing Rules and have extensive experience in the mining industry and are members in good standing of appropriate professional institutions.

Name	Company	Qualification
Peter Onley	GAA	MBA, MSc, BSc(Hons), FAusIMM, CP Peter Onley has more than 40 years experience in the

Name	Company	Qualification
		mining industry holding qualifications in geology, geotechnical engineering and business. He has worked in a variety of roles, starting as an exploration geologist, a mining geologist, exploration manager, mineral industry consultant, business manager and director of two Australian listed companies. He has worked as a mining industry consultant for over 25 years. He was formerly a director of Golder Associates Pty Ltd employing more than 800 staff in Australia. He has consulted to the industry on a wide range of commodities including diamonds, gold, uranium, iron-ore, bauxite, base metals and both sulphide and lateritic nickel together with some minor commodities such as molybdenum and tungsten. He has for some years been a member of the Geological Survey Liaison Committee which reviews and advises on future work programs for the Geological Survey of Western Australia. He is also a member of the AusIMM Geoscience Committee.
Willem van der Schyff	GAA	BSc (Geology), GDE (Mine Engineering) Willem is an Associate with Golder Associates, the Business Unit Leader for the Mining Services Business Unit and a geologist specialising in resource modelling and evaluation. He has 20 years experience on diverse commodities, ranging from Iron Ore, Coal, Heavy Mineral Sands, Base Metals, Gold, Bauxite and Industrial Minerals, on five continents. This experience includes exploration geology, mining geology and resource modelling and estimation. He is a registered Professional Geologist with the South African Council for Natural Scientific Professions and is a member of the Geological Society of South Africa.
Jaco Lotheringen	Ukwazi	B Eng Mining Engineering (UP), Mine Manager's Certificate of Competency Jaco is currently a director of Ukwazi Mining and is its senior mine engineer. He has 12 years mining experience and has been involved in resource estimates, mine feasibility and mine design studies for the past 6 years for major mining companies such as Kumba, BHP Billiton and Anglo Platinum. His professional memberships include: Registered as a Professional Engineer at Engineering Council of South Africa (20030022); Registered as a Member at South African Institute of Mining and Metallurgy (SAIMM)

Name	Company	Qualification
		(701237). Member of the Institute of Directors in South Africa. Jaco has specific commodity experience in precious metals (gold, platinum), base metals (iron and copper) and minerals such as coal.
Anthony James Nieuwenhuys	SNC Lavlin	BSC (Eng) MDP Anthony James Nieuwenhuys is Managing Director – SNC-Lavalin South Africa with over 30 years of extensive experience in managing international multi-disciplinary projects in the mining, metallurgical and beverage sectors. This experience includes both technical and financial aspects of major projects. Mr Nieuwenhuys' management capabilities include sourcing and arranging financing for projects, strong organizational and interpersonal skills, leadership, initiative, marketing, managing a multi-disciplinary engineering company and the ability to work in different business environments. On the technical side, James has extensive experience in the design, construction and operational aspects of most metallurgical facilities and has specific mining and commodity experience in respect of gold, nickel, diamonds and cobalt.

This report was prepared by GAA in order to support the mineral reserve and resource information contained in the Prospectus. The project manager of this technical report was Spencer Eckstein and the project director was Frank Wimberley.

Yours Faithfully,

GOLDER ASSOCIATES AFRICA (PTY) LTD.

Frank Wimberley
Project Director

Willem van der Schyff
Competent Person

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1.0 EXECUTIVE SUMMARY

1.1 Introduction

Golder Associates Africa (Pty) Ltd ("GAA") was commissioned by Glencore International AG ("Glencore"), in November 2010 to prepare a Mineral Experts Report ("MER") in respect of mining assets owned and operated by its subsidiary company, Mopani Copper Mines Plc ("MCM"). Glencore owns 73.1 per cent of MCM with the remainder of the business being owned by First Quantum Minerals Ltd. (16.9 per cent) and ZCCM Investments Holdings Plc (ZCCM-IH 10%). Glencore International plc is expected to be the ultimate parent company of the group.

The purpose of the MER is to assist Glencore by providing it with a technical report, which evaluates the nature and value of the mining assets held by it in order to assist it in its bid to a list Glencore International plc on the London and Hong Kong Stock Exchanges.

This MER has been prepared in accordance with the Australasian Code for Reporting of Exploration Results Mineral Resources and Ore Reserves" (2004) published by the Joint Ore Reserves Committee of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and the Minerals Council of Australia.

The methodology used to compile this report consisted of the following:

- A four site visits between October and January 2011 by various representatives of GAA to inspect the mine site (open pits and underground workings), plant and processing facilities, waste dumps and tailings facilities;
- Interviews with various senior MCM managers from both Nkana and Mufulira;
- GAA's own data analysis, engineering, financial, resource, mining and resource modelling;
- Reliance on previous technical studies and experts reports.

The information contained in this report is current and effective from 1 January 2011, unless otherwise indicated. The results of GAA evaluation are set out below.

Property Description and Location

This MER covers the following operations, projects and associated infrastructure of Mopani located in the Copperbelt province in Zambia which are collectively referred to herein as the "Material Assets", which are listed below:

- Mining assets:
  - Nkana underground mines: the Central Shaft, the South Ore Body, the Mindola Sub-vertical and the Mindola North Shaft; and
  - Nkana open pit mines (Area A, Area D and Area J) (together the "Nkana Mine");
  - Mufulira underground mine; and
  - Mufulira East and West portals (together the "Mufulira Mine").
- Processing assets:
  - a sulphide copper-cobalt concentrator at Nkana ("Nkana concentrator");
  - an oxide copper agitation leach-solvent extraction plant at Nkana ("Nkana Leach' Plant");
  - a cobalt plant which incorporates a copper solvent extraction and an Electro-Winning ("EW") tank house ("Cobalt Plant");

- a sulphide copper concentrator at Mufulira ("Mufulira concentrator");
- an oxide copper agitation leach-solvent extraction plant at Mufulira ("Mufulira Leach Plant");
- an IsaSmelt smelter and refinery at Mufulira.

- Related Infrastructure necessary for the production of saleable metals.

The geographical location for the site is set out below.

1.2 Ownership

Glencore owns 73.1 per cent of Mopani with the remainder of the business being owned by First Quantum Minerals Ltd. (16.9 per cent) and ZCCM Investments Holdings Plc (ZCCM-IH) (10.0 per cent).

1.3 History

Nkana has been in operation since 1931 and Mufulira, has been in operation since 1933. The Nkana Mine site is located near the town of Kitwe on the Copperbelt, Zambia. Mufulira lies 50 kilometres north of Kitwe.

In 2000, Mopani purchased the ZCCM assets at Mufulira comprising of an Underground Mine, concentrator, Smelter, and Refinery and at Nkana, which include the Underground Mines, concentrator and Cobalt Plant from the Government of the Republic of Zambia ("GRZ").

Products

The Nkana Mine produces copper and cobalt ore from four sources: North Shaft, Mindola Sub Vertical, Central Shaft and South Ore Body ("SOB"). In addition, Nkana produces copper from open pits, namely area A, D and J. At Mufulira, the sources of copper are Mufulira Shaft, Mufulira East and Mufulira West and extraction is based on two different types of Mining Operations; the first is the original drill and blast underground mining method and the second, newly commissioned type, is the Leaching method.

1.4 Legal Tenure

Mopani currently has two large scale mining licences, which entitles it to operate these two mines and its associated infrastructure in compliance with current Zambian Mining Legislation.

Name	License Number	Issue Date	Expiry Date	Status
Nkana	7625 HQ – LML	31 March 2000	31 March 2025	Valid
Mufulira	7073 HQ – LML	31 March 2000	31 March 2025	Valid

1.5 Resource Model

Geology

The Zambian Copperbelt lies at the south-eastern end of the 800 kilometres long Lufilian fold belt. It comprises deformed rocks of the late Precambrian Katanga system draped around the flanks of a major northwest trending late-tectonic structural feature, the Kafue Anticline. Various elements of the Basement Complex are exposed in the core of this Anticline. As a result of the Lufilian orogeny, the Katanga rocks have been thrown into a series of long narrow en echelon folds and late tectonic dome and basin like structures. The Chambishi-Nkana basin lies about midway on the southern flank of the Kafue Anticline and is elongated in a north-westerly direction.

The Nkana mining area covers the north-westerly plunging Nkana syncline, which forms a south-eastward prolongation to the Chambishi-Nkana Basin. The deformation of the rocks of the Nkana mining area is related almost completely to the Lufilian Orogeny, which affected both the pre-Katanga and Katanga rocks. Little is known about the pre-Lufilian tectonic history of the Basement Complex within the mining area, and so the following description is confined to a summary of the Lufilian structures.

The predominant mega-structure of the mining area is the northwest-plunging Nkana syncline. This structure is asymmetric, with a curved axial plane inclined steeply to the northwest in the trough of the syncline but upright to westward dipping at higher structural levels. A complex occupies the axial zone of the syncline but this folding dies out on its flanks. As a result of the north-westerly plunge of the Nkana syncline, the present land surface represents a horizontal section through progressively higher structural levels of the syncline from southeast to northwest.

The rocks of the Mufulira Basin are asymmetrically folded, moderately dipping on the south western flank and sub vertical on the north eastern limb, outcropping at Mokambo on the DRC border. The Roan sediments in the Mufulira syncline in the vicinity of the mine dip at approximately 45º to the north east. Small folds and minor faults are present within the mine area. The Lower Roan arenaceous quartzites and greywackes are the host rocks to the copper mineralisation.

Mineralisation

Within the Nkana mining area there are four underground mines and four open pits. All are situated on the north-eastern limb of the Nkana Syncline area. Other cupriferous zones are present in the nose and southwest limb of the syncline. The orebodies are stratiform and are mainly confined to a recognisable ore formation, which occurs near the base of the Katangan sequence within the Lower Roan Group of the Mine Series.

In the underground workings, the principal copper ore minerals are chalcopyrite and bornite with subordinate chalcocite. There is a zoning in the geographical distribution of these minerals. Cobalt occurs as carrollite and cobaltiferious pyrite. The principal ore minerals are malachite, pseudomalchite, chrysocolla, native copper, cuprite and libethenite. In the open pit, malachite and chrysocolla are the principal ore minerals in the zone of oxidation closer to the surface. In some places however, vermiculite, malachite pseudomalachite and accessory wad are more important. At deeper levels chalcopyrite, bornite and chalcocite predominate are present

In the Mufulira mining area, the Basement complex topography appears to have exerted a significant structural control during deformation. The distribution of ore minerals in all three ore bodies is stratigraphically controlled, occurring dominantly as disseminations, blebs and irregular masses. The principal copper minerals are chalcopyrite (60%), bornite (40%), and minor/trace chalcocite. Oxide minerals are confined to near surface occurrences, and supergene enrichment zones. Generally the deposit is structurally simple being characterised by three main folds that are in part overturned with a plunge and dip approximately 10º the northeast. The basin is open and untested at depth.

Mineral Resources and Ore Reserves

With effect from 1st January 2011, Mopani collectively has a total of Measured Mineral Resource and Indicated Mineral Resources of 218 Mt of ore with a grade of 2.02% TCu, 0.23 % ASCu and 0.11% TCo as described in the table below:

Mopani Mineral Resources as at 31st December 2010

	Nkana				Mufulira				Total			
	Mt	%TCu	%TCo	%ASCu	Mt	%TCu	%TCo	%ASCu	Mt	%TCu	%TCo	%ASCu
Measured	145.8	2.00	0.10	0.25	28.2	2.18	-	0.28	173.9	2.01	0.10	0.25
Indicated	34.5	1.80	0.14	0.07	9.9	2.62	-	0.31	44.3	1.93	0.14	0.11
Measured and Indicated	180.3	1.96	0.11	0.21	38.1	2.30	-	0.28	218.2	2.02	0.11	0.23
Inferred	35.4	1.65	0.14	0.06	37.6	2.62	-	0.11	73.0	2.12	0.14	0.09

1) Mineral Resources have been reported in accordance with the classification criteria of the JORC Code.

2) Mineral Resources are quoted inclusive of Mineral Ore Reserves.

3) Mineral Resources are not Mineral Ore Reserves and do not have demonstrated economic viability.

1.6 Reserves Estimate

Set out below are the reserve estimates for Nkana and Mufulira.

Nkana

Underground mining operations at Mopani Copper Mines Plc ("MCM") consist of four active operating underground mines. The underground mining operations are accessed by shafts namely Central, Mindola Sub-vertical ("SV"), SOB and Mindola North Shaft ("MNS"). Underground mining operations started in 1931 with the oldest operating shaft being Central Shaft. The mining methods used include Vertical Crater Retreat ("VCR"), Sub-Level Caving ("SLC"), and Longitudinal Room and Pillar ("RAP"). Average underground production for the last five years is 3.4 million tonnes per annum ("Mtpa") of ore at 1.94 %Cu and 0.12 %Co.

Area A pit is an expansion of Mindola open pit to the south. Depletion of the pit is expected by June 2011 at 40 000 tonnes of ore and 120 000 tonnes of waste per month. Area D is an oxide cap above the Mindola Sub –Vertical Shaft underground workings. The scheduled production from this pit is 40 000 tonnes of ore and 220 000 tonnes of waste per month. Pit depletion is expected by February 2011. Area J started stripping waste in 2010 and currently produces low grade ("LG") ore from the top benches. Oxides below the planned pit bottom are planned for exploitation by underground methods with pit access.

A historical cut-off grade of 1%TCu is applied in all underground mining areas and a true thickness cut-off of 10m% constraint used in thin ore bodies. Mining relative modifying factors and efficiencies vary based on the mining method and ore body mined. Mining recovery ranges from 54% localised to Mindola North to 95% at Central shaft. Dilutions vary from 5% at South syncline to 20% in the SOB upper levels. Extractions vary from 70% to 100% at Nkana.

A total of 2.9 million Run of Mine ("ROM") tonnes was produced from all operations in 2009 at 1.85% Cu. The sulphide ore combined open pit and underground schedules deliver a ROM head grade of 1.83% Cu for a total of 108.1 million tonnes of ROM ore up to the year 2035. Production from the open pit operations is planned up to 2012. The peak production rate from underground operations is 5.1 million tonnes per annum from 2018 to 2026 on ore and 1.2 million tonnes per annum on waste in 2014.

The oxide ore mineral reserve is estimated at 2.6 million tonnes proved and probable mineral reserves at 3.66% Cu and 0.13% Co. The sulphide ore mineral reserve is estimated at 108.1 million tonnes proved and probable mineral reserve at 1.83% Cu and 0.12% Co. Resources were converted based on the mine plan with a diluted grade greater than 1% Cu.

	Proved Reserve				Probable Reserve			
Ore type	Mt	% TCu	% ASCu	% TCo	Mt	% TCu	% ASCu	% TCo
Oxide ore	1.8	4.02	2.89	0.14	0.8	2.84	2.10	0.10
Sulphide ore	92.3	1.84		0.10	15.9	1.80		0.23

Mufulira

The mining methods employed at Mufulira Mine are variants of Mechanised Continuous Retreat ("MCR"). The variant mining methods are Mechanised Continuous Retreat 1 ("MCR1") and Mechanised Continuous Retreat 2 ("MCR2"), employed at Mufulira West and Mufulira Central. RAP mining is employed at Mufulira East. Mining of the Mufulira ore bodies is divided into three areas:

- Mufulira East;
- Mufulira Central; and
- Mufulira West.

Mufulira Central is further sub divided into the Upper, Central and Deeps areas, based on elevation.

Historical cut-offs of 4m true thickness and 2% TCu are applied at Mufulira before applying mining related modifying factors. Internal blocks with grades less than 1% were included in the reserves as internal stope dilutions. Mining efficiencies and mining related modifying factors include dilution, mining recovery and mining extraction. The mining recovery is 83% on average while extraction varies from 82% to 94% based on the mining method and ore body type. Dilutions vary from 18% to 30%.

A total of 1.6 million ROM tonnes were produced from the underground operations in 2009 at 2.0% Cu. The underground schedule delivers a ROM head grade of 2.7% Cu for a total of 12.3 million tonnes of ROM ore up to the year 2022. The bulk of the LOM production tonnes are produced from Mufulira Central Deeps at 1.0 million ROM tonnes per annum from 2015 to 2022.

The mineral reserve is estimated at 10.6 million tonnes proved and probable reserves at 2.6% Cu and 1.0% ASCu.

Proved Reserve			Probable Reserve		
Mt	% TCu	% ASCu	Mt	% TCu	% ASCu
8.1	2.51	0.96	2.5	2.96	-

1.7 Plant and Equipment

At Nkana Mopani operates a concentrator, Cobalt Plant and Leach plants. Conventional methods are employed in the concentrator namely; crushing, grinding, flotation and dewatering. Copper and cobalt concentrates are produced from a bulk concentrate by a segregation process. At Nkana, the concentrator operates in a conventional manner, and has a capacity of 12 000 mt per day. Primary stage crushing of ore is done underground while the secondary and tertiary stage crushing takes place at the concentrator. Ball mills grind the crushed ore for subsequent flotation to produce a copper concentrate grade of approximately 30%.

At Mufulira there is a full complement of metallurgical facilities. The Mufulira concentrate is approximately 41%. At Mufulira, the concentrator operates in a conventional manner, and has a capacity of 8 350 mt per day. The copper concentrate conveyed into the Isasmelt furnace is a blend of concentrate from Nkana and Mufulira as well as from 3rd party tolled concentrate. This process produces Matte and Slag which in turn is channelled to the matte settling furnace ("MSEF") for settling into separate copper matte and slag phases. The resultant matte is transferred to Converters. Blower air is injected into the Converters through tuyeres to remove sulphur and iron. The product, blister copper, is then fire-refined in Anode Furnaces.

Mufulira copper anodes are treated in the Mufulira electrolytic refinery to produce high quality copper cathodes ("MCM" LME brand) for onward sale. The three SX Plants at the Refinery treats PLS from the Vat Leach and Leach operations for the production of copper cathodes at the EW section in the newly constructed tank house.

In terms of the economic valuation as set out below, this includes the value of the plant and equipment.

Concentrator recovery at Nkana is approximately 92.5%. The concentrator recovery at Mufulira is approximately 94%.

1.8 Closure

A closure assessment was conducted on both Nkana and Mufulira. The assessment was based on the mine infrastructure footprint and associated battery limits. The closure costs also take into account the rehabilitation required in terms of the mine property, operations, waste facilities and other relevant land uses. The indicative closure costs for Nkana and Mufulira are tabulated below.

Closure Assessment	Assessed Closure Cost
Nkana	USD 24,56m
Mufulira	USD 27,05m
Total Mopani	USD 51,6m

Reliance has been placed on previous expert reports, technical studies and costs estimates for closure, notably Scott Wilson. In the light of the differences in methodology and the cost estimates between Scott Wilson and GAA, it was recommended that the fair and reasonable financial provision for Mopani would be approximately USD 51m.

1.9 Environmental Review

Nkana

The environmental assessment focused only on critical environmental and social issues, so as to identify risks that could be major liabilities.

Key Results of the Audit

The limitations of this audit notwithstanding, the following conclusions were reached in regards environmental and social management at Nkana Mine:

- The environmental performance of Nkana Mine is compliant with its environmental licence and Environmental Management Plan ("EMP") conditions.
- Environmental impacts which generally exceed licence conditions and pose a risk to Nkana Mine operation in terms of compliance to statutory requirements and the Equator Principles[1] include:
  - Effluent discharge to the environment, particularly from the acid plant and Cobalt Plant, high Cu and Co concentrations to the North Uchi Stream which drains to the Kafue River. It would appear that a significant component of this risk could be managed by ensuring that tailings thickener overflow pH is at least 8.5 and that the Cobalt Plant concentrates is stored under cover prior to slurrying and roasting; As mitigation a dedicated lime plant for the Nkana Leach Plant has been installed to ensure effective neutralisation of leach residue disposed through concentrator Tailings Thickener ("TT"). It is envisaged that this will ensure that TT overflow wastewater into North Uchi is in compliance as regards dissolved copper, cobalt and manganese. In addition in respect of Mindola SV Shaft, Nkana plans to install a filter press underground for filtering out the suspended solids in the water prior to pumping to surface. The filter cake will either be mixed with ore or if of no value mixed with waste rock for disposal (due in 2011).
  - Spillage of tailings from the tailings pipeline, booster pump station and/or tailings bleeds points to the adjacent two streams. As mitigation spilled tailings have been cleaned and deposited in the operating tailings dump (TD15A); and
  - Venting of flue gas from the Cobalt Plant direct to the atmosphere rather than via the acid plant results in SO_2 emissions consistently exceeding the long term limit of 1 000 mg/Nm^3. As mitigation a various options to address the sulphur dioxide emissions are being considered, this includes Gas scrubbing to remove the SO_2 and thereafter neutralise the acidic water before disposal.
  - It is envisaged that when the Synclinorium Project comes on line in 2015, the sulphur in ore and hence in Cobalt concentrates will improve to allow for the operation of the acid plant.

[1] The Equator Principles (EPs) are a voluntary set of standards for determining, assessing and managing social and environmental risk in project financing adopted by the international financial industry (see: ww.equator-principles.com)

- Mopani is complying with its commitment to manage social issues and promote sustainable development within the limits that could reasonably be expected of a private company.
- The management of community expectations driven by legacy issues is a critical factor affecting the long term relationship between the mine and the community.

Mufulira

The environmental assessment focuses only on critical environmental and social issues, so as to identify risks that could be major liabilities. Wherever possible, existing documentation has been used as a basis for conclusions drawn.

Key Results of the Audit

The limitations of this audit notwithstanding, the following conclusions were reached in regard to environmental and social management at Mufulira Mine:

- The environmental performance of Mufulira Mine is compliant with its EMP and licence conditions;
- The quality of the combined effluent streams exiting the mine boundary is compliant;
- Environmental impacts which exceed licence conditions and pose a risk to Mufulira Mine operations in terms of compliance to statutory requirements and the Equator Principles include:
  - The quality of tailings dam discharge is at times non compliant due to incomplete neutralisation of raffinate bleed, which is routed to the tailings thickener for disposal with the tailings. As mitigation the focus is on planting of vegetation on areas of TD11 dump which will not be deposited with tailings in the future e.g. the southern embankment. Rate and extending of annual planting is being intensified since the last two rainy seasons.
- Mopani is complying with its commitment to manage social issues and promote sustainable development within the limits that could reasonably be expected of a private company.
- The management of community expectations driven by legacy issues is a critical factor affecting the long term relationship between the mine and the community.

1.10 Economic Evaluation

An economic evaluation presents a valuation of MCM. Glencore owns 73.1% of MCM. The valuation presented here is a valuation of Glencore's Interest in MCM, being the sum of the 73.1% Equity Value in MCM and Shareholder Loans provided to MCM.

Revenue, Capital and Operating Cost Estimates

Production levels of copper and cobalt for Mopani are based on the mine plans for the various operations and the historical recoveries from the processing plants. Metals prices were provided by Glencore. Operating cost estimates were based on contractual, current and budgeted costs.

Capital expenditure is required for sustaining current and future mining operations and related infrastructure, which include a range of Special Projects:

Special Projects: Capital expenditure for numerous projects across mining, plant and services, including:

- Major overhauls such as the rebuilding of the tank house at the refinery, the rebricking of ISA every 2 years and rebricking of the MSEF every 4 years.
- New operating assets, such as ISA Smelt, MSEF, Acid Plant, Anode Furnaces and Casting Wheels, Converters, Smelter water pipeline to the Kafue.

- Expansion Projects such as Synclinorium Shaft and related infrastructure, Area J open pit stripping, Insitu leach mine and process plants.

Capital Expenditure for Mopani

USD Million	2010 Actual	2011	2012	2013	2014	2015	2016 - 2035	Total (2011 – 2035)
Total Capex	129.6	182.6	178.0	151.1	157.2	74.6	733.3	1,476.8

1.11 Valuation

The valuation was done at a discount rate of 10%, base date 1 January 2011. Based on a 73.1% in MCM and outstanding shareholder loans, Glencore’s economic interest in MCM is USD 1,922 million.

1.12 Mopani MER Extraction Table

Group level	2008A[2]	2009A	2010A	2011E	2012E	2013E	2014E	2015E
Finished metal production capacity (tonnes) - actual / forecast								
Copper	285,000	285,000	300,000	300,000	300,000	300,000	300,000	300,000
Cobalt	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
Finished metal production (tonnes) - actual / forecast								
MCM Metal (own sources)								
Copper	110,261	98,319	94,439	110,630	103,504	100,530	107,515	103,611
Cobalt	1,458	1,271	789	1,331	1,303	1,218	1,215	1,327
MCM Metal (purchases)								
Copper	8,952	2,105	7,941	23,784	7,836	7,835	7,836	7,836
Cobalt	0	0	303	858	858	858	858	858
Toll Treatment								
Copper	46,205	84,248	95,056	101,581	99,151	133,588	116,984	130,716
Cobalt	0	0	0	0	0	0	0	0
Operating Cost[3]	**652,090**	**434,281**	**513,581**	**546,899**	**477,008**	**477,821**	**476,254**	**469,001**
By-products revenues (US$m)	**64,555**	**60,417**	**60,802**	**77,811**	**91,907**	**119,097**	**105,669**	**143,472**
Royalties (as a % market price)								
Copper	3%	3%	3%	3%	3%	3%	3%	3%
Cobalt	3%	3%	3%	3%	3%	3%	3%	3%
Depreciation & amortisation (US$m)	**110,769**	**139,437**	**150,050**	**107,916**	**110,934**	**107,480**	**93,359**	**86,395**
Statutory Tax rate %	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**
Capex (US$m)								
Sustaining	75,679	33,042	91,032	86,002	75,321	59,218	37,215	51,219
Expansionary	61,266	24,512	38,572	96,501	102,727	91,851	120,013	23,358
TOTAL CAPEX	**136,945**	**57,554**	**129,604**	**182,503**	**178,048**	**151,069**	**157,228**	**74,577**

[2] A refers to Actual Amounts and E refers to Estimated Amounts

[3] Excl. depreciation, royalties & by-product revenues) (US$m)

1.13 Mopani Headcount

The staff compliment for Mopani is tabulated below.

December 2010 Mopani Headcount	
Mining	3,495
Engineering	747
Processing	2,228
General and administration	632
Corporate	420
Total	**7,522**
Contract employees MCM	488
Grand total	**8,010**

There are currently 6,413 contractors on site.

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2.0 INTRODUCTION

Golder Associates Africa (Pty) Ltd ("GAA") was commissioned by Glencore International AG ("Glencore"), in November 2010 to prepare a Mineral Experts Report ("MER") in respect of mining assets owned and operated by its subsidiary company, Mopani Copper Mines Plc ("MCM"). Glencore owns 73.1 per cent of Mopani with the remainder of the business being owned by First Quantum Minerals Ltd. (16.9 per cent) and ZCCM Investments Holdings Plc (ZCCM-IH) (10 per cent). Glencore International Plc is expected to be the ultimate parent company of the group.

The purpose of the MER is to assist Glencore by providing it with a technical report, which evaluates the nature and value of the mining assets held by it in order to assist it in its offer to a list Glencore International plc on the London and Hong Kong Stock Exchanges.

3.0 DESCRIPTION OF RESOURCES

3.1 General Geology

3.1.1 Nkana Operation

The general geology was provided by Mopani Mine in the document "Geological guide to Nkana, Mopani Copper Mines Ltd" and is detailed below.

The Zambian Copperbelt lies at the south-eastern end of the 800 kilometres long Lufilian fold belt. It comprises deformed rocks of the late Precambrian Katanga system draped around the flanks of a major northwest trending late-tectonic structural feature, the Kafue Anticline. Various elements of the Basement Complex are exposed in the core of this Anticline. As a result of the Lufilian orogeny, the Katanga rocks have been thrown into a series of long narrow en echelon folds and late tectonic dome and basin like structures. The Chambishi- Nkana basin lies about midway on the southern flank of the Kafue Anticline and is elongated in a north-westerly direction. The Nkana mining area covers the north-westerly plunging Nkana syncline, which forms a south-eastward prolongation to the Chambishi-Nkana Basin.

Within the mining area there are four underground mines and four open pits. All are situated on the north-eastern limb of the Nkana syncline area. Other cupriferous zones are present in the nose and southwest limb of the syncline. The orebodies are stratiform and are mainly confined to a recognisable ore formation, which occurs near the base of the Katangan sequence within the Lower Roan Group of the Mine Series.

In the underground workings, the principal copper ore minerals are chalcopyrite and bornite with subordinate chalcocite. There is a zoning in the geographical distribution of these minerals. Cobalt occurs as carrollite and cobaltiferious pyrite. The principal ore minerals are malachite, pseudomalchite, chrysocolla, native copper, cuprite and libethenite. In the open pit, malachite and chrysocolla are the principal ore minerals in the zone of oxidation closer to the surface. In some places however, vermiculite, malachite pseudomalachite and accessory wad are more important. At deeper levels chalcopyrite, bornite and chalcocite predominate.

3.1.2 Mufulira Operation

The rocks of the Mufulira Basin are asymmetrically folded, moderately dipping on the south western flank and sub vertical on the north eastern limb, outcropping at Mokambo on the DRC border. The Roan sediments in the Mufulira Syncline in the vicinity of the mine dip at approximately 45º to the north east. Small folds and minor faults are present within the mine area. The Lower Roan arenaceous quartzites and greywackes are the host rocks to the copper mineralisation.

The Mufulira deposit consists of three complex superimposed stratiform ore bodies, named A, B and C respectively. The C orebody is the lowermost and most extensive, measuring almost 5.5km along strike and more than 2km below surface. The Basement topography appears to have exerted a significant structural control during deformation. The distribution of ore minerals in all three ore bodies is stratigraphically controlled, occurring dominantly as disseminations, blebs and irregular masses. The principal copper minerals are chalcopyrite (60%), bornite (40%), and minor/trace chalcocite. Oxide minerals are confined to near surface occurrences, and supergene enrichment zones. Generally the deposit is structurally simple being characterised by three main folds that are in part overturned with a plunge and dip approximately 10º the northeast. The basin is open and untested at depth.

The deposit is mined by mechanised continuous retreat. The method involves two sublevels advancing en echelon with a lead lag of three to four fans. The upper mining level carries a chain pillar, the lower level is the extraction level, and generally no rib pillars are involved in the design layout. Stopes designated MCR1 are mined on a single level, while those designated MCR2 have a drilling level in addition to the extraction level.

At Mufulira East and Mufulira West the geology is similar to that outlined above. These deposits are not deep and superficial effects have resulted in a higher proportion of oxides and relatively less competent ground due to weathering. The oxide content at Mufulira West is not as high as that at Mufulira East and the location of mineralisation is different. At the former mineralisation occurs in the D orebody horizon while at the latter A, B and C orebodies are characterised by distinctive malachite, with minor chrysocolla and azurite mineralization.

3.2 Local Geology

3.2.1 Nkana Operation

The deformation of the rocks of the Nkana mining area is related almost completely to the Lufilian Orogeny, which affected both the pre-Katanga and Katanga rocks. Little is known about the pre-Lufilian tectonic history of the Basement Complex within the mining area, and so the following description is confined to a summary of the Lufilian structures. A generalised stratigraphic column for the Nkana mining area is shown in Figure 1.

The predominant mega-structure of the mining area is the northwest-plunging Nkana syncline. This structure is asymmetric, with a curved axial plane inclined steeply to the northwest in the trough of the syncline but upright to westward dipping at higher structural levels. A complex occupies the axial zone of the syncline but this folding dies out on its flanks. As a result of the north-westerly plunge of the Nkana syncline, the present land surface represents a horizontal section through progressively higher structural levels of the syncline from southeast to northwest. Similarly, current underground mining operations at South orebody Shaft are located along the north-eastern edge of the folded axial zone whereas at Central, Mindola and North Shafts these operations are mainly in the relatively undeformed steep to shallow-dipping north-eastern flank of the Nkana syncline.

Outside the working areas, surface mapping and diamond drilling from both underground and surface provide the basis for structural interpretation. Even so, the structure of the deeper parts of the syncline, particularly from the Kitwe Barren Gap northwards, is little known.

Within the axial zone of the Nkana syncline, shear folding is characteristic of the deformation style of the Lufilian Orogeny, with transposed bedding attenuated to sheared-out folds limbs, axial swelling and chevron structures being developed. The structures indicate thrusting directed towards the northeast, with decollement present at the Basement/Lower Roan and Footwall Formation/Ore Formation boundaries. In addition, the Basement Complex adjacent to the Lower Roan cover has been sheared with refoliation developed parallel to the axial planes of the folds in the Katanga rocks. During the early stages of deformation, open symmetrical folds such as the C anticline at South Orebody Shaft and the Zero Anticline at Central Shaft, were formed. As shearing stress built up, these earlier structures were modified; in some cases substantially. Post-shearing effects such as reversals of fold plunges, trans-current movements, faulting and kink zones are probably related to the late-tectonic up-doming of the Kafue anticline as the Katanga cover rocks adjusted themselves to essentially vertical movements between blocks of different competency within the underlying basement and complex. In places, for example at 4800S (SOB), there is evidence to suggest that the late-tectonic vertical movements have accented the pre-Katanga palaeo-topography, which itself has influenced the deformation by the buttressing effect produced by the granite gneiss palaeo-hills.

The following brief descriptions of the structure at Mindola and North Shafts and Central and South orebody Shafts serve to demonstrate the contrasting deformational styles on the flanks and in the axial zone respectively of the Nkana syncline.

3.2.1.1 Mindola and North Shaft

In the North Shaft area, that is between 1550N and 3700N the orebody dips at an average of 30° westwards above 1380L with only minor rolls to disturb its planar habit. Below 1380L the dip increases to about 45° and increases both southwards to the dyke at 1300N and with increasing depth, locally it reaches about 70°. South of the dyke, the dip becomes steep to over-turn and assumes a maximum reverse value of 75° at 5660S. Dewatering and exploration drilling in the area between 2330S and 5000S have indicated folding of the hanging wall beds. This folding and the reversal of dip in the far south of Mindola is probably related to the buttressing effect of the Kitwe Barren Gap combined with the axial zone deformation where it plunges northwards through the barren gap from Central Shaft area.

3.2.1.2 Central Shaft

At Central Shaft, the folded lower part of the north-eastern flank of the syncline is exposed by past and current mining operations. There are three major folds present on the north-eastern flank. From east to west, these are the North, Zero and J folds. The plunges are variable between 20° and 45° to the northwest. The Zero Fold consists of an open upright symmetrical anticline with maximum amplitude of 350m and an asymmetric complementary syncline to the east. Axial planar shear has occurred on the crest of the Zero Anticline, affecting the Ore Formation and hanging wall beds in particular. Traced up-plunge, the Zero Anticline becomes a tight asymmetric structure similar to the North and J Anticlines, which flank it. These folds are shear folds, with axial planes steeply inclined to the southwest at the top but overturned to the northwest at the base of the fold. Typically, the anticline has short northeast facing limbs and long southwest-facing limbs, indicating that shearing stress was directed towards the northeast.

3.2.1.3 South orebody Shaft

The complex folded axial zone of the Nkana syncline is best known at South orebody Shaft, where past and current mining development, including hanging wall dewatering drilling and exploration drilling from both underground and surface has been and is being carried out in this part of the main syncline.

There are at least six major complex folds from east to west. The folds are arranged en echelon and plunges undulate erratically. There is a marked flattening of plunge in barren gap areas, which are associated with basement ‘highs’, with a corresponding steepening of plunge off the flanks of the barren gaps. The folds are tightly compressed, with attenuation of limbs, bedding plane crumpling, axial plane cleavage and axial plane shearing well developed. Minor shear folds are commonly developed on the limbs of the major structures, the axial zones of which are usually feathered out by axial plane shear. These shear features are particularly well displayed where units of different competency are juxtaposed for example the Footwall Formation and the Near Water Sediments and Dolomite Argillite Sequence on either sides of it. The C-anticline, with maximum amplitude of 250m, is a good example of an earlier more open, upright symmetrical fold which has been modified by subsequent axial plane shearing.

3.2.1.4 The West Limb

The West Limb of the Nkana syncline is only partially understood, the geological evidence being obtained from diamond drilling and surface mapping. However, it is clear that the West Limb is folded in a similar fashion to the axial zone of the main syncline. North of 7800N (Central Shaft), folding of the West Limb dies out gradually as the Nkana syncline opens out into the Chambishi-Nkana Basin. The major structure on the west Limb between the nose area and 7800N (Central Shaft) is the Luanshimba Anticline. This has a shallow undulating plunge and its limbs have been deformed by a complex of en enchelon shear folds with curved axial planes fanning outwards from the Luanshimba Anticline.

3.2.1.5 Metamorphism

Broadly speaking, the lithological terms applied to the Katanga rocks are misleading in that they imply a lower grade of metamorphism than is, in fact, the case. All the sediments have undergone a degree of metamorphic recrystallisation, although in the case of the quartzitic rocks this has not been sufficient to destroy the sedimentary micro – and micro-textures. The most common metamorphic minerals are biotite, chlorite, tremolite, talc, sericite and albite. This assemblage indicates a metamorphic grade in the

Greenschist Facies. There is some variation in grade from the quartrz-albite-epidote-biotite sub facies in the more highly deformed areas to the quartz-albite-muscovite-chlorite sub facies in the less deformed rocks.

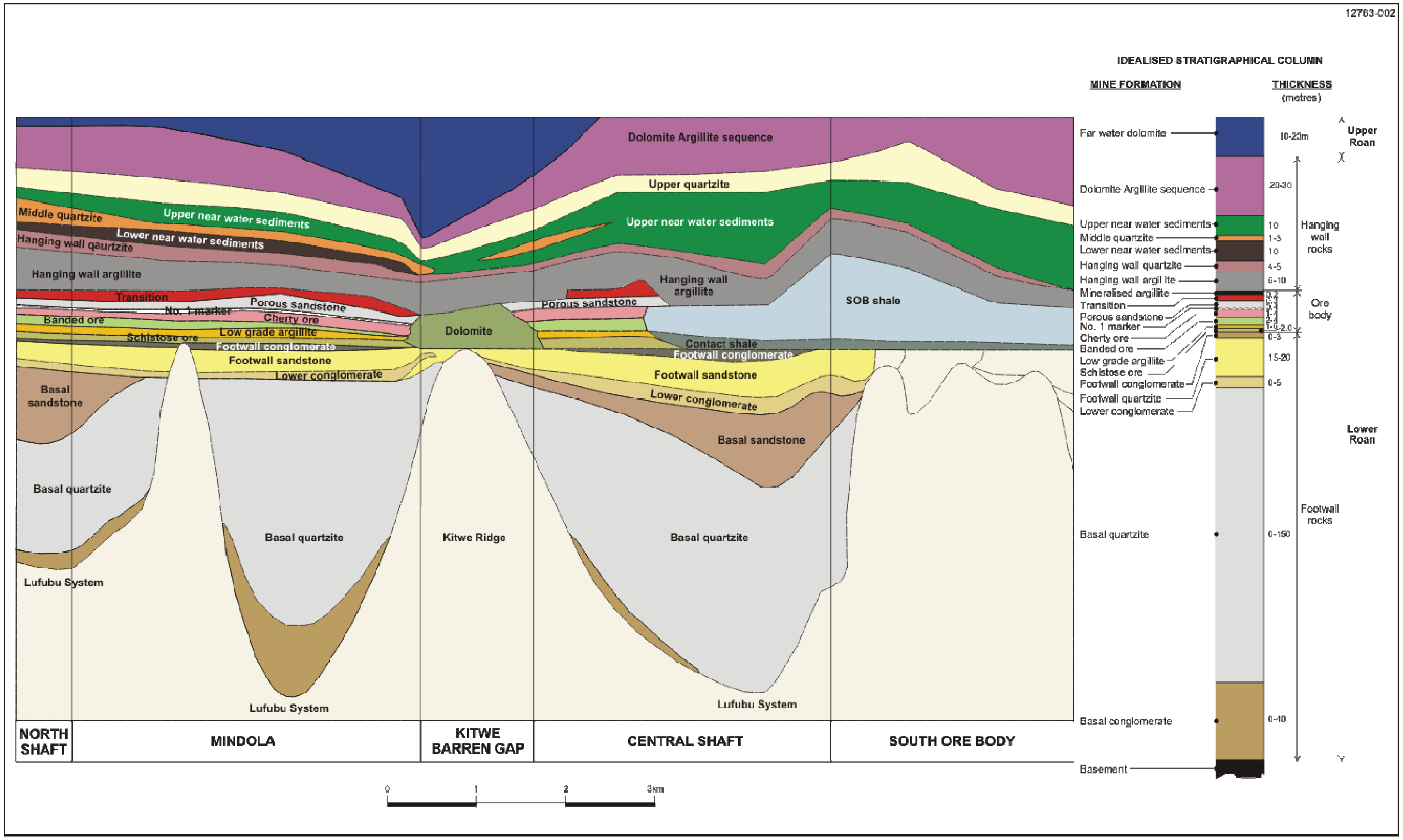


Figure 1: A generalised stratigraphic column for Nkana Mine

3.2.2 Mufulira Operation

Structurally, the Mufulira orebodies are much less complex. It consists of three superimposed stratiform ore bodies within the Lower Roan and locally named as the A, B and C orebodies. The C orebody is the lowermost and most extensive, measuring almost 5.5km along strike and more than 2km below surface. The Basement and Complex topography appears to have exerted a significant control on the distribution of mineralisation. The distribution of ore minerals in all three ore bodies is stratigraphically controlled, occurring dominantly as disseminations, blebs and irregular masses. The principal copper minerals are bornite, chalcopyrite and chalcocite. Oxide minerals are confined to near surface occurrences, supergene enrichment zones and occasionally on top of Basement and Complex highs. Generally the deposit is structurally simple being characterised by three main folds that are in part overturned with a plunge and dip approximately 10° the northeast.

The statigraphic column is illustrated in figure below:

MUFULIRA STRATIGRAPHIC COLUMN

(*modified after Brandt et al., 1961; Wendorff, 2005*)

Group	Formation	Thickness (m)	Stratigraphic Column	Lithology
Mwashia			Lower	Sandstones and Shales
			Middle	Siliciclastics, Carbonates and Shales
			Upper	Conglomerates with clasts of Roan rocks
			unconformity	
>760 Ma		500 +		Upper Dolomite Aquifer
				Barrier Quartzite
				Upper Dolomite Aquifer
				Upper Roan mineralisation
Upper Roan		50 - 45		Interbedded Shale and Quartzite
		4 - 6		Blue Shale
		30 - 45		Upper Intermediate Dolomite Aquifer
		6 - 12		Middle Quartzite
		20 - 50		Lower Intermediate Dolomite Aquifer
Lower Roan	HW Formation	6 -12		Glassy Quartzite
		20 - 40		Upper Argillaceous Quartzite
		4 - 6		Marker Grit
		20 - 40		Lower Argillaceous Quartzite
				95' Dolomite Aquifer
				Lower Argillaceous Quartzite
				85' Dolomite Aquifer
				Lower Argillaceous Quartzite
				70' Dolomite Aquifer
				Lower Argillaceous Quartzite
	Ore Formation	3 -12		A Ore Horizon
		10 - 30		Inter A/B Beds
		3 - 5		Lower Dolomite
		3 - 15		B Ore Horizon
		4 - 15		Inter B/C Beds
		3 - 20		C Ore Horizon
	FW Formation	0 - 150	Upper	FW Quartzites and Grits
			Middle	
			Lower	
880 Ma		0 - 15		Basal conglomerate
			unconformity	
Basement/Complex				Granite Intrusive into Lufubu Schist

Figure 2: Mufulira Stratigraphic column

3.3 Mineral Resource Estimation Methodology

3.3.1 Exploration and Data

3.3.1.1 Nkana

The data used for the resource areas include three sources of sampling, namely:

- Underground evaluation holes drilled on a 120m to 300m grid size, later reduced to 60m, using a NQ drill size at the collar reducing to BQ drill size when problems are experienced. These holes form the base of the information used for geological modelling and estimation.
- Dewatering drill holes are drilled every 60m and are fanned out to cover the available envelope to be dewatered. Drilling is completed approximately 5 years before mining in an area. The dewatering holes are collared at HQ size and reduced to NQ size.
- Underground channel samples are completed at 30m intervals on the northern wall of the exposure to determine the actual mineral grades of the exposed ore.

The current diamond drilling for Mopani (both at Nkana and Mufulira) is carried out by Reldrilza Zambia Ltd and supervised by Mopani geologists at the relevant shaft. The evaluation holes are drilled by using smaller pneumatic machines which can drill up to 200m. The larger hydraulic-electric machines are used for drilling exploration and dewatering holes of between 200m and 500m.

The contractual obligation between Reldrilza and Mopani is that a core recovery of 90% in general and 95% in the orebody has to be obtained. If this criterion is not met, Reldrilza are required to re-drill the hole at their own expense. The drills are equipped with wire line equipment for efficient core recovery. The recovered core is placed in metal core trays and carefully labelled by the driller. The core is transported to the core shed every morning and a daily drilling report is submitted by the driller who lists the recorded metres drilled and identifies any problems encountered.

Boreholes in excess of 100m require an in-hole camera survey to be completed by the contractor.

The sample length is based on the geological boundaries and varies between a quarter of a metre to one metre; however, a sample length of one metre is preferred, when possible. The core samples are halved for analysis. The geologist logs the core by hand on paper log sheets whereby the geologist describes the core conditions, core recovery (from the driller), core angles in degrees, formation, Minerals (first, second and third), visual (%) estimate of mineralisation and a description of the core to include; colour, grain size, shape, alterations, textures and additional comments. The log sheet also allows for capturing of the copper and cobalt assay results. Previously itemised codes were used for logging; however, this has been done away with to accommodate better description of the core. The geologist enters the data into an excel spreadsheet or directly into a temporary access database. The temporary databases are cleaned and validated before combining the data into a “Stand Alone Database” for each of the shafts, which is again validated. Once the final validation is complete the “Stand Alone Database” is updated into the SQL Database on the Main server. The main server is automatically backed up bi-weekly to conform to the current Mopani database management practices.

No samples for measurement of specific gravity (“SG”) are taken at this stage, and an SG of 2.56 t/m^3 is assigned for the entire orebody.

Table 1: Summary of data provided in Collar Tables for Nkana

Database	Number Hole ID's	Boreholes	Chips
Central SOB	1,317	1,008	309
Mindola	918	683	235
Mindola North	2,005	1,061	944
Area A	82	82	-
Area D	27	27	-
Area J	51	51	-
Area K	113	113	-
C Syncline	40	29	11
D Anticline	155	97	58
F Syncline	68	68	-
Central Upper Levels	86	82	4
Total	**4,862**	**3,301**	**1,561**

3.3.1.2 Mufulira

Drill core, rock chip sampling and sludge sampling are the principal forms of sampling used in grade and tonnage estimations.

Geological samples: Rock chip samples are taken along the walls of underground crosscut development that is generally perpendicular to strike. Sample length varies from 0.5m to 1.0m. Before sampling is carried out the face is cleaned, mapped for rock type, structure and mineralisation, and the lithological contacts painted. Chip samples are then taken at grade elevation (approximately 1.5m above floor) every metre along the length of exposure, with each sample weighing about 2kg. Samples are not taken across lithological contacts.

Sludge sampling: Sludge holes are drilled at grade elevation and collared between 0º and +10º. Samples are collected using a bucket placed beneath the hole over a 1.5m interval (which corresponds to the length of the drill rod). The samples are logged for colour, grain size, lithology and mineralisation. Possible dilution is reduced through prolonged washing/flushing of the hole between sample intervals.

Drill core samples: Drill samples are taken after the drill hole is completed and the core has been logged. Sample interval varies from 0.4m to 1.0m and does not cross lithological or mineralogical boundaries. Where core is split one half is retained for future reference.

Production samples: Grab samples are taken at production stope faces as part of grade control and reconciliation procedures. A nine point grid is visualised across the stope face, and a grab taken from each point to make up the stope sample. Generally a sample is taken at the start and end of each shift (first and last loader buckets) and then at intervals of about 15 buckets (approximately every 100-200 tonnes). Each sample weighs approximately 2kg.

Percussion chips: The surface exploration programme at Mufulira included chip sample from DTH percussion drilling. The chip samples were sampled over one metre intervals measured on the rod with the sample taken from the accumulated dust pile adjacent to the collar.

Diamond coring is used to delineate the orebody underground. Drill hole spacing is variable depending on the drill hole target, the position of primary development and requirements of the hole. Exploration holes are generally drilled to NQ size as well as BQ/BX size by conventional techniques, depending on the drill rig used. Routine sampling drill holes are drilled to AXT and BQ sizes. Routine orebody delineation holes are spaced at approximately 20 – 30m whilst deeper exploration types of holes are spaced at up to 100m or greater. Intersection points are targeted mainly along strike with the down dip target tending to be constrained by the collar location sited in the geological footwall.

All drill holes are logged for lithology and structural characteristics (mainly dip and mineralisation). Recovery measurements are part of the logging process. Once logging is completed all drill holes are plotted on plan and section. Holes oblique to section are plotted by either perpendicular or strike/dip projection to the nearest section. Core from all exploration drill holes is photographed.

Core from exploration boreholes is split in half by cutting with a manual feed diamond saw. One half of the split core is submitted for analysis. The remaining half is retained along with the remainder of the borehole and stored in the well maintained Mufulira mine geology core shed.

Where core is not split (i.e. routine sampling drill holes) the entire mineralised intercept is submitted for analysis. The remaining core from these holes is discarded when assay results have been received and checked against the original log.

All samples are crushed, riffle split, and then pulverised to a 250g sub 80 micron sample. Coarse rejects are retained until such time that results have been checked and verified against the original logs.

Chippings from sludge holes are hand sampled by random grabs after thorough mixing of the wet material. Approximately 2kg of sample from each drill run is submitted for analysis, where it is dried before pulverising and assaying. The remaining material from the percussion hole is discarded.

All samples are numbered sequentially, including the duplicate and blank samples identified. After every 10^{th} sample a blank is inserted, consisting of Mufulira grey granite with a known TCu of 0.1%. In the document on sampling procedures, "Procedure on Borehole Core Logging, Sampling and Data entry into Geological Database", no mention is made on the inclusion of duplicate samples. Personal communication to GAA, however, revealed that more or less every 10^{th} sample is duplicated by quartering the core for the exploration drill holes. No standard samples are submitted. The sample is then put into a plastic bag with two sample tags with the sample number on inside the bag.

The Geology Department records the sample numbers and the variable(s) to be analysed for in a sampling book, and the samples are then transported to the local laboratory, where the person in charge of the sample preparation checks the samples and signs for it. By this, sample custody is transferred to the laboratory.

All drill hole collars, bearing, inclination and elevations are located by survey. Chip sampling and sludge hole collars, bearing, inclination and elevations are located by sectional geological samplers from 1:200 plans and sections using known survey pegs, checked by geologists and entered into the geological database.

The drill hole databases were validated in Access using the filter key to search for missing data in the mandatory tables (collar and survey). In the collar table, the X, Y, Z and final depths were checked for blanks or zeros. In the survey table the depths, azimuths and dip were checked for blanks as well as missing survey data for collar and assay data. The databases received were clean and no major errors were found.

3.4 Quality Assurance and Quality Control

Mopani Copper Mines has two laboratories, one at Nkana and the other at Mufulira. Both are ISO accredited for Quality Management System ISO9001:2008. The certificate expires in January 2013. Inter-laboratory analysis is conducted every three months at the Mufulira Mine laboratory. The referee laboratory for samples is the Alfred H Knight Laboratory in Kitwe which is SANAS accredited (T0141).

3.4.1 Nkana

GAA completed a QA/QC duplicate sample analysis for the crushed duplicate samples. At the time 20 pairs of duplicates were provided from the SOB-Central database. The analysis is described in more detail below.

The results from the analysis show that the average precision for %TCu duplicates is 74.8% for 95% of the samples and the average precision for the %TCo duplicates is 48.4% for 95% of the samples. For both the

%TCu and the %TCo duplicates the precision is not within acceptable limits. This may be attributable to the differences noted between mineralisation in the two halves of the core.

GAA analysed the results from the Standard samples, as supplied by geology, as well as from the laboratory. The statistical information for the standards is summarised in Table 2.

Table 2: Statistics for the Standards used at Mopani Mine

Division	Standard	%TCu				%TCo			
		Min	Max	Ave	1 std dev	Min	Max	Ave	1 std dev
Geology	SWA 1	1.03	1.11	1.06	0.020	0.049	0.055	0.052	0.002
	SWA 2	2.04	2.04	2.11	0.039	0.074	0.080	0.077	0.002
Laboratory	Nk51	2.08	2.48	2.28	0.200	0.137	0.177	0.157	0.020
	Nk52	1.64	2.04	1.84	0.200	0.069	0.109	0.089	0.020
	Nk53	1.65	2.05	1.85	0.200	0.088	0.128	0.108	0.020
	Nk54	1.50	1.90	1.70	0.200	0.069	0.109	0.089	0.020

This information was used to plot the analysed value versus the standard values for both the geology samples and the laboratory samples.

A criterion of +/-2 times the standard deviation of the average value is an accepted failure criteria for interpreting standards. It can be seen from the graphs that the majority of the samples in the geology are plotting outside of 2 times the standard deviation. It is advised that the batches to which these samples belong will be reanalysed before the QA/QC of these samples can be fully accepted. In the case of the laboratory only tolerances were provided and these were assumed to be standard deviations from the mean. The results for these standards were within acceptable limits.

3.4.2 Mufulira

GAA completed a QA/QC duplicate sample analysis for the duplicate samples. Duplicates for 139 pairs of duplicates were provided from the database. The analysis is described in more detail below.

The results from the analysis show that the average precision for %TCu duplicates is 34.1% for 95% of the samples. The average HARD for this dataset is 14.08%.

GAA received the results from 42 blank samples submitted since August 2007. These blank samples are from grey Mufulira granite with an expected result of 0.1%TCu. The graphed results are shown in Figure 3. From this graph it is clear that contamination does occur from time to time.

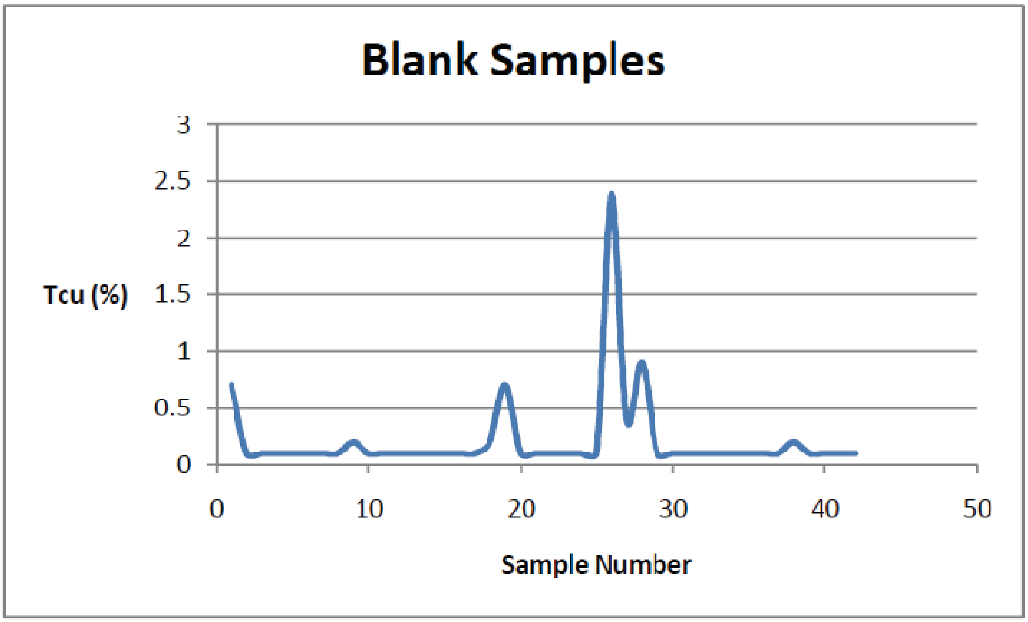


Figure 3: Results from the Blank Samples

3.5 Geological Modelling

The geological solids used for the estimation for the Nkana and Mufulira operations are shown in Figure 4; Figure 5 and Figure 6, respectively.

The geological interpretations were done by Mopani and were digitized in Surpac geological modelling software. However, due to complex geology, SOB and Central Shaft sections were manually done and imported into Surpac via a digitiser tablet.

A 1% TCu cut-off was used for interpreting the mineralized zones.

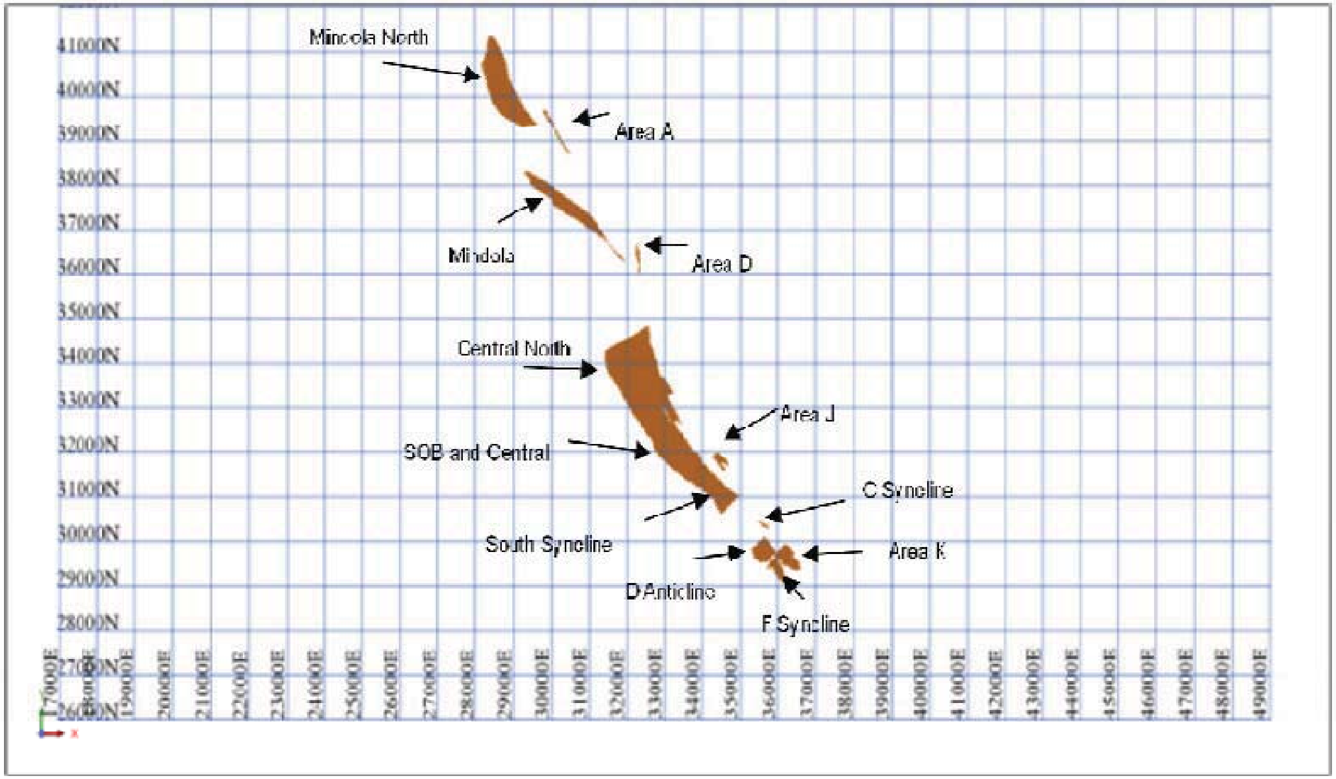


Figure 4: Wireframes of the mineralized areas - Nkana

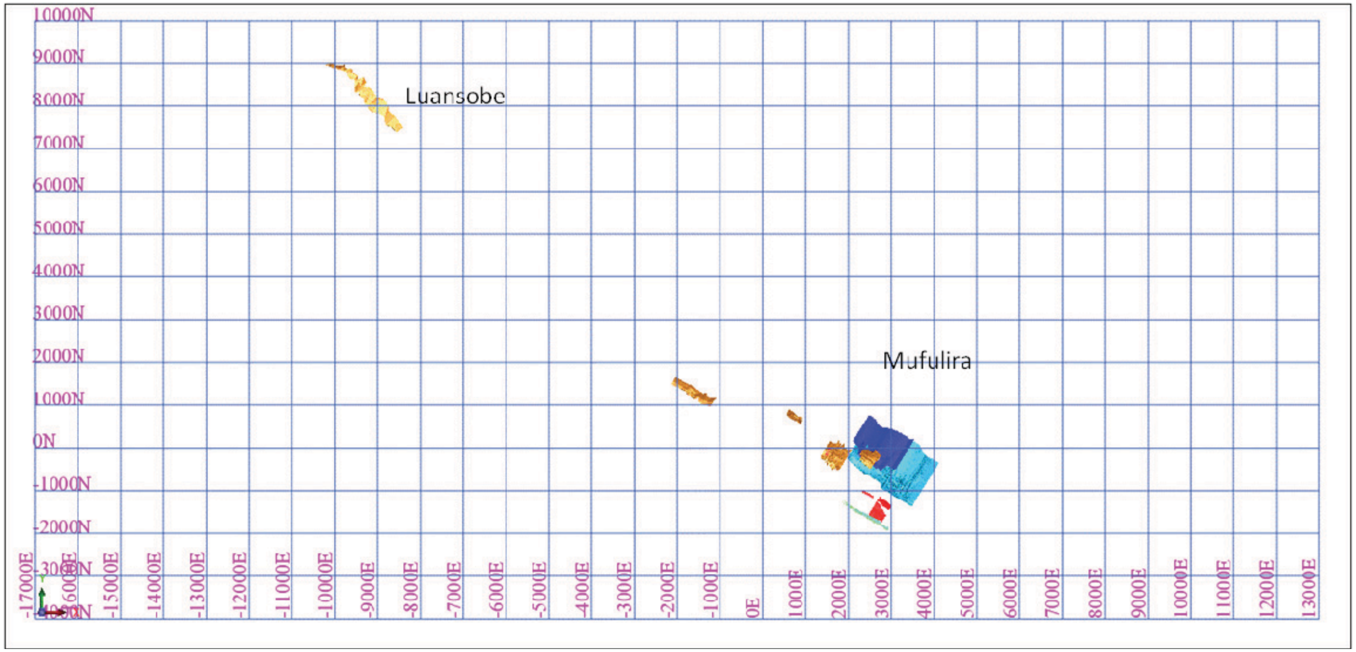


Figure 5: Mufulira Solids relative to the Luansobe Solids

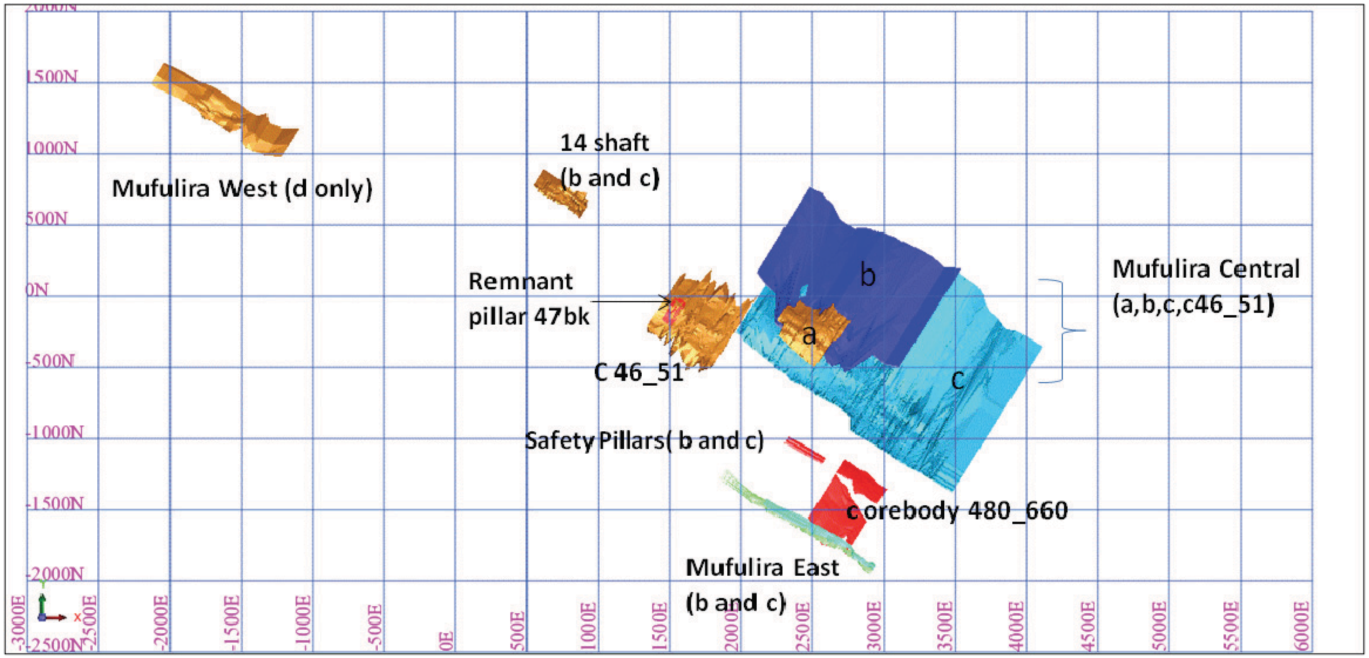


Figure 6: Solids for the mineralized areas in Mufulira

3.6 Variography Analysis

Statistical analysis was conducted on composited data in order to understand the underlying distribution for each project area, as well as to understand the differences in grade between different sample support types. The two different drill types found in project areas include diamond drilling and chip samples. The different types of sampling imply different types of sample support and there is different level of confidence associated to the different types of sampling. There is a much higher confidence in the diamond drilling because chip sampling can at times be selective to softer lithologies, which are normally the ore zones, and often causes smearing of the data. It is therefore imperative to understand the underlying distributions of the different drill types to understand whether these datasets can be combined.

The diamond borehole samples were used for estimation.

Variographic analysis of the variables was performed in Surpac. The spherical model was used to derive all variogram parameters from the experimental variograms.

Spherical model variograms were generated using the lag modelled according to the typical drill hole spacing for each project area.

The nugget variances were modelled from experimental down hole variograms based on a straight composite of 1m. The down hole variograms provided the nugget for the variogram model.

Table 3: Parameters Used for the Down hole Variogram Generation

Parameter	Value
Azimuth	0
Plunge	0
Spread	90
Lag	0.5
Maximum Distance	50

The type of variogram generated for each of the project areas is shown in Table 4 and Table 5.

Table 4: Nkana Variogram Types

Project Area	Variogram Type
Mindola North	Omni-directional
Area A	Directional
Mindola	Omni-directional
Area D	Directional
Central North	Omni-directional
Central and SOB	Omni-directional
South Syncline	Omni-directional
ZJ Limb	Omni-directional
Area J	Directional
C Syncline	Omni-directional
D Anticline	Omni-directional
	Omni-directional
F Syncline	Omni-directional
Area K	Directional

Table 5: Mufulira Variogram Types

Project Area	Variogram Type
Luansobe	ID^2
Mufulira West	Omni directional
14 Shaft B orebody	Omni directional
14 Shaft C orebody	Omni directional
Mufulira Central A orebody	Omni directional
Mufulira Central B orebody	Omni directional
Mufulira Central orebody	Omni directional
Mufulira Central C46_51 orebody	Omni directional
Mufulira East B orebody	Omni directional
Mufulira East C orebody	Omni directional
Remnant Pillar 47	Omni directional
Safety Pillar B	Omni directional
Safety Pillar C	Omni directional
Safety Pillar Middling	Omni directional
C orebody 480_660	Omni directional

3.6.1 Nugget Inference

The variogram nugget variance was modelled by calculating down hole variograms using a lag of 1m as majority of the sample spacing was 1m in length.

3.6.2 Variography Results

3.6.2.1 Nkana

The spherical model variograms from the variography to be used in the estimation are tabulated in Table 6 and Table 7.

Table 6: Nkana variography results for all the omni-directional variograms

Area	Domain	Variable	Nugget	Sill1	Range1	Sill2	Range2
Mindola North	Diamond	%TCu	0.020	1.022	66	0.537	108
		%TCo	0.001	0.017	10	0.003	101
Mindola North	Chip	%TCu	0.035	0.824	18	0.348	263
		%TCo	0.002	0.007	20	0.001	67
Mindola		%TCu	0.083	1.341	8	0.368	150
		%TCo	0.001	0.020	16	0.003	240
Central North		%TCu	0.057	1.065	11	0.123	159
		%TCo	0.002	0.02	7	0.018	44
SOB and Central	East	%TCu	0.115	1.020	12	0.327	215
		%TCo	0.001	0.008	23	0.002	119
	Middle	%TCu	0.283	1.048	15	0.531	96
		%TCo	0.001	0.008	19	0.001	119
	West	%TCu	0.099	1.766	17	0.445	37
		%TCo	0.000	0.004	20	0.005	64
South Syncline		%TCu	0.052	0.835	18	0.713	96
		%TCo	0.000	0.007	12	0.002	70
ZJ_Limb		%TCu	0.019	0.392	42	0.181	83
		%TCo	0.000	0.006	112	-	-
C_Syncline		%TCu	0.027	0.520	11	0.177	74
		%TCo	0.000	0.001	47	0.001	80
D_Anticline	Domain 1	%TCu	0.022	0.712	7	0.181	51
		%TCo	0.000	0.004	7	0.009	121
	Domain 2	%TCu	0.013	0.750	8	0.148	61
		%TCo	0.000	0.003	10	0.002	61
F Syncline		%TCu	0.037	0.629	26	0.123	91
		%TCo	0.000	0.003	4	0.002	41
		%ASCu	0.000	0.007	16	0.02	68

Table 7: Nkana variography results for all the directional variograms

Area	Variable	Nugget	Major					Semi major			Minor		
			Sill1	Range1	Sill2	Range2	Maj-Dir	Range1	Range2	Semi-Dir	Range1	Range2	Minor-Dir
Area A	%TCu	0.250	2.55	30	0.770	200	130	15	125	40	9	30	90
	%TCo	0.002	0.013	50	0.003	200	120	25	100	30	5	20	90
	%ASCu	0.190	2.60	75	0.480	200	150	25	75	60	5	22	90
	%ASCo	Not Estimated											
Area D	%TCu	0.150	1.55	20	0.360	220	110	15	125	20	9	30	90
	%TCo	0.002	0.013	50	0.003	200	120	25	100	30	5	20	90
	%ASCu	0.320	3.33	75	1.40	200	160	25	75	70	5	22	90
	%ASCo	Not Estimated											
Area J	%TCu	2.20	6.26	35	0.200	200	130	30	200	40	7	30	90
	%TCo	0.003	0.040	45	0.006	250	120	35	100	30	6	19	90
	%ASCu	2	4.70	30	0.900	225	120	30	90	30	8	30	90
	%ASCo	Not Estimated											
Area K	%TCu	0.260	2.05	55	0.030	250	160	40	173	70	3	20	90
	%TCo	0.002	0.009	55	0.004	250	160	50	200	70	7	30	90
	%ASCu	0.120	0.640	100	0.220	200	160	50	150	70	3	17	90
	%ASCo	Not Estimated											

3.6.2.2 Mufulira

The spherical model variograms from the variography to be used in the estimation are tabulated in Table 8.

Table 8: Mufulira variography results for all the omni-directional variograms

Area	Domain	Variable	Nugget	Sill1	Range1	Sill2	Range2
Luansobe		%TCu	ID^2 Estimation				60.000
		%ASCu	ID^2 Estimation				60.000
Mufulira West		%TCu	0.018	0.760	13.230	0.230	52.000
		%ASCu	0.006	0.430	3.960	0.270	55.000
14 Shaft	B	%TCu	0.057	0.120	2.080	0.290	34.000
	C	%TCu	0.004	0.380	13.810	0.380	127.300
Mufulira Central	A	%TCu	0.032	6.100	3.710	0.560	69.700
	B	%TCu	0.070	1.430	17.260	0.600	203.360
	C	%TCu	0.130	1.360	14.930	1.100	271.990
	C46_51	%TCu	0.008	1.160	9.500	0.360	184.360
Mufulira East	B	%TCu	0.000	12.170	62.670	-	-
		%ASCu	0.013	0.660	7.300	0.220	48.700
	C	%TCu	0.145	2.560	7.840	1.250	52.040
		%ASCu	0.008	1.850	7.940	0.795	33.160
Safety Pillars	B	%TCu	0.000	8.210	53.550	-	-
	C	%TCu	0.001	0.860	4.700	0.150	36.700
	Middling	%TCu	0.002	0.190	3.160	0.220	19.700
C orebody 660		%TCu	0.006	1.400	5.940	0.320	38.200

3.7 Estimation Parameters

3.7.1 Block Model

Change of support was conducted on some of the project areas to determine the optimal block size. The geological block models were validated by comparing the solids volume to the block model volume as shown in Table 9 and Table 10. No major differences were noted.

Table 9: Summary of solid volumes versus block volumes for Nkana

Area	Wireframe Volume (cm^3)	Block Model Volume (cm^3)	% Difference
Mindola North	9,201,694	9,201,310	-0.00
Area A	452,758	452,750	-0.00
Mindola	23,201,325	23,208,246	0.03
Area D	283,232	282,200	-0.37
Central North	45,018,732	44,693,300	-0.73
Central, SOB and South Syncline	94,852,825	94,856,732	0.00
ZJ Limb	1,717,471	1,686,850	-1.82
Area J	1,756,689	1,753,475	-0.18
C Syncline	658,668	659,094	0.06
D Anticline	3,109,318	3,109,419	0.00
F Syncline	1,749,760	1,750,475	0.04
Area K	2,391,118	2,392,875	0.07

Table 10: Summary of solid volumes versus block model volumes for Mufulira

Area	Wireframe Volume (cm^3)	Block Model Volume (cm^3)	% Difference
Luansobe	4,072,755	4,074,175	0.035
Mufulira West	7,210,405	7,210,313	0.00
14 Shaft B orebody	1,808,936	1,808,936	0.00
14 Shaft C orebody	2,725,472	2,677,875	-1.78
Mufulira Central A orebody	1,556,499	1,555,694	-0.052
Mufulira Central B orebody	9,939,852	9,914,913	-0.252
Mufulira Central C orebody	26,175,715	26,060,706	-0.441
Mufulira Central C46_51 orebody	4,151,052	4,151,681	0.015
Mufulira East B orebody	238,441	238,188	-0.11
Mufulira East C orebody	783,042	783,325	0.04
Safety Pillar B	96,618	96,631	0.01
Safety Pillar C	145,069	145,419	0.24
Safety Pillar Middling	110,696	110,600	-0.09
C orebody 480_660	467,053	467,063	0.00

3.7.1.1 Nkana

It was decided that a block size of 20x20x4 would be used for all the areas to allow for combining of block models at a later stage. The sub-block size used was 5m x 5m x1m to allow for easier reporting.

3.7.1.2 Mufulira

It was decided that a block size of 10x10x4 would be used for all the areas to allow for combining of block models at a later stage. The sub-block size used was 2.5m x 2.5m x 1m to allow for easier reporting.

3.7.2 Estimation Plan

Ordinary Kriging ("OK") was used, which is a specific algorithm that satisfies the requirement for objective results by ensuring that the kriging weights in the local estimation are summed to 1. The grade interpolation was carried out in Surpac.

A four pass estimation plan was used to enable estimation of the full volume of the block models. Estimation pass quality and reliability decreases with each increasing pass. The passes were based on the following:

- Pass 1: 2/3 of the range of the variogram;
- Pass 2: the variogram range;
- Pass 3: 1.5 times the variogram range; and
- Pass 4: Global Average.

In each pass a minimum of 4 and maximum number of 25 samples were used and only the ranges were changed.

3.7.3 Density Assignment

3.7.3.1 Nkana

From as early as 1945, SG determinations were carried out at Nkana Mine. With over 358 determinations over the years, a weighted average bulk density of 2.79 t/m^3 was arrived at. This is 9% higher than the 2.56 t/m^3 that is currently been used for resource calculations.

GAA believes that this density may be on the conservative side and deems to the value of 2.56 t/m^3 to be acceptable.

3.7.3.2 Mufulira

In the document "Mineral Resources and Mineral Reserves Statement as at 1st January 2010" as received from Mufulira Mine, it is noted that to convert the volumes from modelling to tonnages, a SG of 2.65 t/m^3 for most of the areas is used, except for Mufulira West, where a value of 2.5 t/m^3 was used based on historical information.

The density values used for conversion of volume to tonnage in each project are shown in Table 11.

Table 11: Mufulira density values assigned for tonnage calculations

Project Area	Density t/m^3
Luansobe	2.50
Mufulira West	2.50
14 Shaft B orebody	2.65
14 Shaft C orebody	2.65
Mufulira Central A orebody	2.65
Mufulira Central B orebody	2.65
Mufulira Central C orebody	2.65
Mufulira Central C46_51 orebody	2.65
Mufulira East B orebody	2.50
Mufulira East C orebody	2.50
Safety Pillar B	2.65
Safety Pillar C	2.65
C orebody 660	2.65

3.7.4 Block Model Validation

The average grade conformance is a global representation over the entire domain. To assess average grade conformance progressively across the deposits, swaths plots were used. In these plots, both data and model estimates are averaged into Easting, Northing and RL slices and the conformance of grade is assessed for each slice, in a particular direction.

Overall in the project areas, the average grade conformance on the swath plots is acceptable with underestimation of high grade samples and overestimation of the low grade samples, resulting in a smoothed estimate. This is to be expected when interpolating using the OK method.

3.7.5 Nkana Grade Distribution

3.7.5.1 Mindola North

The %TCu and %TCo grade distribution for Mindola North is shown in Figure 7.

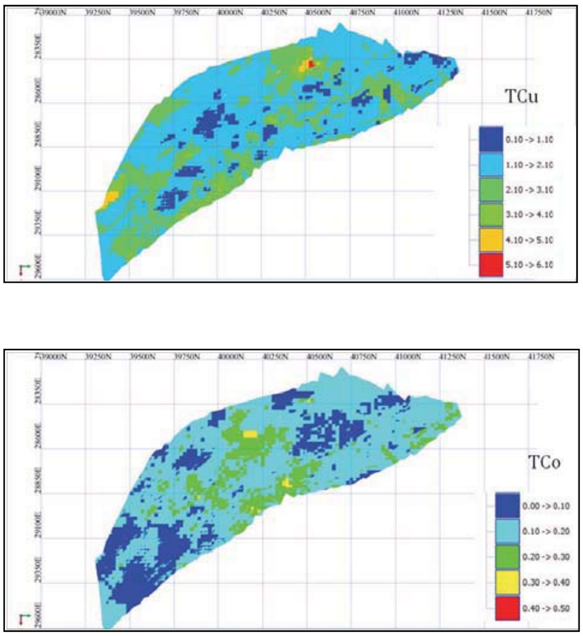


Figure 7: Distribution of %TCu and %TCo grades for Mindola North

3.7.5.2 Area A

The %TCu, %TCo and %ASCu grade distribution for Area A is shown in Figure 8.

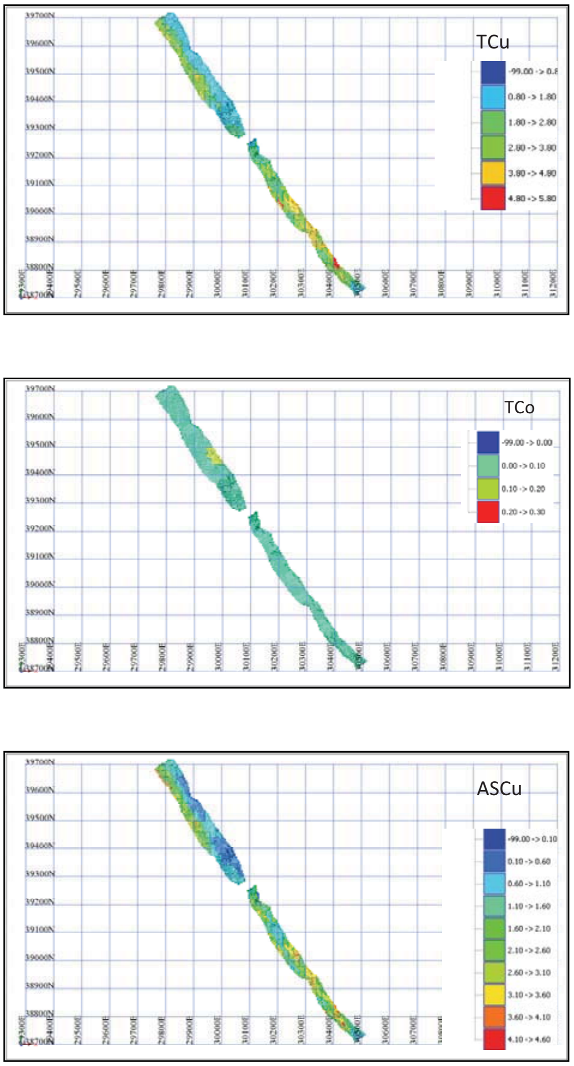


Figure 8: Distribution of %TCu, %TCo and %ASCu grades for Area A

3.7.5.3 Mindola

The %TCu and %TCo grade distribution for Mindola is shown in Figure 9.

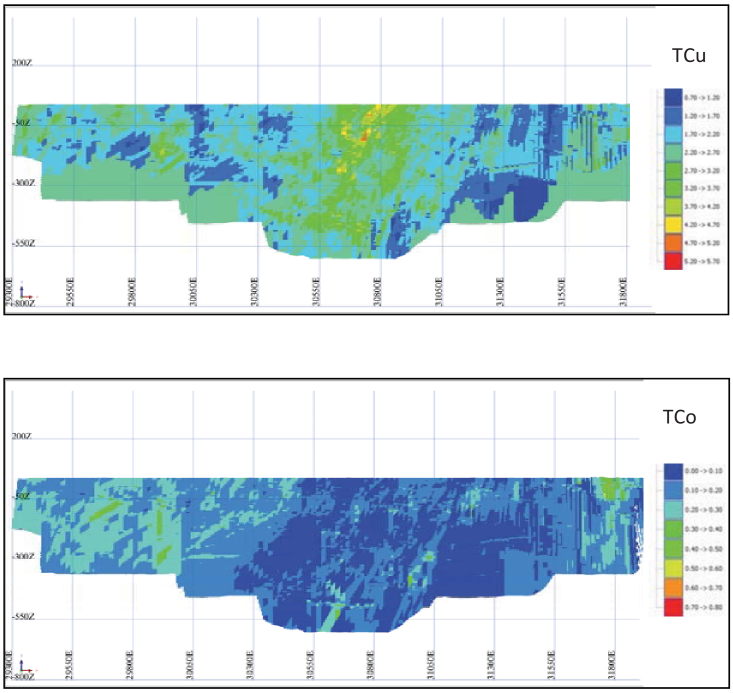


Figure 9: Distribution of %TCu and %TCo grades for Mindola

3.7.5.4 Area D

The %TCu, %TCo and %ASCu grade distribution for Area D is shown in Figure 10.

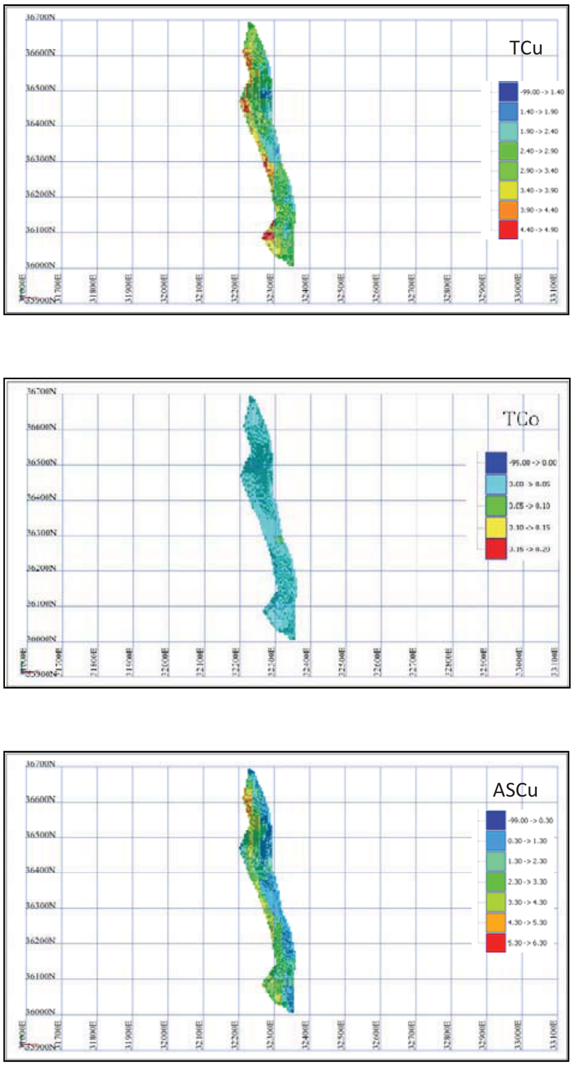


Figure 10: Distribution of %TCu, %TCo and %ASCu grades for Area D

3.7.5.5 Central North

The % TCu and % TCo grade distribution for Central North is shown in Figure 11.

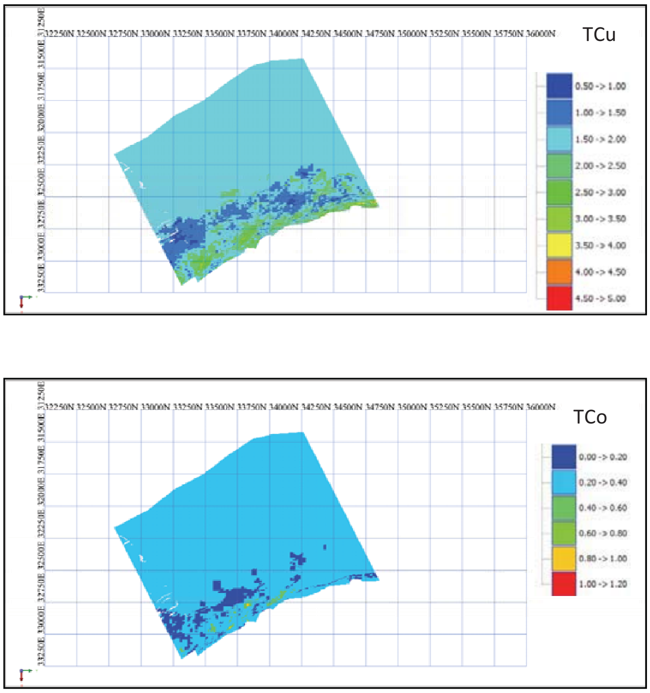


Figure 11: Distribution of %TCu and %TCo grades for Central North

3.7.5.6 SOB and Central

The % TCu and % TCo grade distribution for SOB is shown in Figure 12.

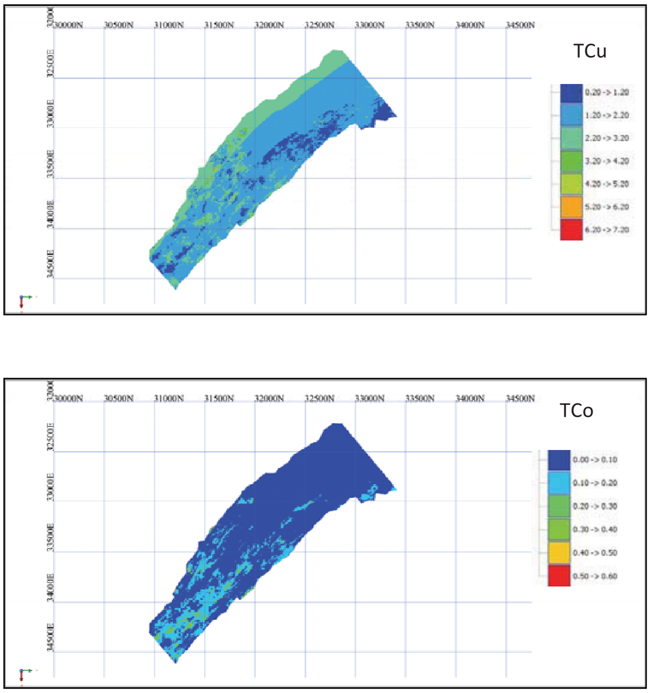


Figure 12: Distribution of %TCu and %TCo grades for SOB

3.7.5.7 South Syncline

The % TCu and % TCo grade distribution for South Syncline is shown in Figure 13.

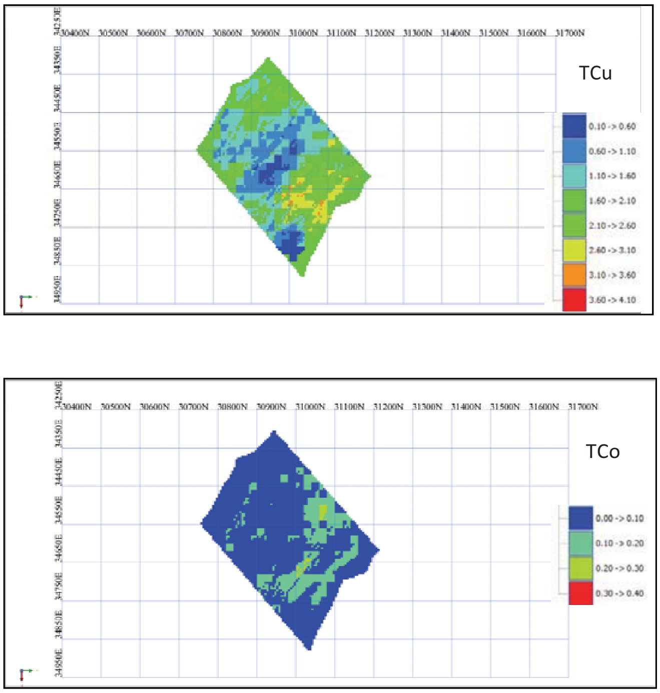


Figure 13: Distribution of %TCu and %TCo grades for South Syncline

3.7.5.8 ZJ Limb

The % TCu and % TCo grade distribution for ZJ Limb is shown in Figure 14.

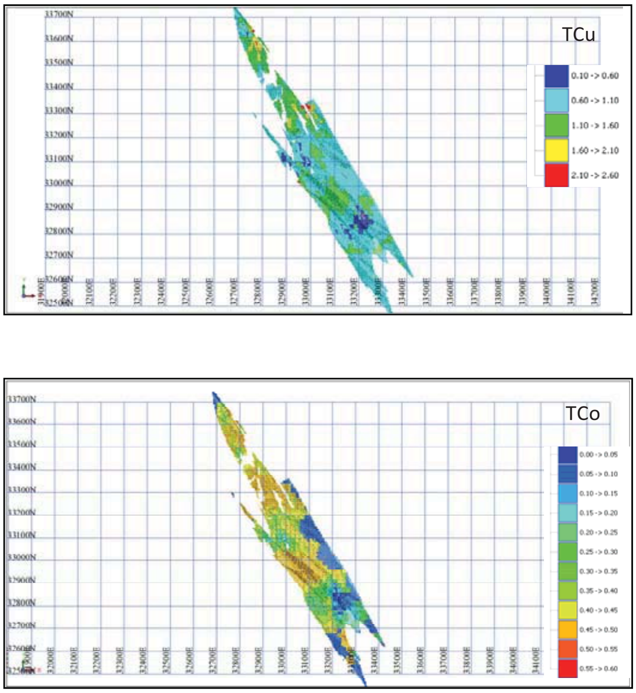


Figure 14: Distribution of %TCu and %TCo grades for ZJ Limb

3.7.5.9 Area J

The %TCu, %TCo and %ASCU grade distribution for Area J is shown in Figure 15.

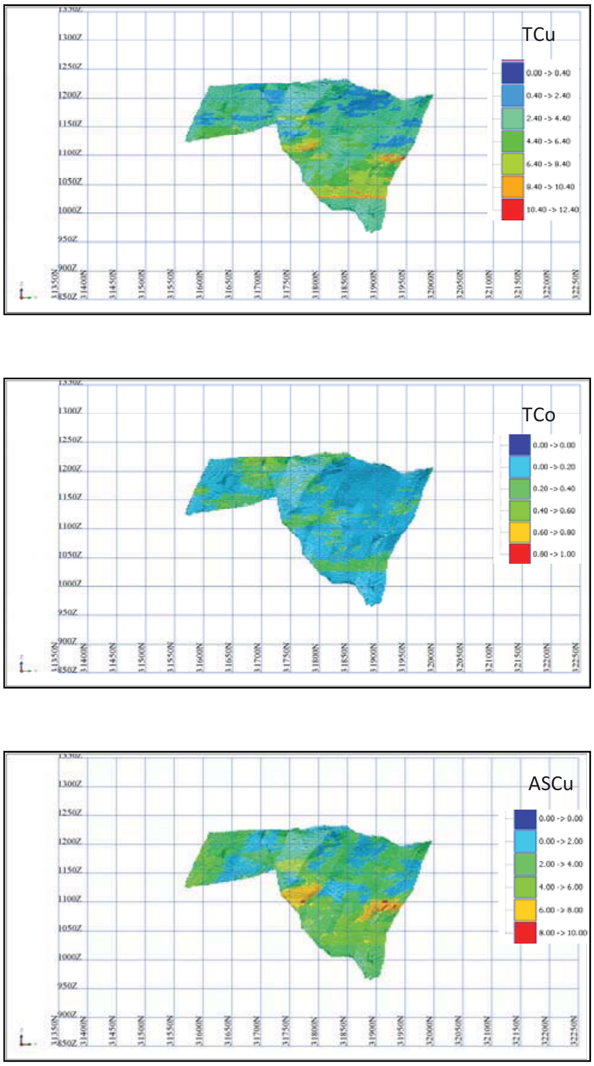


Figure 15: Distribution of %TCu, %TCo and % ASCu grades for Area J

3.7.5.10 C Syncline

The % TCu and % TCo grade distribution for C Syncline is shown in Figure 16.

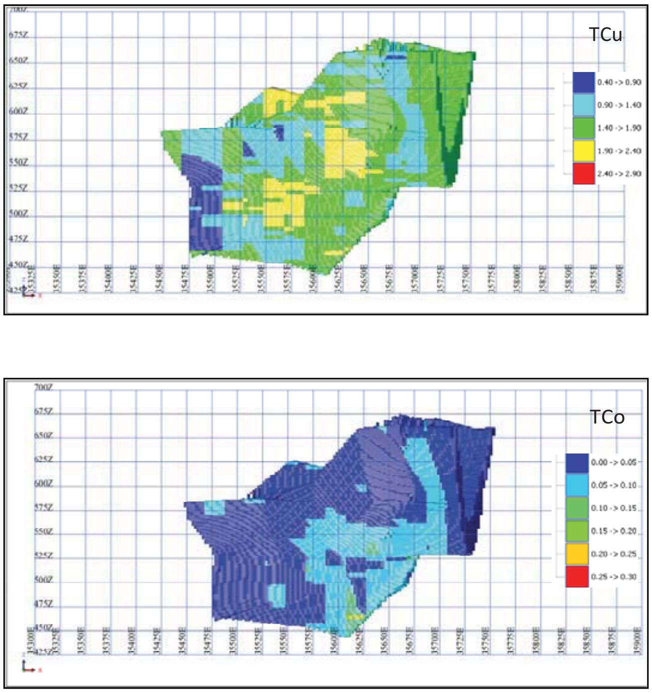


Figure 16: Distribution of %TCu and %TCo grades for C Syncline

3.7.5.11 D Anticline

The % TCu and % TCo grade distribution for D Anticline is shown in Figure 17.

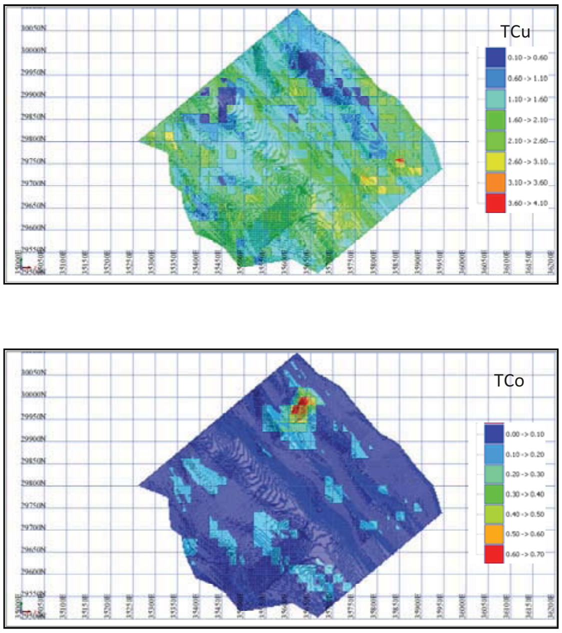


Figure 17: Distribution of %TCu and %TCo grades for D Anticline

3.7.5.12 F Syncline

The % TCu and % TCo grade distribution for F Syncline is shown in Figure 18.

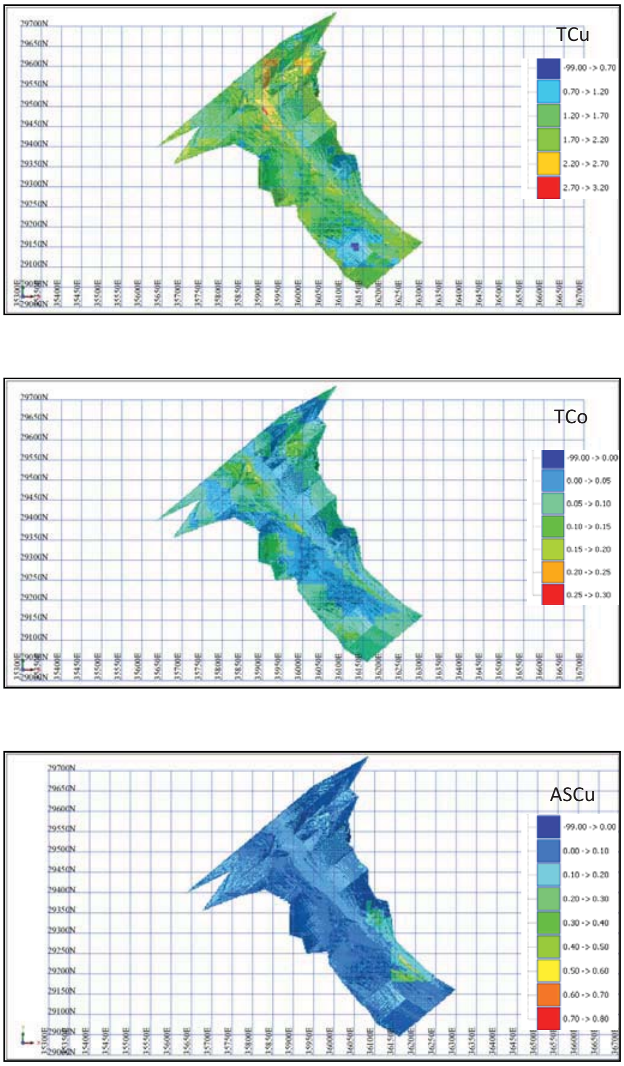


Figure 18: Distribution of %TCu, %TCo and %AScu grades for F Syncline

3.7.5.13 Area K

The %TCu, %TCo and %ASCu grade distribution for Area K is shown in Figure 19.

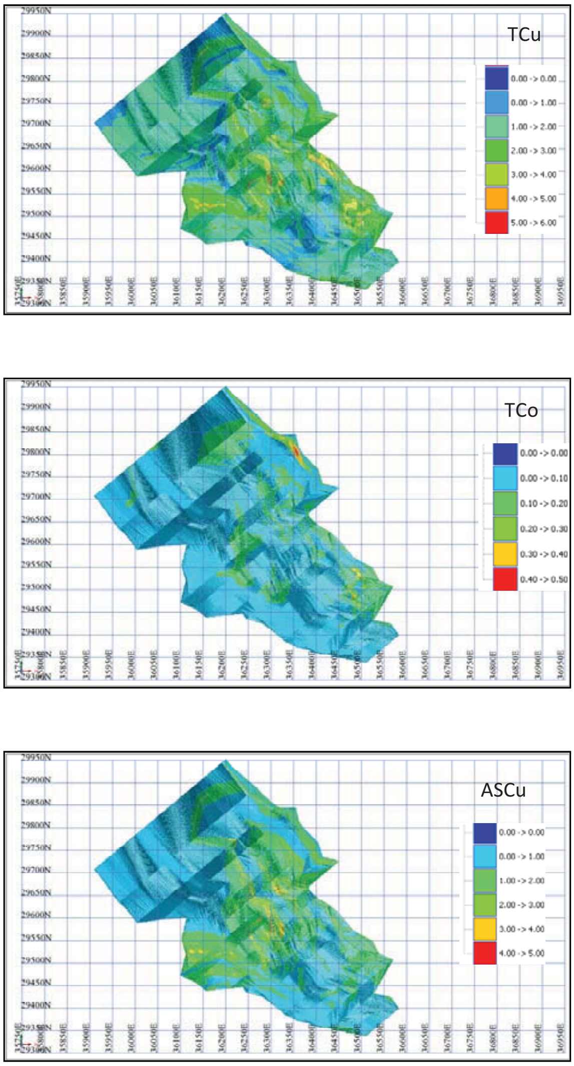
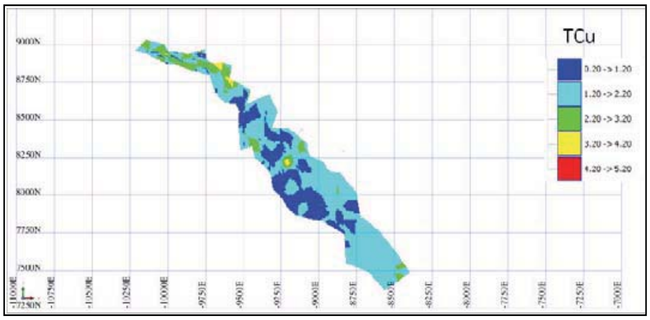


Figure 19: Distribution of %TCu, %TCo and %ASCu grades for Area K

3.7.6 Mufulira Grade Distribution

3.7.6.1 Luansobe

The %TCu and %ASCu grade distribution for Luansobe is shown in Figure 20.



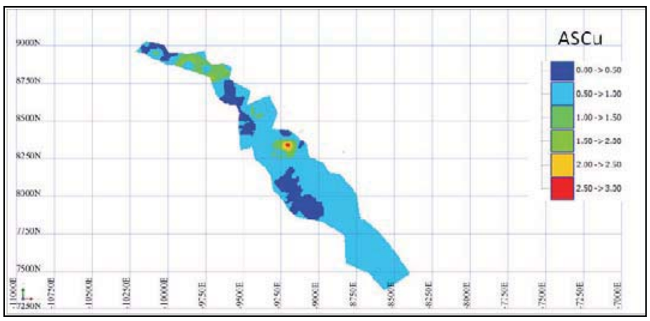
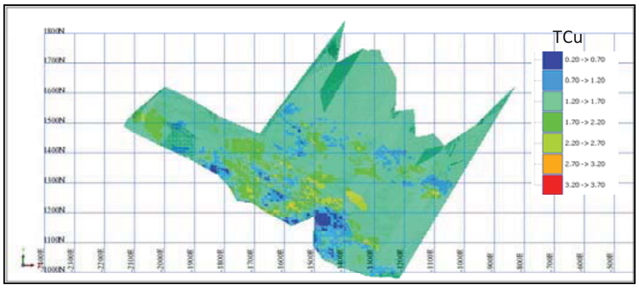


Figure 20: Distribution of %TCu and %ASCu grades for Luansobe

3.7.6.2 Mufulira West

The %TCu and %ASCu grade distribution for Mufulira West is shown in Figure 21



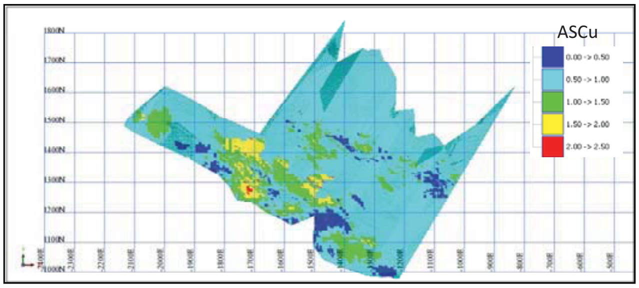


Figure 21: Distribution of %TCu and %ASCu grades for Mufulira West

3.7.6.3 14 Shaft B Orebody

The %TCu grade distribution for 14 Shaft B Orebody is shown in Figure 22.

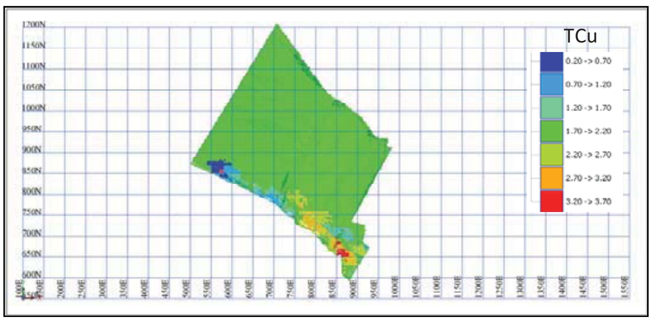


Figure 22: Distribution of %TCu grades for 14 Shaft B Orebody

3.7.6.4 14 Shaft C Orebody

The %TCu grade distribution for 14 Shaft C Orebody is shown in Figure 23.

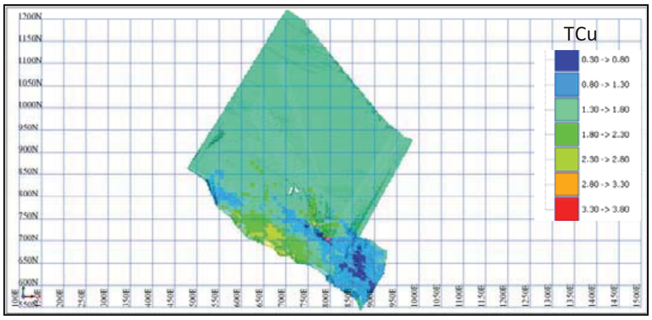


Figure 23: Distribution of %TCu grades for 14 Shaft C Orebody

3.7.6.5 Mufulira Central A Orebody

The %TCu grade distribution for Mufulira Central A Orebody is shown in Figure 24.

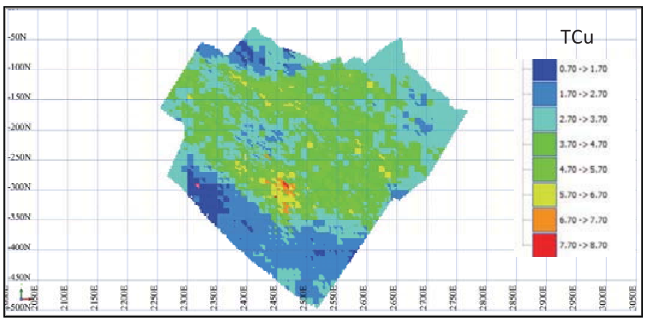


Figure 24: Distribution of %TCu grades for Mufulira Central A Orebody

3.7.6.6 Mufulira Central B Orebody

The %TCu grade distribution for Mufulira Central B Orebody is shown in Figure 25.

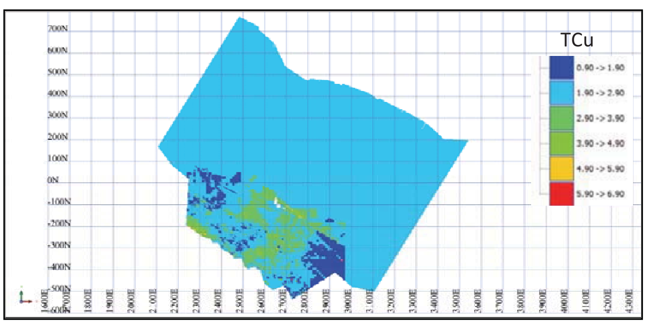


Figure 25: Distribution of %TCu grades for Mufulira Central B Orebody

3.7.6.7 Mufulira Central C Orebody

The %TCu grade distribution for Mufulira Central C Orebody is shown in Figure 26.

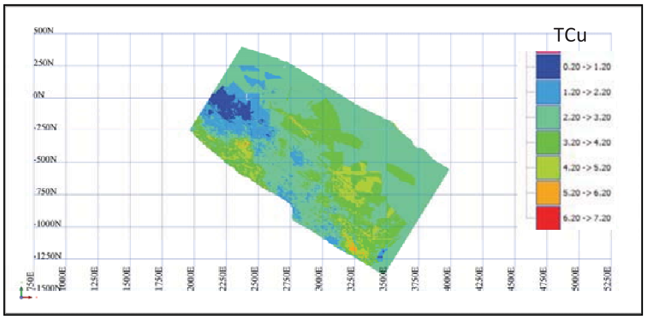


Figure 26: Distribution of %TCu grades for Mufulira Central C Orebody

3.7.6.8 Mufulira Central C 46_51 Orebody

The %TCu grade distribution for Mufulira Central C46_51 Orebody is shown in Figure 27.

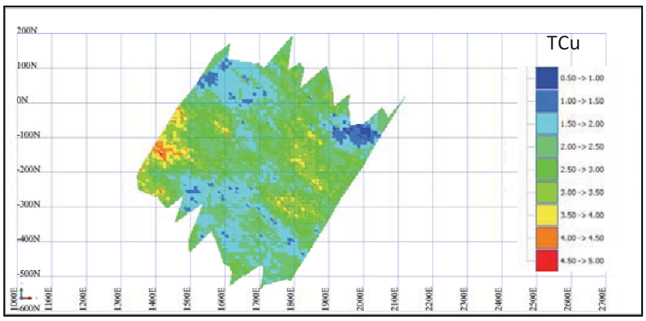
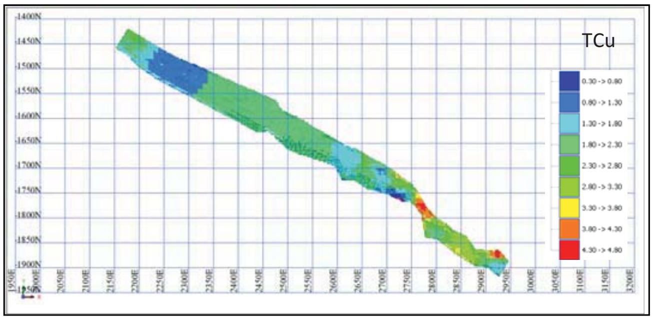


Figure 27: Distribution of TCu grades for Mufulira Central C46_51 Orebody

3.7.6.9 Mufulira East B Orebody

The %TCu and %ASCu grade distribution for Mufulira East B Orebody is shown in Figure 28.



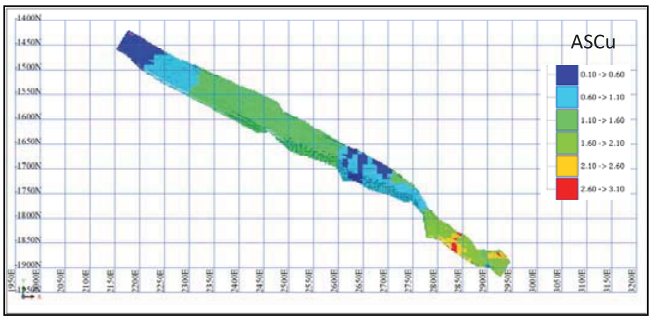


Figure 28: Distribution of %TCu and %ASCu grades for Mufulira East B Orebody

3.7.6.10 Mufulira East C Orebody

The %TCu and %ASCu grade distribution for Mufulira East C Orebody is shown in Figure 29.

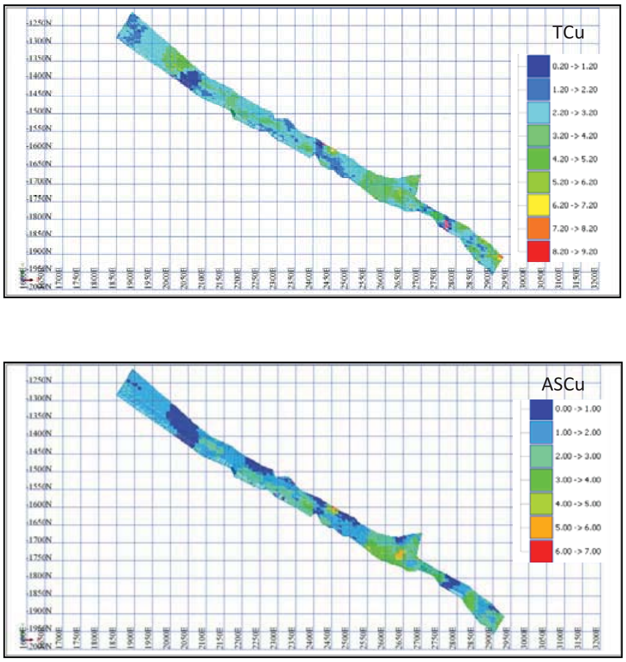


Figure 29: Distribution of %TCu and %ASCu grades for Mufulira East C Orebody

3.7.6.11 Safety Pillar B and C

The %TCu grade distribution for Safety Pillar B and C is shown in Figure 30.

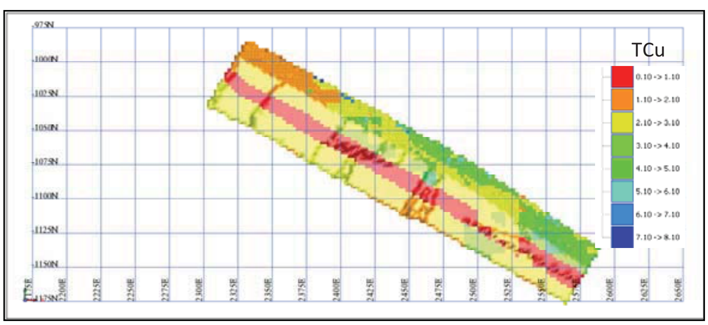


Figure 30: Distribution of %TCu grades for Safety Pillar B and C

3.7.6.12 C Orebody 660

The %TCu grade distribution for C Orebody 660 is shown in Figure 31.

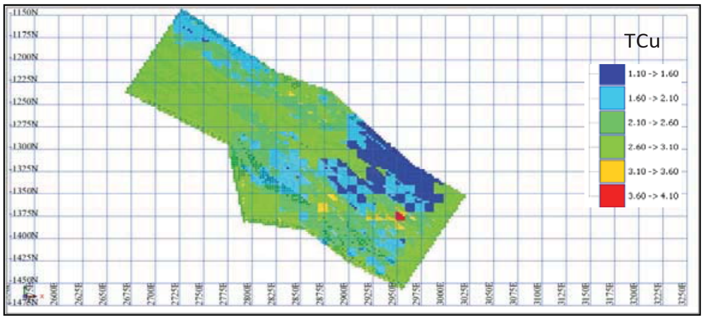


Figure 31: Distribution of %TCu grades for C Orebody 660

3.8 Mineral Resource Classification

3.8.1 Criteria for Classification

The Australian Code for reporting of Exploration Results, Mineral Resources and Ore Reserves, more commonly known as the "JORC Code" was used for mineral resource classification. It describes a Mineral Resource as follows:

"A 'Mineral Resource' is a concentration or occurrence of material of intrinsic economic interest in or on the Earth's crust in such form, quality and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, grade, geological characteristics and continuity of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge. Mineral Resources are subdivided, in order of increasing confidence, into Inferred, Indicated or Measured categories."

It further describes an Inferred, Indicated and Measured Resource as follows:

"*An 'Inferred Mineral Resource' is that part of a Mineral Resource for which tonnage, grade and mineral content can be estimated with only a low level of confidence. It is inferred from geological evidence and assumed but not verified geologically and/or grade continuity. It is based on information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes which may be limited or of uncertain quality and reliability."*

"An 'Indicated Mineral Resource' is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence. It is based on exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are too widely or inappropriately spaced to confirm geological and/or grade continuity but are spaced closely enough for continuity to be assumed."

A 'Measured Mineral Resource' is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence. It is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are spaced closely enough to confirm geological and grade continuity."

The following elements from the JORC Code have been taken into account in the classification of the Mineral Resource areas:

- Pass for estimation;
- Number of samples used in the estimation;
- Anisotropic distance;

- Average distance; and
- Kriging variance.

The Mineral Resources for each area are described in the sections that follow and are based on the data composited within the solid. It is anticipated that once the solids have been reviewed to include more of the analysed data the reliability of the estimate will improve for each area.

3.9 Mineral Resource Statement

A summary of the estimated Mineral Resource with no cut-offs applied, for Mopani's Nkana and Mufulira operations, is shown in Table 12 and Table 13, respectively.

Table 12: Summary of Mineral Resources for Nkana Mine at 31st December 2010

Underground Project Areas	Structure	Measured				Indicated				Inferred				Total			
		Mt	%TCu	%ASCu	%TCo	Mt	%TCu	%ASCu	%TCo	Mt	%TCu	%ASCu	%TCo	Mt	%TCu	%ASCu	%TCo
Mindola North		1.70	1.75		0.13	2.50	2.27		0.13	0.50	1.78		0.14	4.60	2.03		0.13
Mindola		18.20	2.18		0.13	6.80	2.00		0.14	6.80	1.79		0.15	31.70	2.06		0.14
Central	Central and Central North	23.20	1.72		0.14	7.10	1.66		0.23	8.70	1.71		0.23	39.00	1.71		0.18
Synclinorium	Sob, Central and South Syncline	89.30	1.97		0.09	11.10	1.82		0.07	14.90	1.64		0.08	115.50	1.91		0.09
Central Upper Levels	ZJ - Limb					1.70	1.00		0.39	1.90	1.03		0.28	3.60	1.02		0.33
SOB Upper Levels	D - Anticline	1.30	1.21		0.12	3.60	1.65		0.08	1.60	1.57		0.06	6.50	1.54		0.08
	C - Syncline	0.30	1.67		0.04	0.60	1.66		0.05	0.50	1.29		0.04	1.50	1.54		0.04
F - Syncline	Below 1107m	2.50	1.81		0.07	0.80	1.58		0.06	0.40	1.53		0.05	3.70	1.73		0.07
	Nose Area (F Syncline above 1107m)	0.05	1.47	0.14	0.05	0.08	1.53	0.05	0.16	0.008	1.48	0.06	0.13	0.14	1.51	0.08	0.12
SUBTOTAL		**136.60**	**1.94**	**0.14**	**0.10**	**34.30**	**1.79**	**0.05**	**0.14**	**35.30**	**1.65**	**0.06**	**0.14**	**206.20**	**1.86**	**0.08**	**0.12**

Oxide Caps		Measured				Indicated				Inferred				Total			
		Mt	%TCu	%ASCu	%TCo	Mt	%TCu	%ASCu	%TCo	Mt	%TCu	%ASCu	%TCo	Mt	%TCu	%ASCu	%TCo
Area A		0.90	2.59	1.71	0.04	0.02	2.68	1.96	0.03	0.002	2.64	2.06	0.03	0.90	2.59	1.72	0.04
Area D		0.40	3.32	2.47	0.02									0.40	3.32	2.47	0.02
Area J		4.20	3.81	2.76	0.15	0.12	5.68	4.22	0.22	0.02	7.41	4.67	0.28	4.30	3.88	2.81	0.15
Area K		2.90	1.74	1.06	0.09	0.07	1.80	0.99	0.10	0.06	1.94	1.06	0.10	3.10	1.75	1.06	0.09
SUBTOTAL		**8.40**	**2.93**	**2.04**	**0.11**	**0.21**	**4.12**	**2.95**	**0.16**	**0.08**	**3.31**	**1.97**	**0.14**	**8.70**	**2.96**	**2.06**	**0.11**
Remnant/Pillars	**Structure**	**Measured**				**Indicated**				**Inferred**				**Total**			
		Mt	**%TCu**	**%ASCu**	**%TCo**	**Mt**	**%TCu**	**%ASCu**	**%TCo**	**Mt**	**%TCu**	**%ASCu**	**%TCo**	**Mt**	**%TCu**	**%ASCu**	**%TCo**
Mindola North	Pillar	0.80	2.09		0.11									0.80	2.09		0.11
SUBTOTAL		**0.80**	**2.09**		**0.11**									**0.80**	**2.09**		**0.11**
GRANDTOTAL		**145.80**	**2.00**	**0.25**	**0.10**	**34.50**	**1.80**	**0.07**	**0.14**	**35.4**	**1.65**	**0.06**	**0.14**	**215.70**	**1.91**	**0.16**	**0.12**

1) Mineral Resources have been reported in accordance with the classification criteria of the JORC Code.
2) Mineral Resources are quoted inclusive of Mineral Ore Reserves.
3) Mineral Resources are not Mineral Ore Reserves and do not have demonstrated economic viability.

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Table 13: Summary of Mineral Resources for Mufulira at 31st December 2010

Project Area	Orebody	Measured			Indicated			Inferred			Total		
		Mt	%TCu	%ASCu	Mt	%TCu	%ASCu	Mt	%TCu	%ASCu	Mt	%TCu	%ASCu
Luansobe		4.50	1.65	0.78	0.60	1.29	0.66	0.40	1.22	0.76	5.60	1.58	0.76
Mufulira West	D	2.20	1.39	0.91	1.60	1.71	1.26	2.80	1.64	1.04	6.60	1.57	1.05
14 Shaft	B	0.30	2.02	-	0.20	1.88	-	0.30	1.90	-	0.80	1.94	-
	C	1.30	1.22	-	0.30	1.57	-	0.30	1.50	-	1.90	1.32	-
Mufulira Central	A	0.50	3.73	-	0.20	3.40	-	0.20	3.38	-	0.80	3.58	-
	B	2.50	2.56	-	1.00	2.45	-	9.50	2.54	-	13.00	2.54	-
	C	12.40	2.42	-	4.80	3.22	-	23.10	2.84	-	40.30	2.76	-
	C46_51	1.90	2.03	-	0.30	2.43	-	-	-	-	2.30	2.09	-
Mufulira East	B	0.20	2.47	1.43	0.03	1.69	0.80	0.40	1.75	0.93	0.60	1.96	1.07
	C	1.00	2.95	1.99	0.50	2.98	1.33	0.30	2.50	1.63	1.80	2.88	1.76
SUBTOTAL		**26.80**	**2.17**	**0.29**	**9.50**	**2.65**	**0.32**	**37.30**	**2.63**	**0.11**	**73.70**	**2.46**	**0.20**
Historical Blocks													
Remnant 47	C46_51	0.30	2.77	-	-	-	-	-	-	-	0.30	2.77	-
Remnant 50_51	C46_51	0.10	3.10	-	-	-	-	-	-	-	0.10	3.10	-
Safety Pillar	B	0.20	3.41	-	0.03	2.30	-	0.05	1.58	-	0.30	2.89	-
	C	0.30	2.31	-	0.05	2.19	-	0.07	2.15	-	0.40	2.27	-
	Middling	0.20	0.69	-	0.03	0.63	-	0.04	0.61	-	0.30	0.67	-
C orebody 480_660		0.20	2.27	-	0.20	187.00	-	0.20	2.23	-	0.60	2.11	-
SUBTOTAL		**1.30**	**2.37**	**-**	**0.30**	**1.86**	**-**	**0.37**	**2.19**	**-**	**2.00**	**2.21**	**-**
GRANDTOTAL		**28.20**	**2.18**	**0.29**	**9.90**	**2.62**	**0.31**	**37.6**	**2.62**	**0.11**	**75.70**	**2.46**	**0.20**

1) Mineral Resources have been reported in accordance with the classification criteria of the JORC Code.
2) Mineral Resources are quoted inclusive of Mineral Ore Reserves.
3) Mineral Resources are not Mineral Ore Reserves and do not have demonstrated economic viability.

3.10 Long term prospects

Both Nkana and Mufulira operations have good long term prospects. As part of the resource estimation, GAA evaluated the long term prospects for both operations.

The upside potential for the Nkana Mine is shown in Table 14. The majority of the upside potential extends from Synclinorium through to Central North regions as well as Mindola North and requires further drilling to upgrade the deposit to Mineral Resource. Medium term exploration plans to test this extension and is included in the relevant budgetary submissions. Provisionally projected expenditure is in the region of US 5 million over a 5 year period.

Table 14: Upside Potential for Nkana at 31st December 2010

Project Areas	Structure	Upside Potential			
		Mt	%TCu	%ASCu	%TCo
Mindola North	Mindola North (Single Orebody)	0.40	1.91		0.13
Mindola	Mindola (Single Orebody)	7.40	2.23		0.18
Central	Central and Central North	52.6	1.86		0.23
Synclinorium	Sob, Central and South Syncline	87.5	2.16		0.08
Central Upper Levels	ZJ - Limb	0.40	1.07		0.25
SOB Upper Levels	D - Anticline	1.00	1.61		0.07
	C - Syncline	0.20	1.67		0.04
F - Syncline	Below 1107m	0.60	1.72		0.06
	Nose Area (F Syncline above 1107m)	0.10	1.75	0.10	0.06
GRANDTOTAL		**150.10**	**2.05**	**0.10**	**0.14**

The upside potential for the Mufulira Mine is shown in Table 15. The Mufulira Central deposit is untested at depth, notably the C orebody, where the Inferred Mineral Resource is confidently projected some 300m below the existing ore reserve base. Longer term exploration plans to test this extension and is included in the relevant budgetary submissions. Provisionally projected expenditure is in the region of US 5 million over a 5 year period.

Table 15: Upside Potential for Mufulira at 31st December 2010

Project Area	Structure	Upside Potential		
		Mt	%TCu	%ASCu
Luansobe	Single Orebody	0.30	1.55	0.77
14 Shaft	B	3.30	1.98	-
	C	3.50	1.42	-
Mufulira Central	A	0.10	3.32	-
	B	10.40	2.55	-
	C	13.90	2.97	-
SUBTOTAL		**31.50**	**2.54**	**0.77**
Historical Blocks				
C orebody 480_660	Single Orebody	0.06	2.69	-
SUBTOTAL		**0.06**	**2.69**	**-**
GRANDTOTAL		**31.50**	**2.54**	**0.77**

3.11 References

Garlick, W.G. 1961 Geology of the Northern Rhodesian Copperbelt. In Chambishi, Mendelsohn, F (ed). Macdonald, London, pp 3 – 10.

4.0 DESCRIPTION OF RESERVES

Set out below are the reserve estimates for Nkana and Mufulira. It should be noted that the reserve estimates were completed in December 2010 and are the forecast reserves at 1 January 2011.

4.1 Nkana

The Nkana Mine site is situated in the Copperbelt Province of Zambia. The mine lies in the world famous Copper-Cobalt Metallogenic Province of Zambia-Democratic Republic of Congo ("DRC") Copperbelt. The Nkana ore bodies extend for a strike length of 16 km and lie along the Nkana north-westerly trending eastern limb of the Nkana Synclinorium and the Nkana-Chambeshi Basin. The Mine property lies some 400 km north of Lusaka, the capital city of Zambia and was visited by the mining team during October 2010.

The life of Mine ("LOM") plan and resulting reserve estimate for the open pit and underground operations were conducted by African Mining Consultants ("AMC"), based in the town of Kitwe in Zambia. This document is based on and contains various extracts from the AMC reports.

4.1.1 Mining methods

4.1.1.1 Underground Mining

Underground mining operations at Mopani Copper Mines Plc ("MCM") consist of four active operating underground mines. The underground mining operations are accessed by shafts namely:

- Central;
- Mindola Sub-vertical ("SV");
- South Ore Body ("SOB"); and
- Mindola North.

Underground mining operations started in 1931 with the oldest operating shaft being Central Shaft. Various mining methods are employed depending on existing ore body characteristics and ground conditions.

Vertical Crater Retreat (“VCR”), Sub-Level Caving (“SLC”), and Longitudinal Room and Pillar (“RAP”) are among the underground mining methods employed at the various shafts. The relative tonnage contribution of each mining method in the LOM plan is 13%, 40% and 46% for RAP, VCR and SLC respectively. Average underground production for the last five years is 3.4 million tonnes per annum of ore at 1.94 %Cu and 0.12 %Co.

Mindola SV was opened in 1934. It has three shafts namely, Mindola No.1, Mindola No.2 and Sub-Vertical Shafts. The practical annual hoisting capacities are 1.3 million tonnes for Mindola No.1, 2.0 million tonnes for Mindola No.2 and 2.0 million tonnes for Sub-Vertical Shaft. The mining operations have extended to a depth of more than 1 500m. There are currently six active production areas. The annual production for the last five years is 1.1 million tonnes of ore on average.

Central was opened in 1931. It has three shafts namely, Central, B, and Sub-Vertical Shafts. The practical annual hoisting capacities are 1.4 million tonnes for Central Shaft, 0.9 million tonnes for Sub-Vertical and 0.3 million tonnes for B Shaft. The B Shaft is mainly used for waste hoisting. The mining operations have extended to over a kilometre down. There are currently five active production areas. The annual production average for the last five years is 0.5 million tonnes of ore at 1.62 %Cu and 0.13 %Co.

SOB Shaft was opened in 1952. The practical annual hoisting capacity is 1.7 million tonnes. The mining operations have extended to a depth of 1000m. There are currently six active production areas. The annual production average for the last five years is 1.2 million tonnes of ore.

4.1.1.2 Surface Mining

Four active open pits exist at Nkana; namely Mindola open pit (“MOP”), Area A, Area D and Area J.

MOP was first mined in 1965 to exploit the oxide caps above the Mindola North underground workings. The pit and underground openings are separated by a 25m vertical Crown Pillar. Due to the short remaining LOM, the remaining pit resources were not considered for conversion to Reserves.

Area A pit is an expansion of Mindola pit to the south. A geotechnical analysis of the area was done by Australian Mining Consultants (“AusMC”) in 2007. AMC however recommended that the crown pillar could be reduced from 18m to 12m that implies the availability of a further 6m bench. Depletion of the pit is expected by June 2011 at a planned rate of 40 000 tonnes of ore and 120 000 tonnes of waste per month.

Area D is an oxide cap above the Mindola No.1 Shaft underground workings. The planned ultimate pit depth is 45m. The 18m crown pillar and all other pit design parameters are based on studies done by AusMC on Area A. From October 2010, competent rock has been reached that requires blasting activities. Due to the fact that Area D is located close to a road, dozers are used to rip the fresh rock. The scheduled production from this pit is 40 000 tonnes of ore and 220 000 tonnes of waste per month. Pit depletion is expected by February 2011.

Area J started stripping waste in 2010 and is now producing some low grade ore from the top benches. The Area J open pit is located close to SOB Shaft and is currently under geotechnical studies by AMC to assess the final pit limit, the influence of the nearby caving area and pit design parameters. The current design and schedule is based on the design parameters and modifying factors of Area A. The current design has a maximum depth of 74m subject to the outcome of the geotechnical investigations. Oxides below the planned pit bottom are planned for exploitation using underground methods with access from the pit.

4.1.2 Modifying Factors

4.1.2.1 Underground Mining

Geotechnical

Stope designs are based on recommendations by MCM geotechnical personnel and external consultants. Some of the consultants involved are SRK Consulting Engineers ("SRK"), AusMC, AMC and Itasca.

Economic

A historical cut-off grade of 1%TCu is applied in all underground mining areas and a true thickness cut-off of 10m% constraint used in thin ore bodies.

Mining Efficiencies

The recovery factors as defined and used at Nkana are defined and applied in three stages:

- Extraction: A factor used to account for the net losses of blasted ore due to the mining equipment and mining method inefficiency at the loading and hauling stage.
- Dilution: This factor accounts for the internal and external dilution and economic limits that are broken during blasting handled as ore.
- Recovery: A discount factor used to account for the loss of ore due to the selection of mining method and associated mine layout. The factor caters for the exclusion of planned irrecoverable pillars and other fringe or limit losses on the extremity of the planned mining operations.

Mining related modifying factors applied to the underground mining areas are tabled below. Averages from well monitored stopes were used for recoveries and dilution factors as opposed to the design parameters. Factors were applied globally level by level opposed to stope by stope.

Table 16: Nkana underground mining efficiencies

Mining operation	Structure	Mining method	Recovery	Dilution	Extraction
Synclinorium	SOB	SLC	95%	15%	100%
	Central	VCR	85%	15%	95%
	South syncline	SLOS	85%	5%	95%
SOB Upper levels	F - Syncline	SLOS	85%	20%	80%
	D - Anticline	SLC	95%	20%	90%
	C - Syncline	VCR	80%	15%	90%
Central	Central and Central North	SLC	95%	15%	100%
Mindola	Above 4370	VCR-DD	80%	11%	85%
	4440	SLC	82%	12%	93%
	Below 4440	VCR-UD	80%	15%	83%
Mindola North	Pillar	Room and pillar	54%	9%	70%

4.1.2.2 Surface Mining

Geotechnical

AusMC carried out a review in 2007 concerning the Area A open pit. The results of this report were used as a basis for the design of the Area D open pit and for some preliminary design work for Area J. The geotechnical parameters and resulting slope angles are tabulated below.

Table 17: Nkana geotechnical parameters

Material	Parameter	Unit	Hanging Wall	Footwall
Weathered Material	Berm	metres	3.0	3.0
	Batter Angle	degrees	65.0	65.0
	Batter Height	metres	6.0	6.0
Fresh Rock	Berm	metres	4.0	-
	Batter Angle	degrees	70.0	28-45
	Batter Height	metres	4.5	22.5
	Overall angle	degrees	50.4	45 maximum

Table 18: Nkana design pit slope angles

	Fresh	Weathered	Fresh	Weathered	Fresh	Weathered	Fresh
F/W	30	35	30	35	29	35	48
H/W	50	35	50	35	50	35	50

Mining efficiencies

The following modifying factors have been applied to the various open pit mining areas.

Table 19: Nkana open pit efficiency factors

Mining operation	Mining method	Recovery	Dilution	Extraction
Area A	Open pit	100%	5%	100%
Area D	Open pit	100%	5%	100%
Area J	Open pit	100%	5%	100%

Economic

A GEMCOM Whittle (“Whittle”) pit optimisation was undertaken to determine the economic and optimal extent of the open pits. The parameters used in the optimisation process are tabulated below.

Table 20: Pit optimisation parameters

Parameter	Details	Unit	Area A	Area D	Area J
Recoveries	Dilution	%	10%	10%	10%
	Overall plant	%	85%	85%	85%
	Mining ore loss	%	5%	5%	5%
Capital	Plant	USD	-	-	-
	Infrastructure	USD	-	-	-
	Pre-stripping	USD	-	-	-
	Sustaining (USD 1,000,000)	USD	95,144	112,856	792,000
	Discount rate	%	12%	12%	12%
Limits	Mining (3,600,000 pa)	tpa	-	-	-
	Plant (870,000 pa)	tpa	-	-	-
Mining costs	**VARIABLE**				
	Drill, blast haul (contractor)	USD/t	3.94	3.94	3.94
	Haulage cost		2.56	1.53	1.63
			6.50	**5.47**	**5.57**
	FIXED/TIME COSTS				
	Supervision	USD/Ore	0.35	0.35	0.35
Processing costs	**ROM**				
	Crushing and milling	USD/t	5	5	5
	Leaching, SE/EW	USD/t (sold)	953	953	953
Realisation costs	Marketing, shipping & insurance	USD/t (sold)	330	330	330
	Applied to selling node	USD/t (sold)	**1,283**	**1,283**	**1,283**
Selling price (copper)	2011	USD/t	7,865	7,865	7,865
	2012	USD/t	7,613	7,613	7,613
	2013	USD/t	7,328	7,328	7,328
	2014	USD/t	7,036	7,036	7,036
	2015	USD/t	6,776	6,776	6,776

The result of the optimisation process is tabulated below.

Table 21: Pit optimisation results

Parameter	Value		
	Area A	Area D	Area J
Optimum Pit Shell	30	35	32
Ore tonnes	164,124	218,430	1.455Mt
Stripping Ratio	1.12:1	4.26:1	5.74:1
%ASCu (diluted)	0.83	2.23	1.96
Mine Life:	<1 year	<1 year	2.86 years

The pits were not redesigned to follow the optimum Whittle shells. AMC considered the current pit designs adequate for areas A and D, taking into account the crown pillars and existing nearby surface infrastructure such as roads and buildings. However, the pit design for Area J should be reviewed once the current geotechnical studies by AMC are concluded.

4.1.3 Mining schedule

The LOM production schedule were produced taking into account shaft production constraints and the implementation of the planned Synclinorium Shaft. The availability of multiple active production areas per shaft is commended and makes blending ores feasible.

A total of 2.9 million ROM tonnes were produced from the open pit and underground operations in 2009 at 1.85% Cu. The combined open pit and underground schedules deliver a ROM head grade of 1.83% Cu for a total of 108.1 million tonnes of ROM sulphide ore and a grade of 3.94% Cu for a total of 2.6 million tonnes of ROM oxide ore up to 2035. Production from the open pit operations is planned up to 2012. The peak production rate from underground operations is 5.1 million tonnes per annum from 2018 to 2026 on ore and 1.2 million tonnes per annum on waste in 2014.

The ROM production profiles for each operation at Nkana and a cumulative sulphide copper grade is shown in the figure below. Designs containing Measured Resource and Indicated Resource were included in the LOM schedule. The bulk of the LOM Plan tonnes are planned from Synclinorium Shaft.

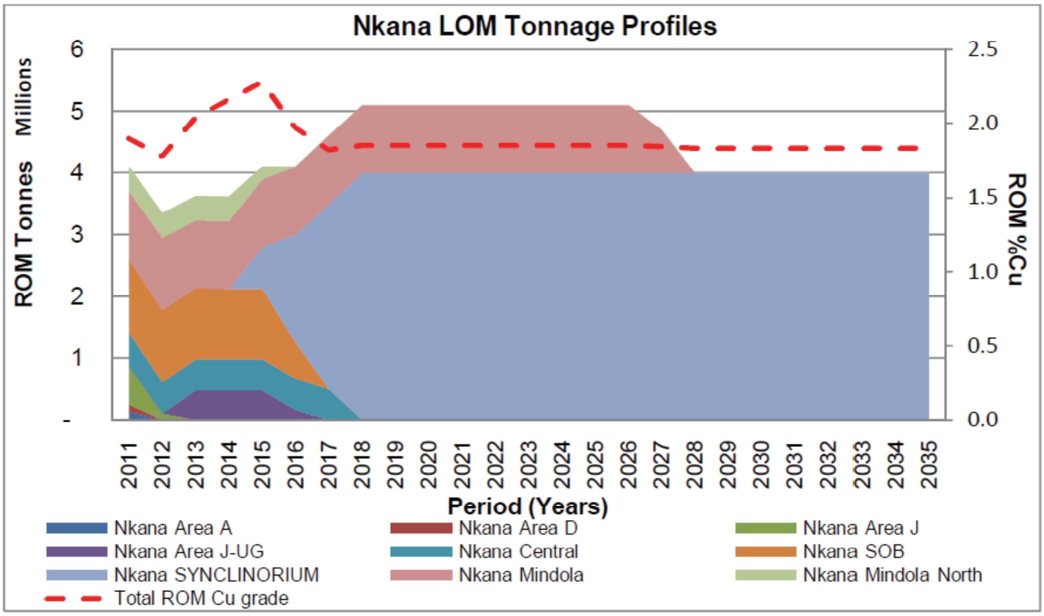


Figure 32: Nkana LOM schedule

The current sulphide plant feed capacity at Nkana is 4.3 million tonnes per annum with additional expenditures approved to ramp up the sulphide plant to 5.1 million tonnes per annum. The required LOM waste tonnage profile is shown in the figure below.

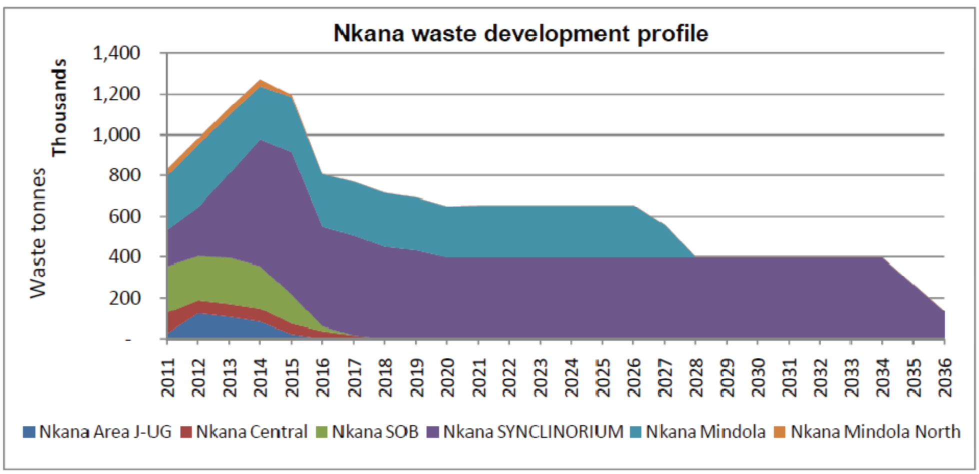


Figure 33: Nkana underground development schedule

Based on average recoveries of 88% for copper and 38% for cobalt, the resulting recovered copper profile is shown below.

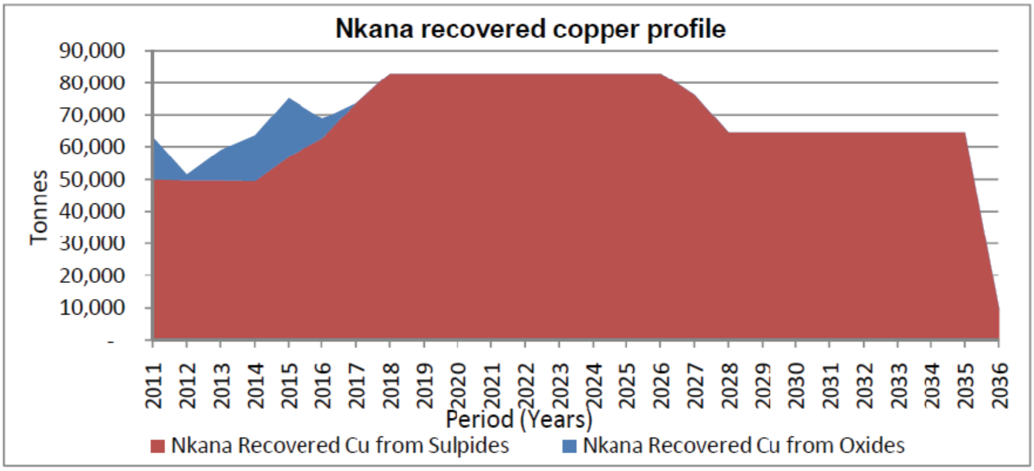


Figure 34: Nkana recovered copper profile

The recovered cobalt profile is indicated in the figure below. A maximum of 1 700 tonnes of recovered cobalt is achieved from 2018 to 2026.

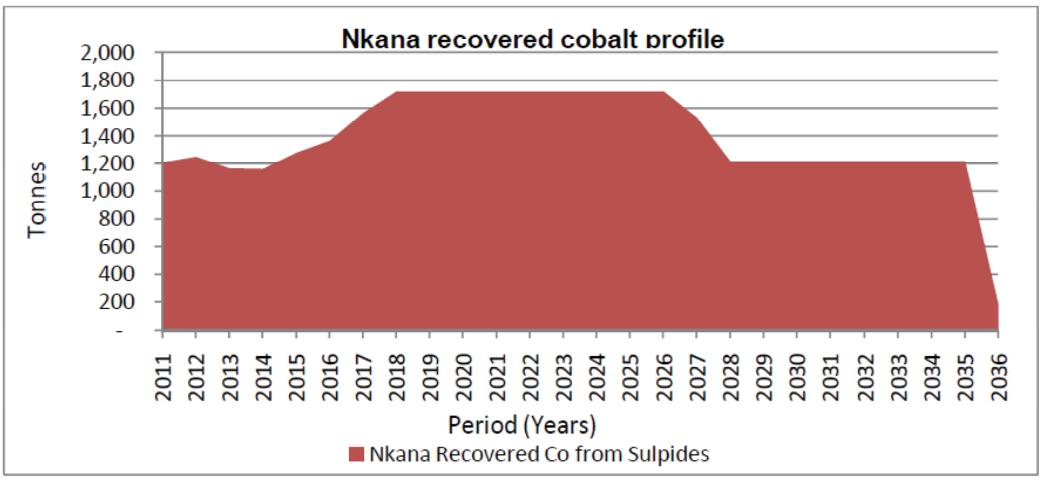


Figure 35: Nkana recovered cobalt profile

4.1.4 Reserve estimate

The mineral reserve is estimated at 110.7 million tonnes proved mineral reserves and probable mineral reserves. The Mineral Reserve consists of 108.1 million tonnes sulphide ore at 1.83% TCu and 2.5 million tonnes oxide ore at 2.85% ASCu. Resources were converted if a mining plan existed and the diluted grade is above 1% Cu. The reserve estimate is tabulated below.

Table 22: Nkana Reserve Estimate

Mining operation	Structure	Proved				Probable			
		Mt	% TCu	% ASCu	% TCo	Mt	% TCu	% ASCu	% TCo
Area A (Open pit)		0.10	1.40	0.69	0.04	-	-	-	-
Area D (Open pit)		0.10	2.91	2.30	0.03	-	-	-	-
Area J (Open pit)		-	-	-	-	0.70	2.54	1.91	0.09
Area J (Underground)		1.50	4.33	3.12	0.16	0.10	6.57	4.52	0.24
Synclinorium	**SOB**	41.70	1.71	-	0.08	4.20	1.85	-	0.07
	Central	15.00	1.86	-	0.09	1.10	1.85	-	0.07
	South syncline	13.20	2.25	-	0.07	2.70	1.88	-	0.06
SOB Upper levels	**F - Syncline**	2.10	1.51	-	0.06	0.70	1.32	-	0.05
	D - Anticline	0.50	1.44	-	0.06	1.50	1.48	-	0.05
	C - Syncline	0.30	1.43	-	0.04	0.40	1.43	-	0.04
Central	**Central and Central North**	4.80	1.65	-	0.12	-	-	-	-
Mindola		2.50	1.86	-	0.16	0.50	2.07	-	0.16
		1.00	1.72	-	0.14	0.30	1.88	-	0.18
		10.30	1.99	-	0.10	3.80	1.79	-	0.12
Mindola North		1.00	1.71	-	0.11	0.80	1.83	-	0.12
TOTAL		**94.10**	**1.88**	**2.89**	**0.10**	**16.6**	**1.83**	**2.21**	**0.22**

Table 23: Nkana Reserve Estimate Summary

	Proved Reserve				Probable Reserve			
Ore type	**Mt**	**% TCu**	**% ASCu**	**% TCo**	**Mt**	**% TCu**	**% ASCu**	**% TCo**
Oxide ore	1.80	4.02	2.89	0.14	0.80	2.84	2.10	0.10
Sulphide ore	92.30	1.84	-	0.10	15.90	1.80	-	0.23
TOTAL	**94.10**	**1.88**	**2.89**	**0.10**	**16.60**	**1.86**	**2.10**	**0.23**

4.1.5 Recommendations

- Area J underground is scheduled for 373 000 tonnes of ROM production in 2012. The Area J pit would be active until the second quarter of 2012 while underground development starts in the third quarter of 2011. This implies simultaneous development of the open pit and underground operations. Accessing the Area J underground ore body could be considered from existing underground workings. Detail studies must be undertaken to create an implementation design and schedule based up updated geological and geotechnical information. Various safety aspects have to be addressed and comprehensive risk assessments should be undertaken to define and mitigate the risks. Any delay in the underground development profile will have a negative impact on the ROM production profile.

- Area J open pit should be re-optimised and the pit redesigned once the geotechnical studies are concluded;
- Three dimensional stope and development designs and schedules should be created in General Mine Planning ("GMP") software. Reserves should be declared on a yearly basis based on the results of the GMP schedule. The current report is based on a general level by block basis. GMP designed stopes (in Surpac in this case) will add value to the existing long term and short term production scheduling.

4.2 Mufulira

Mufulira Mine site lies on the north eastern side of the Kafue Anticline at an elevation of about 1250m above sea level and 10km south of the border with the DRC. The deposit was discovered in 1923 with mine production initiated in 1933.

4.2.1 Mining Methods

The mining methods employed at Mufulira Mine are variants of Mechanised Continuous Retreat ("MCR") which is in essence a sub-level open stoping mining method. The variant mining methods are Mechanised Continuous Retreat 1 ("MCR1") and Mechanised Continuous Retreat 2 ("MCR2"), employed at Mufulira West and Mufulira Central. RAP mining is employed at Mufulira East.

Mining of the Mufulira ore bodies is divided into three areas, Mufulira East, Mufulira Central and Mufulira West. Mufulira Central is further sub divided into three areas, Upper, Central and Deeps based on elevation. The current mining methods used at Mufulira are variants of MCR. This mining method is essentially a sub-level open stoping method. The mining methods involve establishing longitudinal stope blocks across the strike of the ore body.

In the MCR1 mining method, drilling and extraction operations are conducted at each sub-level; with ore body cross cuts developed at 25m intervals along the length of the footwall drive. In the MCR2 mining method, the first sub-level is used as a drilling drive, with no ore extraction on this level. Every second level is used as an extraction level. Ore body cross cuts are developed every 50m on the drilling level and every 25m on the extraction level.

Currently the development drilling at Mufulira is done by both conventional and electro hydraulic rigs. The electro hydraulic rig fleet comprises of a variety of face rigs from major equipment suppliers such as Atlas Copco Ltd and Sandvik mining and construction Ltd. Blasted rock from the development ends is lashed using LHDs. The LHD fleet mainly comprises loaders with a bucket capacity of 4.6 cubic metres. However smaller loaders are also operated.

Production drilling is carried out using long hole electro hydraulic rigs in the mining drive. The holes are drilled in a fan pattern and are directed upwards. Generally the ring burden is 1.8m and the toe burden is 2.1m. The holes are drilled up to the bottom of the crown pillar. Stoping is initiated by creating a slot cut. This cut extends across the ore body width from the position of the slot raise. It is created by firing rings positioned in the cross cut using the slot as a breaking face. The slot cut creates a breaking face for the long hole blasting. Blast holes are charged using bulk emulsion explosives. The stoping direction is always in retreat. The developing of a slot at every 50m interval ensures that the mining echelon is maintained. Ore is extracted from the stopes via cross cuts using LHD's. Depending on proximity of the ore pass, the LHD's either hauling the ore to an ore pass or load into a truck.

4.2.2 Modifying factors

4.2.2.1 Geotechnical

The ore body is massive and generally fairly competent in all the areas with an average uniaxial compressive strength ("UCS") of 200MPa. In most cases, the ore body is moderately jointed with two major joint sets. The footwall of the ore body is characterised by very competent ground with an average UCS of 250MPa and fair to weak ground with an average UCS of 140MPa. The hanging wall of the ore body is fairly competent with an average UCS of 180MPa. The geotechnical studies for the stope designs were done using the updated stability graph by MCM Rock Mechanics Engineers.

4.2.2.2 Economic

Historical cut-offs of 4m true thickness and 2% TCu are applied at Mufulira before applying mining related modifying factors. Internal blocks with grades less than 1% were included in the Reserves as internal stope dilutions.

4.2.2.3 Mining efficiencies

The mining efficiency factors at Mufulira are defined and applied in three stages.

- Extraction: The discount factor used to account for the loss of ore due to the selection of mining method and associated mine layout. The factor caters for the exclusion of planned irrecoverable pillars and other fringe or limit losses on the extremity of the planned mining operations;
- Dilution: The factor covers the internal and external dilution and material outside of the ore zone economic limits, that is broken during blasting and handled as ore during stoping;
- Recovery: A factor used to account for the net losses of blasted ore due to the mining equipment and mining method inefficiency at the loading and hauling stage.

Note: The mining efficiencies are historical terminology in use and defined by the mine and do not necessarily reflect industry accepted interpretations. These factors also have different interpretations at Mufulira and Nkana Mines. The combination of these efficiency factors however does reflect realistically assumed modification.

Since all the scheduled operational areas are active, the factors used were agreed upon between MCM and AMC and were based mostly on historical stope efficiencies. Mining related modifying factors applied to the underground mining areas are tabled below.

Table 24: Mufulira mining efficiencies

Project Area	Ore body	Mining method	Recovery	Dilution	Extraction
Mufulira West	D	MCR2	83%	18%	92%
Mufulira Central	A	MCR1	83%	35%	82%
	B	MCR1	83%	13%	82%
	C	MCR2	83%	30%	92%
Mufulira East	C	R&P	83%	19%	94%

4.2.3 Mining schedule

A total of 1.6 million ROM tonnes were produced from the underground operations in 2009 at 2.0% Cu. The underground schedule delivers a ROM head grade of 2.7% Cu for a total of 12.3 million tonnes of ROM ore, up to the year 2022. The bulk of the LOM production tonnes are produced from Mufulira Central Deeps at 1.0 million ROM tonnes per annum from 2015 to 2022. The peak waste production from Mufulira Central Deeps is 0.3 Mt in 2015.

The ROM production profiles for each operation at Mufulira and a cumulative copper head grade is shown in the figure below. Some Inferred Mineral Resources were included in the LOM schedule for Mufulira Central Deeps. The bulk of the LOM tonnes are planned from Mufulira Central Deeps.

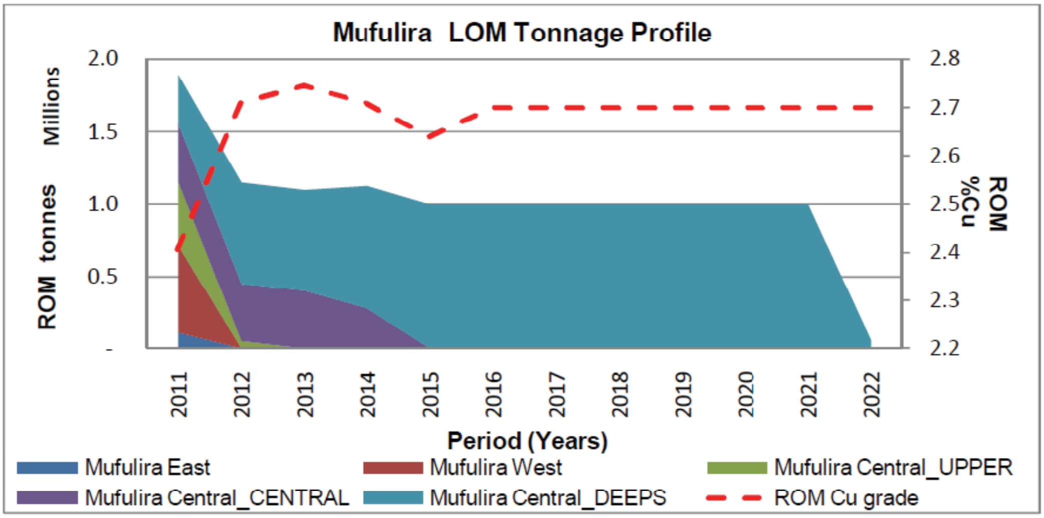


Figure 36: Mufulira LOM Tonnage Profile

The ROM head grade of 2.7% Cu is achieved in 2013 and is maintained on average for the LOM. The current plant feed capacity for the Mufulira is 2.95 million tonnes. It is evident from the LOM profile that less than 50% of the plant feed capacity is achieved. The LOM waste tonnage profiles are indicated in Figure 37.

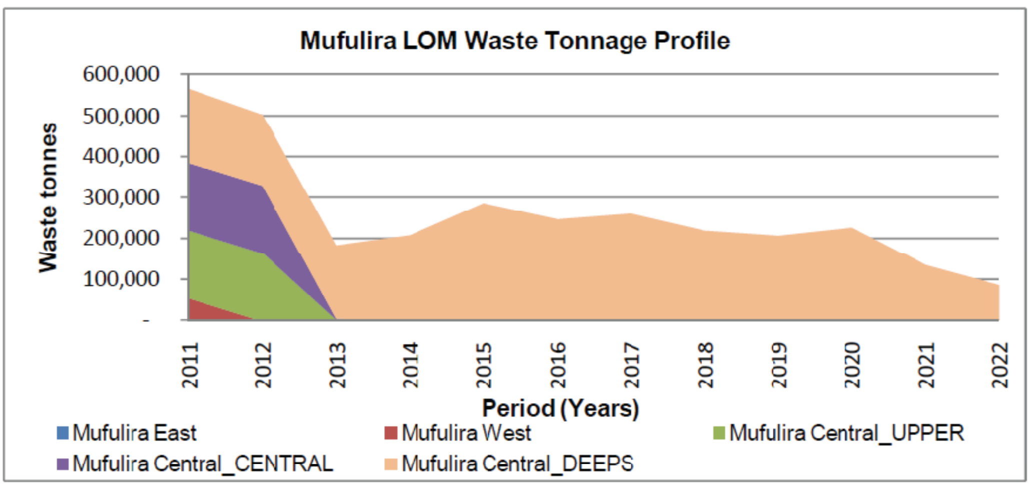


Figure 37: Mufulira waste development profile

Based on average recoveries of 90% for copper, the resulting recovered copper profile is shown below.

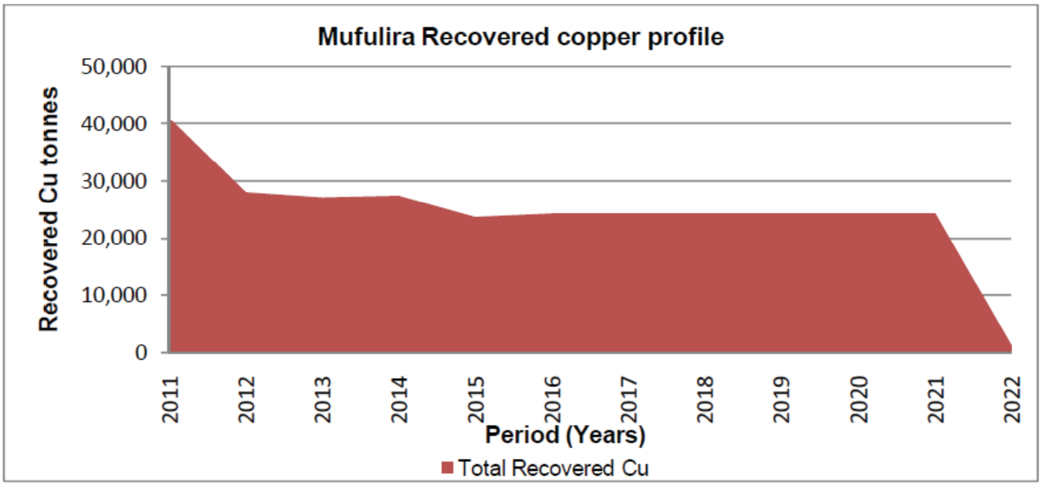


Figure 38: Mufulira recovered copper profile

4.2.4 Mineral Reserve

Mineral reserves were estimated by AMC for MCM-Mufulira Mine as at 31st December 2010. The conversion of the mineral resource estimate into a mineral reserve was based on practical mining methods current efficiency factors and mining related modifying factors. Due to the practical mining layout, 1.7 million tonnes at 2.86%TCu of Inferred Mineral Resources have been included in the LOM plan.

The Mineral Reserve is estimated at 10.6 million tonnes proved mineral reserves and probable reserves at 2.6% Cu and 1.0% ASCu. The reserve table is shown below.

Table 25: Mufulira Mineral Reserve Estimate

Project Area	Ore body	Mining method	Proved			Probable		
			Mt	% TCu	% ASCu	Mt	% TCu	% ASCu
Mufulira West	D	MCR2	0.60	1.17	0.77	-	-	-
Mufulira Central	A	MCR1	0.40	2.83	-	0.20	2.84	-
	B	MCR1	1.20	2.72	-	0.30	2.86	-
	C	MCR2	5.70	2.57	-	2.00	2.99	-
Mufulira East	C	R&P	0.10	3.01	2.03	-	-	-
Total			**8.10**	**2.51**	**0.96**	**2.50**	**2.96**	-

4.2.5 Recommendations

- Three dimensional stope and development designs and schedules should be created in GMP software. Reserves should be declared on a yearly basis based on the results of the GMP schedule. The current report is based on a general level by block basis. GMP designed stopes (in Surpac in this case) will add value to the existing long term and short term production scheduling.
- Sources of dilution should be investigated as the current factors are relatively high.

5.0 PLANT AND EQUIPMENT

5.1 Mopani Mines General Process Commentary

The assets of Mopani Copper Mines reside at the Nkana and Mufulira sites. These are located approximately 50km apart geographically.

For the overall Mineral Experts Report ("MER") it would be sufficient to state that operational processing facilities exist at both sites and that they are more than capable of treating the material arising from the current mining operations at acceptable levels of plant availability and mineral recovery from both the Nkana and Mufulira sites. However, each site was visited and a detailed report generated for each processing installation which follows this preliminary opening narrative.

Mopani Copper Mines is located in the country of Zambia with Nkana located adjacent to the town of Kitwe and Mufulira some 50km to the north east.

Nkana has a mine and processing plant and produces a sulphide rich concentrate which is transported to Mufulira for further treatment. It should be noted that Nkana is reliant upon the facilities at Mufulira to realise copper metal production from its sulphide circuits.

In addition it also produces electro-won cathode copper as final product from its acid soluble oxide ore treatment plant.

At the Mufulira site there is a mine, processing plant along with all of the pyrometallurgical processes of smelters, converters and equipment to produce copper anodes for the electro refining process; here the final copper product is achieved by plating the copper to produce a pure copper cathode with a four nines 99.99% Cu priority.

At Nkana the installed process plant capacity is 4.3 million tonnes per annum ("tpa") while the current throughput is in the region of 3.3 million tpa, at Mufulira the installed capacity is 2.95 million tpa compared to the actual throughput being 1.5 million tpa; the important point to note is that the process plant is neither restricting throughput nor copper production.

All copper and cobalt product is shipped out in sealed containers and is exported via the port of Durban in South Africa; it was explained to us during the site visit that this route has been selected for security reasons and to reduce the possibility of theft.

Both sites, Nkana and Mufulira, were originally built and commissioned in the 1930's and both operations have been operated continuously since then. Where necessary capacity has been increased and capability modified as equipment wore out or became obsolete, technology improved or new markets were realised; an example being the cobalt circuit which was added at Nkana after it became a commodity of "interest" and when it became an economically viable product to produce. It is also significant to note that despite their relative ages both installations are still achieving metal recoveries for copper in the high eighties and appear to be well maintained. It is also pertinent to indicate that at the time of our visit there was a visibly good standard of housekeeping around both sites.

At Nkana the cobalt floats with the copper and then has to be separated out by a differential float using lime to alter the pH and sodium cyanide; this is not an exact process and as a result some of the copper remains within the cobalt stream which is recycled in the process and recovered later.

From 2000 onwards both sites introduced solvent extraction ("SX") technology with the incorporation of mixer settlers and these enable a more precise split between the copper and cobalt to be obtained and as a result the copper and the cobalt can be plated out as metal in their relevant electro winning ("EW") sections at Nkana while at Mufulira SX enables the oxide soluble copper to be recovered.

Both sites feature additional processing capability, at Nkana there is an oxide plant which recovers the acid soluble copper via leach, counter current decantation ("CCD") and SX while at Mufulira there is an underground leach of the oxide type ores also to recover the acid soluble copper via SX while the sulphide copper ore is mined and sent to the process plant for recovery through the main processing circuit, smelter and electro-refining sections.

Ideally and if the ore body were to be discovered in current times a significantly different plant footprint would be seen, however both Nkana and Mufulira have the process plants that they have and are making the best of the situation.

As indicated earlier at Nkana the flotation circuit has been upgraded by the addition to the flotation circuit of both tank cells and column cells with the existing cells being retained and still utilised just in a different duty, while at Mufulira the process plant has seen an upgrade to the milling section with the addition of the new "Vecor" mills.

It would seem unlikely that at this stage in the life of both mines that large scale replacement of the process plant equipment would be carried out but that is to some extent determined by the geology and the size of the deposit that remains as recoverable.

In summary both the Nkana and Mufulira sites have sufficient processing capability to treat all of the material produced by the mining operations and in addition both sites are achieving acceptable levels of metal recovery.

5.1.1 Valuation of the Plant

It is difficult to place a value on the process plant at the Nkana and Mufulira sites as they have been in place for some 80 years and modified and added to with the passage of time.

If the process plants were to be built today, they would be a much more streamlined and modern process with a smaller footprint. Undoubtedly the plant has long been paid back from the operating revenue and certainly cannot owe money at either site. A sensible option would be to cost a replacement and discount the value.

In reality the value of the plant lies in its ability to treat all of the material coming from either above the ground open pit operations and the underground operations.

The value of the plant and equipment has been taken into account in the economic valuation set out in Section 12.0.

5.2 Nkana

5.2.1 Introduction

A plant site visit to the Mopani Copper Mines, Nkana the "concentrator" was undertaken on 16 October 2010.The main feed to the concentrator plant is copper/cobalt ore from underground with occasional supplementary feed ore from the open pit.

The open pit material is predominantly oxide type material while the feed from underground is mainly sulphide in nature this will dictate the type of plant to be built in order to treat the ore. It should be noted, at this point, that operations commenced at the Nkana site in the early 1930s' and have carried on continuously since then and, while the plant may not be what would be constructed if the ore body were to be discovered today, the process plant still satisfies the requirements as it treats all of the material fed to it with capacity to spare and does this at an adequate level of recovery efficiency of copper and cobalt and plant availability.

It should also be borne in mind that in the 1930s' there was no identified use for cobalt and, as such, this is a comparatively recent addition to the flow sheet.

At the time of the site visit, all of the equipment was in a useable condition and it was clear from our walk round the plant that there is a high degree of emphasis on housekeeping as spillage and general rubbish was minimal and things were generally tidy. In addition, we were informed that the plant is closed on a regular basis during morning shift in order to perform routine planned maintenance.

5.2.2 The Process Plant

5.2.2.1 Ore Reception and Crushing

Ore is received from underground from the Mindola, SOB and Central Shafts. Mindola and SOB are outside the plant area and ore is railed across to the concentrator while ore from Central is delivered into the ore reception bin. The mined ore is initially passed through a primary crusher underground before transport to the surface except ore from Central Shaft which is passed through a dedicated primary crusher in the concentrator. The plant was off line at the time of our visit so it was not possible to verify the actual material size.

Material is transported by conveyor into a bin prior to being fed into the secondary crushers which are 7 foot Standard Symons cone crushers with a gap setting of average 30 mm; these discharge onto a screen with the undersize passing to the mill feed bin and the screen oversize passing into the 7 foot short head crushers which are set at an average 18 mm gap and are in closed circuit with a sizing screen the oversize is recycled back into the crushers and the undersize joins the undersize in the mill bins.

5.2.2.2 Milling

Figure 39: Mill Building at Nkana

Milling units comprise of a rod mill working with a ball mill, feed from the bin goes into the rod mill and the discharge passes to a cyclone where the overflow reports to the flotation circuit while the cyclone undersize reports to the ball mill feed, the ball mill discharges into the same rod mill discharge sump which again pumps up to the cyclone, this ensures that only correctly sized material passes to the flotation section. The mine source rods, balls and liners locally.

5.2.2.3 Flotation

Cyclone overflow from the milling section is fed into four “tank cells” where xanthate and frother are added. The tank cell tailings pass into the old flotation section of the plant where they undergo further flotation in Wemco type float cells; these cells are divided in duty in that the first few cells send their concentrate with the tank cell concentrate while the latter cell concentrates report back into a middlings stream which reports back to the mill sump.

The Wemco cell tailings pass as final process plant tailings via the tailings thickener.

The combined tank cell and Wemco concentrates pass to the Primary column cells for a cleaner float with the Primary column tailings passing to a Secondary column for further flotation where the concentrate is combined with the primary column concentrate and moves into the next step of the process and the secondary column tailings is recycled back to the mill sump.

5.2.2.4 Splitting Copper and Cobalt

Under the flotation conditions in the process a concentrate has been produced that contains both the copper and the cobalt. It is now necessary to split the two into discrete streams; this is achieved by raising the pH to 12 with the addition of lime and adding sodium cyanide a copper rich concentrate can be floated off in a dedicated column cell leaving the majority of the cobalt behind. However, this is not an exact separation and the aim is to achieve a copper only concentrate leaving behind some of the copper in the cobalt stream. There is additional flotation capacity which is used in rougher, cleaner and scavenger duties with the concentrate being added to the copper concentrate. The copper concentrate is on average 30% Cu and 0.4% Co while the cobalt stream is on average 10% Cu and 1.8% Co.

The copper concentrate produced is thickened in a concentrate thickener and then through a disc ceramic filter to produce a filter cake which is passed into the storage shed prior to being trucked to the pyrometallurgical plant at Mufulira for the recovery of the copper into metal.

A portion of the cobalt stream is pumped to the Cobalt Plant for recovery of the cobalt while the remainder passes into the rotary drum filter plant to produce a filter cake which is also transported to Cobalt Plant to extract copper and cobalt. The Nkana process plant did originally have its own dedicated smelter but when the mines were up for sale Mopani did not purchase the pyrometallurgical complex and now relies upon Mufulira to realize the bulk of its revenue stream.

The cobalt concentrate is treated through a Roast-Leach-SX/EW route. A new roaster was installed replacing the obsolete one in 2006.

Figure 40: Old and New Roaster at Nkana Cobalt Plant

5.2.2.5 Other Processing Capability

In addition and comparatively recently in the 80 year life of the Nkana facility a copper oxide recovery plant has been added and this follows the more modern and conventional approach to the recovery of copper, albeit on a smaller scale than the sulphide plant that is milling, leaching, CCD circuit, SX/EW to give a copper product. This facility treats oxide ore from the open pits and uses milling and leaching to remove the metals into solution.

New standard crushers have been installed in the circuit to improve the crushed ore size to 25 mm for efficient feed to the SAG mill (Ref Figure 41)

Figure 41: New Standard Crusher in Nkana Leach Plant

Figure 42: "Oxide" Plant Mill Installation

This is then followed by a counter current decantation ("CCD") section.

Figure 43: The Oxide Plant CCD Circuit

This produces a relatively clear solution which then passes to the solvent extraction ("SX") CCD's further enhance recovery of copper from leached solids into solution.

Figure 44: Solvent Extraction (SX) Building

Here, in the solvent extraction process, is where the metal in solution is taken into an organic phase and then, in a second reaction back into spent electrolyte which is now in a form that the metal can now be plated out in the electro winning ("EW") section.

5.2.3 Electrowinning

Nkana has both copper and a cobalt tank houses in which each of the metals is electroplated out of solution onto stainless steel cathode plates.

The tank houses are the final process for Nkana oxide leach/SX and copper cobalt Roast-Leach-SX plants where metal product is obtained, the EW process effectively acts as a cell passing the current through the cell from the lead anode to the stainless steel cathode plates through the loaded solution and the positively charged metal particles are plated in the form of copper metal onto the cathode plates.

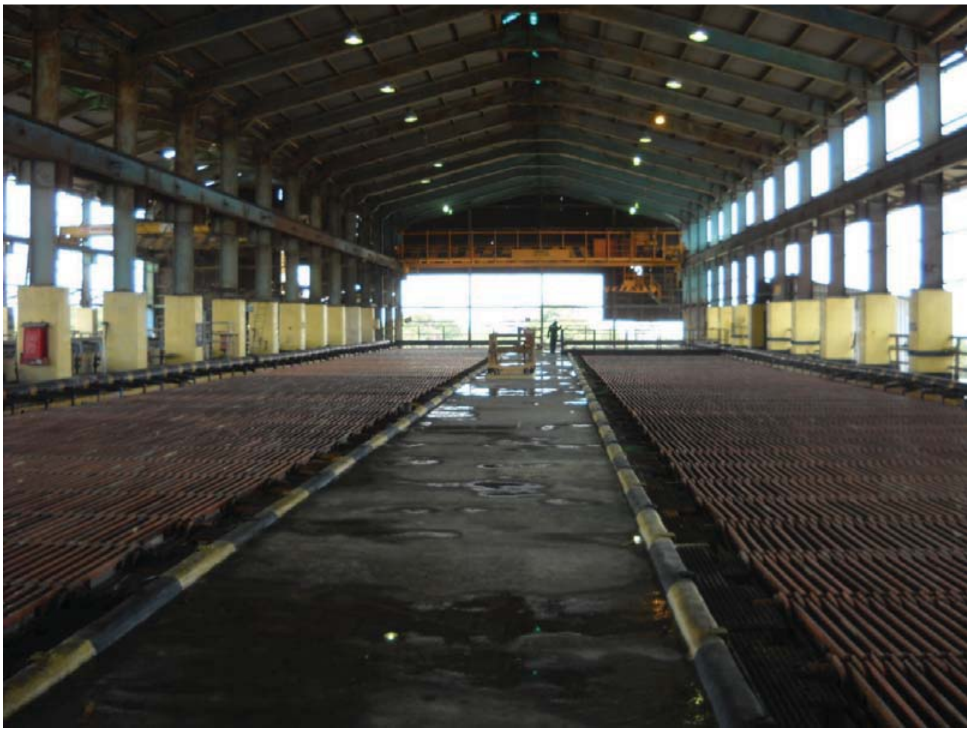


Figure 45: Nkana Copper Tank House

The tank houses contain the final process in the concentrator; this is where metal product is obtained, the EW process effectively acts as a cell passing the current through the cell from the anode to the cathode through the loaded solution and the positively charged metal particles (anions) are plated in the form of copper metal onto the cathode.

5.2.3.1 Copper

For copper the electrodes when they have reached a sufficient thickness are stripped off of the stainless steel cathodes in the stripping machine, strapped together in bundles of 40 copper plates and weighed prior to export.

5.2.3.2 Cobalt

With regard to cobalt the EW process plates out the metal onto stainless steel cathodes in a similar manner to copper EW. The stripped cobalt metal plates are crushed into metal chips. The crushed pieces are placed in a degassing furnace and heated to temperature of 800 degrees Celsius to diffuse out hydrogen from the metal matrix. The metal is then tumbled in a mill to restore the “shine” to the metal flakes these are then drummed and shipped out. The cobalt metal produced is at least 99.65% purity and its band are listed with the LME.

5.2.4 Copper Cobalt Metal Transportation

The copper cathodes in bundles are loaded in containers/rail wagons and transported via Dar-Es Salaam (Tanzania)/Durban (South Africa). The drummed cobalt product are packed into containers and trucked out to leave the continent via Durban in South Africa. For cobalt this method is preferred to the more direct route via Dar es Salaam as it poses a much lower security risk.

5.2.5 Maintenance

As indicated maintenance is carried out on a regular basis and is programmed to take place on the morning shift which means that everyone is available should they be required. It is important to note that Mopani have realised the overall benefit to the operation to maintaining a planned maintenance schedule and it is to their credit that the equipment is still running.

5.2.6 Risk

It is pertinent to highlight the risks that could impact significantly upon the Mopani operations and they are as follows:

- an extended power failure, the Nkana plant does not have a significant emergency power generation capability and should the power fail for an extended period without prior notification the consequences will be severe;
- a water in rush in the mine will obviously stop the ore extraction process; and
- a significant reduction in the copper price, will clearly affect the profitability of the process.

5.2.7 Flow Sheets and Aerial Photography

The following block flow diagrams show the actual process step in the Nkana plant and the aerial photographs attempt to give an overall feel of the size of the Nkana installation to the reader.

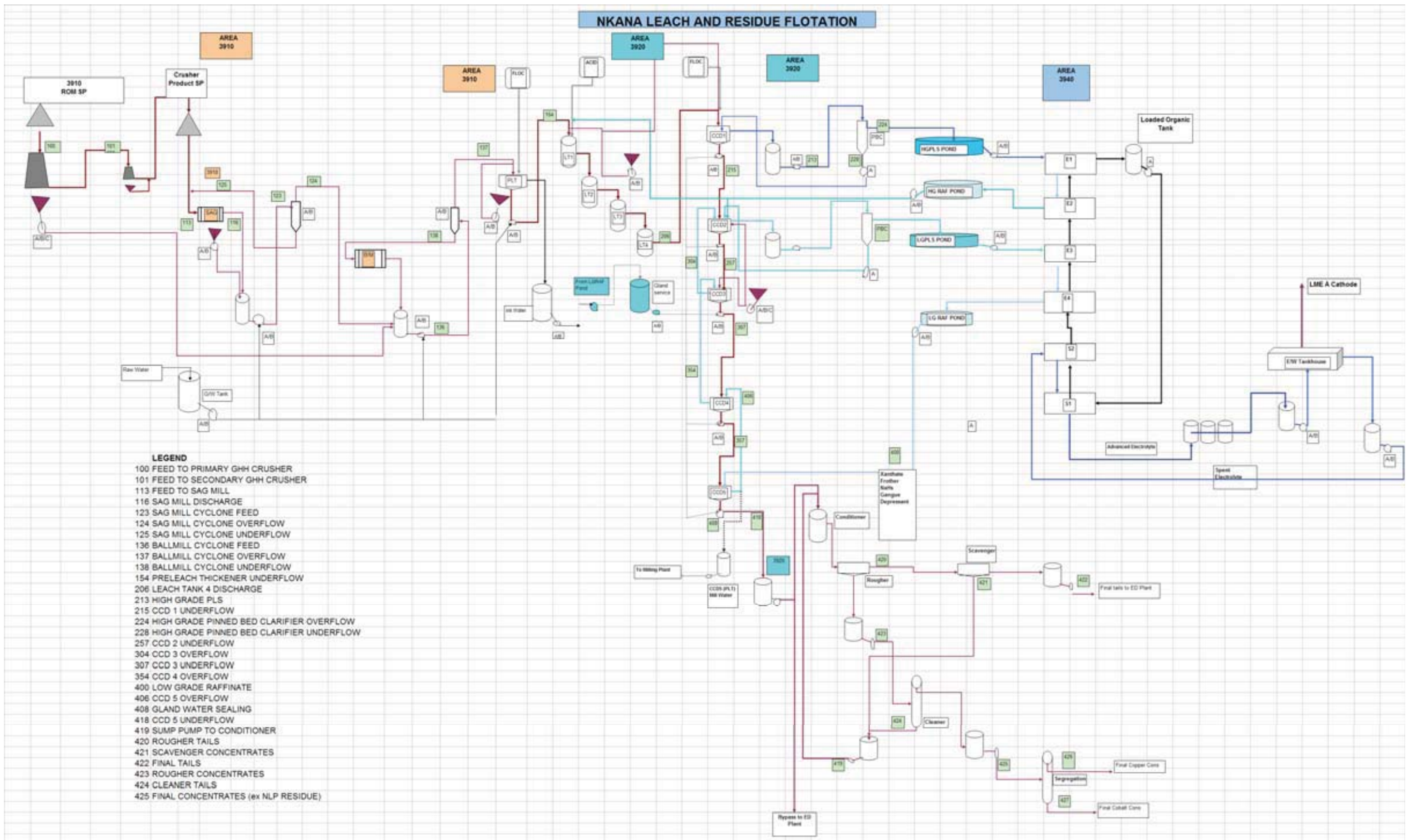


Figure 46: Nkana Leach and Residue Flotation

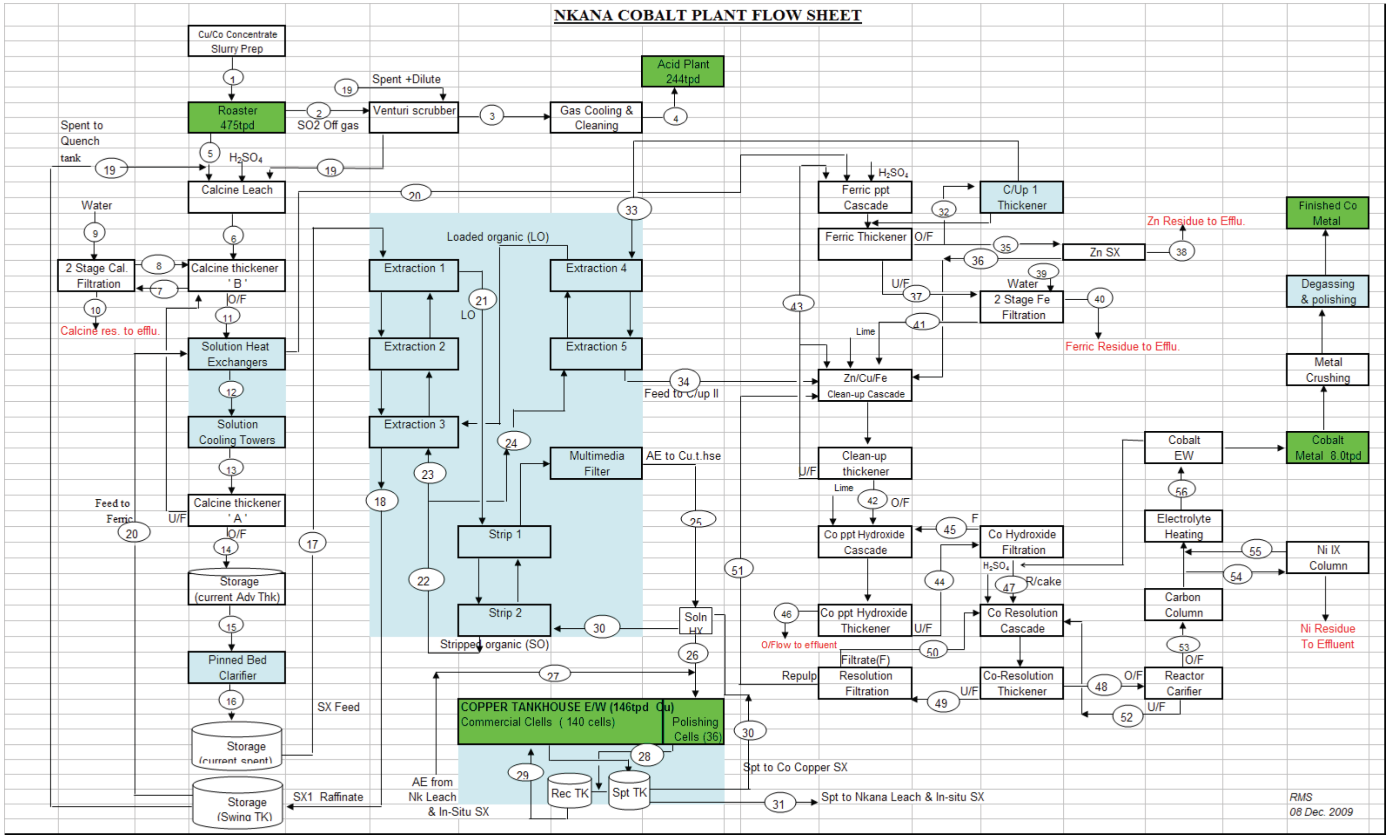


Figure 47: Nkana Plant Cobalt Recovery Flow Sheet

5.2.8 Summary

The Nkana installation is old and that technology has moved on sufficiently such that a plant like this would not be built today.

However, it has been modified with the inclusion of new equipment i.e. the flotation tank and column cells that will bring copper recoveries up to that of a more modern facility, refer to the following table.

Comparing Nkana against other sites recovering the same materials within a 100km radius it is in a far better condition, is cleaner and, it appears that there is far more emphasis on housekeeping by Nkana management and staff. The plant is old but it is currently satisfying operational requirements. With the introduction of the oxide leach plant it is securing its future from a processing perspective.

5.3 Mufulira

5.3.1 Introduction

A site visit to view the Mopani Copper Mines facilities at Mufulira was undertaken on the 17th of October 2010. Our host for the visit was Narain Goyal the Chief Processing Officer at Mufulira.

The SNC/GAA group split up in order to allow the geologist and mining engineer time to visit the open pit operations while the remainder of our group took part in a visit around the processing and smelting facilities.

Like Nkana, Mufulira has been an operating facility since the 1930's; opening slightly after the Nkana operation began and has been in use continuously since then. Although the Mufulira operation has a lower rated throughput than Nkana, Mufulira is an important part of the Mopani operations as it not only has its own mineral processing and concentration plant but importantly has the pyrometallurgical smelting, converting and casting facilities along with the electro refining capability that Nkana lacks to convert its concentrate obtained from its sulphide ore processing facility into final metal product.

The big difference is that Mufulira has very low levels of cobalt and as a result does not have a cobalt circuit

While the processing plant at Mufulira is old it has been subjected to several upgrades and modifications as either equipment became worn out and was replaced by newer equipment or as processes generally improved and these improvements were added to the flow sheet during its lifetime, examples of this are the Vecor mills and the column cells along with the underground and surface heap leach plants to recover the acid soluble copper.

5.3.2 Process Description

The following narrative attempts to describe the flow of material around the processing circuit and the accompanying photographs show the equipment items and general condition.

5.3.3 Ore Reception and Crushing

Crushed ore is received from 5, 7 and 14 Shafts and is transported by conveyor from the underground skip and is discharged into the secondary and tertiary crushing circuits with the tertiary crushers being in closed circuit to ensure that no oversize passes downstream into the milling circuit.

Two SHD Hydrocone crushers were installed in 2004 and one in 2005. Also one STD crusher was installed in 2005 and another one 2006 in the crushing section to replace obsolete secondary and tertiary crushers. (Ref Figure 48)

Figure 48: New SHD Hydrocone Crusher

Figure 49: Secondary and Tertiary Crusher Building

5.3.4 Milling

Material is drawn from the fine ore bin and is fed into each of the eight “Hardinge” ball mills and the two “Vecor” mills according to the requirements. The fine ore bin holds approximately a 12 to 15 hours buffer capacity of mill feed, depending upon the number of mills running at the time.

With all eight Hardinge mills working along with one Vecor mill running and an availability of 95% daily mill capacity is 6 749 tonnes or 281 t/h. This is equivalent to the downstream plant capacity.

Figure 50: Mill Feed Bin

The original installation was the twenty eight Hardinge Mills, with a throughput of 27 t/h each and the Vector Mills installed later as a maintenance cost reduction measure. Each Vecor Mill replaced three Hardinge Mills in terms of capacity. These were installed with the rated capacity of 80 t/h each but later optimised to 90 t/h each. These are located 90º to the Hardinge installation at either side of the Milling building.

There is also regrind milling capacity available but this was not running at the time of our visit with one of the mills having its liners removed awaiting relining and the second being charged with balls; it is presumed that the mills will be returned to service once the work has been completed.

Flotation Plant

Milled ore passes into the flotation circuit where it undergoes a series of rougher and cleaner floats, the result is a final tail and a concentrate along with various streams recycled internally to be returned to the regrind circuit and further flotation to help increase the recoveries. Cleaner flotation is performed in the column cells.

The column flotation concentrate passes into the concentrate thickeners with the thickener underflow reporting to the disc filters which then produce a filter cake with a moisture content of ±10%. The filter cake is then discharged onto a conveyor where it passes to a storage area to await treatment in the pyrometallurgical section.

Figure 51: Rougher and Cleaner Flotation (Photograph 1)

Figure 52: Concentrate Thickener

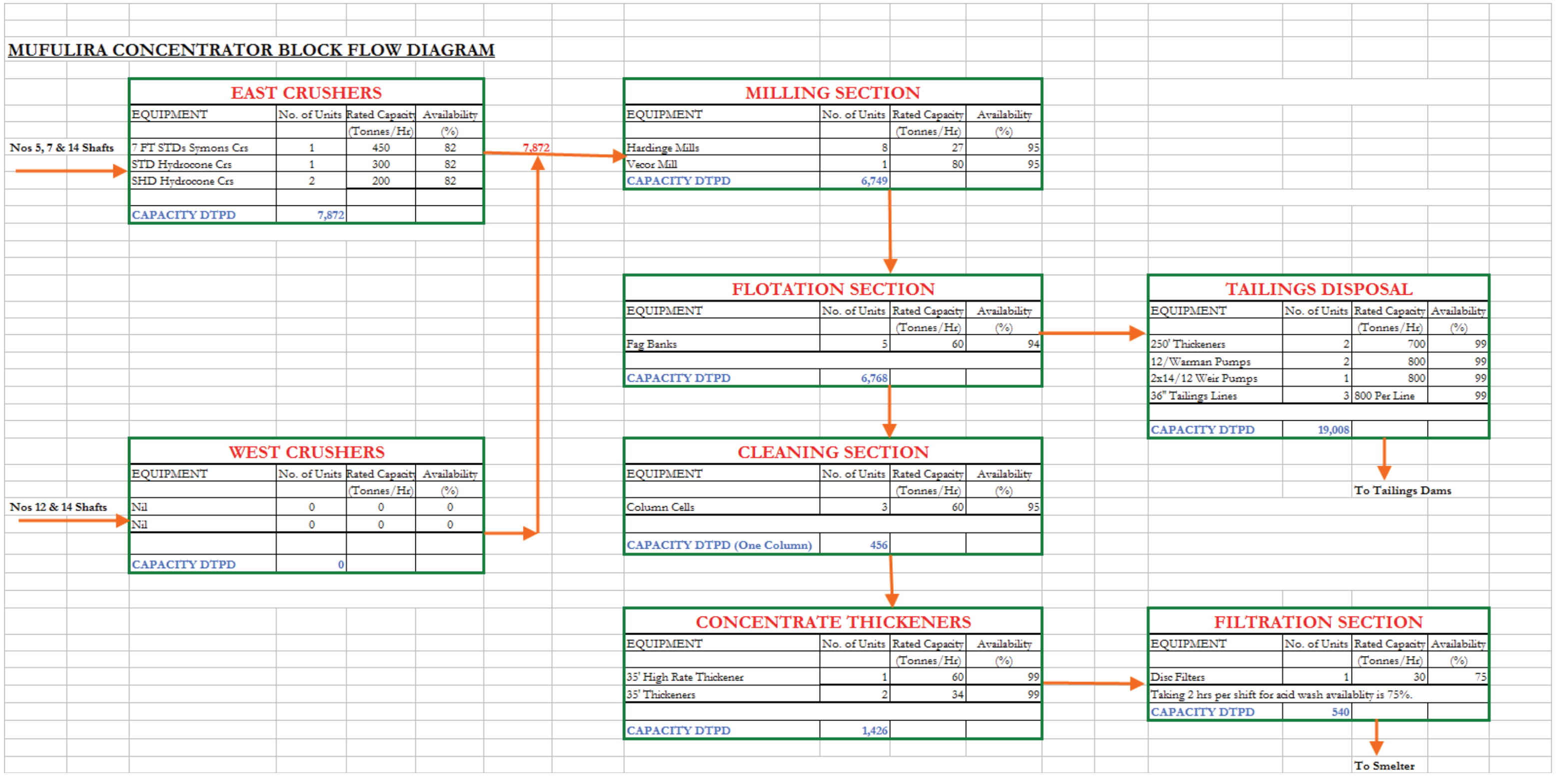


Figure 53: Mufulira concentrator Flow Diagram

5.3.5 Pyrometallurgical Section

This is an important processing operation as it treats both Nkana and Mufulira sulphide.

5.3.5.1 Smelting, Converters and Anode Casting

The initial metal production is via the Isa Smelt furnace. Here the concentrate is blended with flux and reductant in the form of coal and fed into the Isa Smelt furnace. A mixture of matte and slag is tapped from time to time into Matte Settling Electric Furnace ("MSEF") for separation.

ISA smelt furnace uses reaction heat to effect smelting and electricity provides the heat source in MSEF. The SO_2 is captured and used in the acid plant to make sulphuric acid (H_2SO_4).

Products from the MSEF are matte and slag. 'Matte' is tapped into a ladle and is transported to the converters using the main aisle overhead cranes. Slag is skimmed and granulated with high pressure water jet. The granulated slag is recovered by mechanical grab and fed into a bin. The slag is disposed off to the slag dump using the dump trucks.

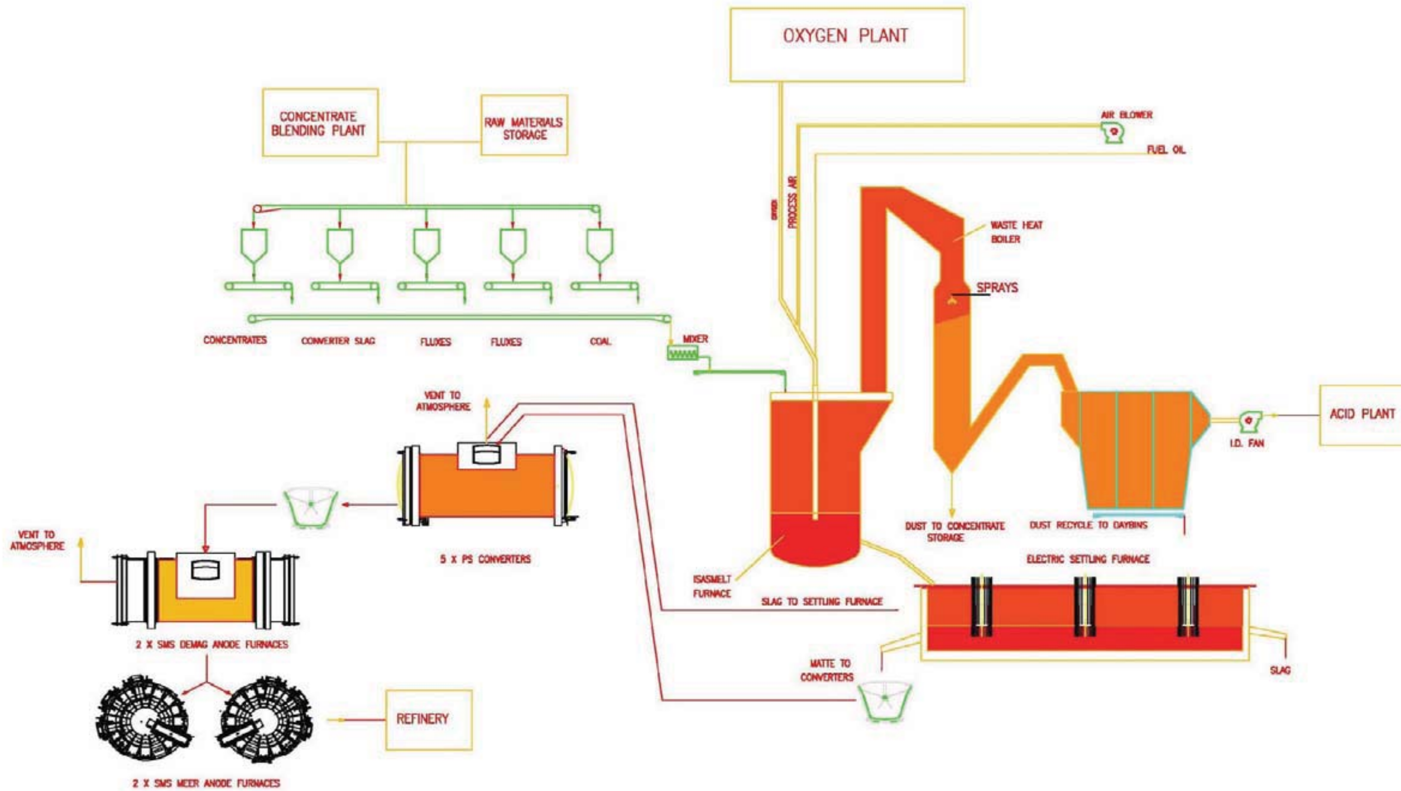


Figure 54: The Mufulira Smelting Plant

Figure 55: Molten Metal "Matte" being poured into the Converter

The matte is upgraded to blister copper in the converters by removing iron and sulphur. The enriched metal, called blister copper is transferred to one of the two anode furnaces. At present the converters vent to the atmosphere but there is a project in progress to replace the existing 30 feet by 13 feet converters with larger 35 feet by 15 feet units with gas handling facilities. There will be two of these new bigger converters, one to be commissioned in December 2011 and second one in December 2012. In addition to these two new bigger converters, one of the existing converters will be refurbished and a new water cooled hood with off gas handling facility will be installed in all the three. Capturing the gas not only reduces the environmental emissions but as the off gas contains significant amounts of sulphur dioxide are captured and sent to the sulphuric acid plant to produce acid.

The blister copper is further refined in anode furnaces to remove sulphur and oxygen before it is cast as anodes. Two new anode furnaces each of 400 T capacity and a twin anode casting Wheel of 80 tonnes per hour casting capacity were installed into the smelter facility replacing obsolete and inefficient anode furnaces and casting wheel. Anodes are sent by rail cars to the refinery for electro refining.

We were unable to witness the anode furnaces in operation but there was plenty of evidence that they were working in the form of freshly cast anodes.

Figure 56: Old Converter in Operation

Figure 57: New Anode Furnaces each of 400T Capacity

Figure 58: New Twin Anode Casting Wheel (80 tph capacity)

5.3.6 Electro Refining Section

The next step in the process is to refine the metal to improve its purity and make it into a saleable product.

5.3.6.1 Cathode Starter Sheet Preparation

Similar to the EW process mentioned previously some of the copper anodes are placed into cells with titanium blanks as cathodes. The current is passed through the cell core and the titanium blanks are plated with pure copper. The titanium blanks are pulled after a comparatively short time (24 hours), when the deposit 0.5 to 0.8mm thick the copper sheets, as deposited, are stripped. These copper sheets are then used as the starter sheets for the electro refining process. A new starter sheet preparation machine was installed in 2005.

Electro refining differs from EW in that metal is produced from the anode onto the copper cathode, whereas in EW copper is produced out of the electrolyte solution and deposited onto the cathode. Electro-refining ends up with finished copper cathodes with a copper purity of 99.99% Cu whereas in electro wining Cu purity is around 99.95%. In electro refining the copper anode has to be replaced after every 24 days of anode cycle.

5.3.7 Electro Refining

In the electro refining commercial section the cast copper anodes are placed into cells with the copper starter sheets.

Figure 59: Cast Copper Anodes

Figure 60: Tank House

By utilising the electrolysis process copper is moved from anodes to electrolyte solution and then to starter sheet. The impurities are left behind in the cells as sludge (Se, Au, Ag, Pt, Pd and others) and some amount goes into electrolyte solution (Fe, Ni, Bi and others). The cathodes thus produced have a purity of 99.99% Cu. The anodes decrease in size over time as they are consumed by the electro refining process and the copper is removed onto the cathode. The spent anodes are then recycled back for melting in converters/anode furnace in Smelter.

5.3.8 Tank House General

The Mufulira refinery was originally equipped with four tank houses (T/H 1, 2, 3 and 4). Tank houses 1, 3 and 4 and the stripper section have been overhauled and upgraded in addition tank house 5 was commission in 2006. Tank house 2 was commencing a refit at the time of the economic slump in 2009 when the copper price fell dramatically and the rebuild project was put on hold. At this stage there is adequate electro refining capacity in 1, 3, 4 and 5 for the tonnage of copper being produced. In view of this tank house 2 is not currently required. Should tonnage increase, the tank house could be returned to service in the future after a major rebuild.

The Mufulira tank house is self sustaining as it makes its own copper starter sheets and receives a continuous supply of anodes from the Smelter.

Figure 61: The Closed Module 2 of the Tank House

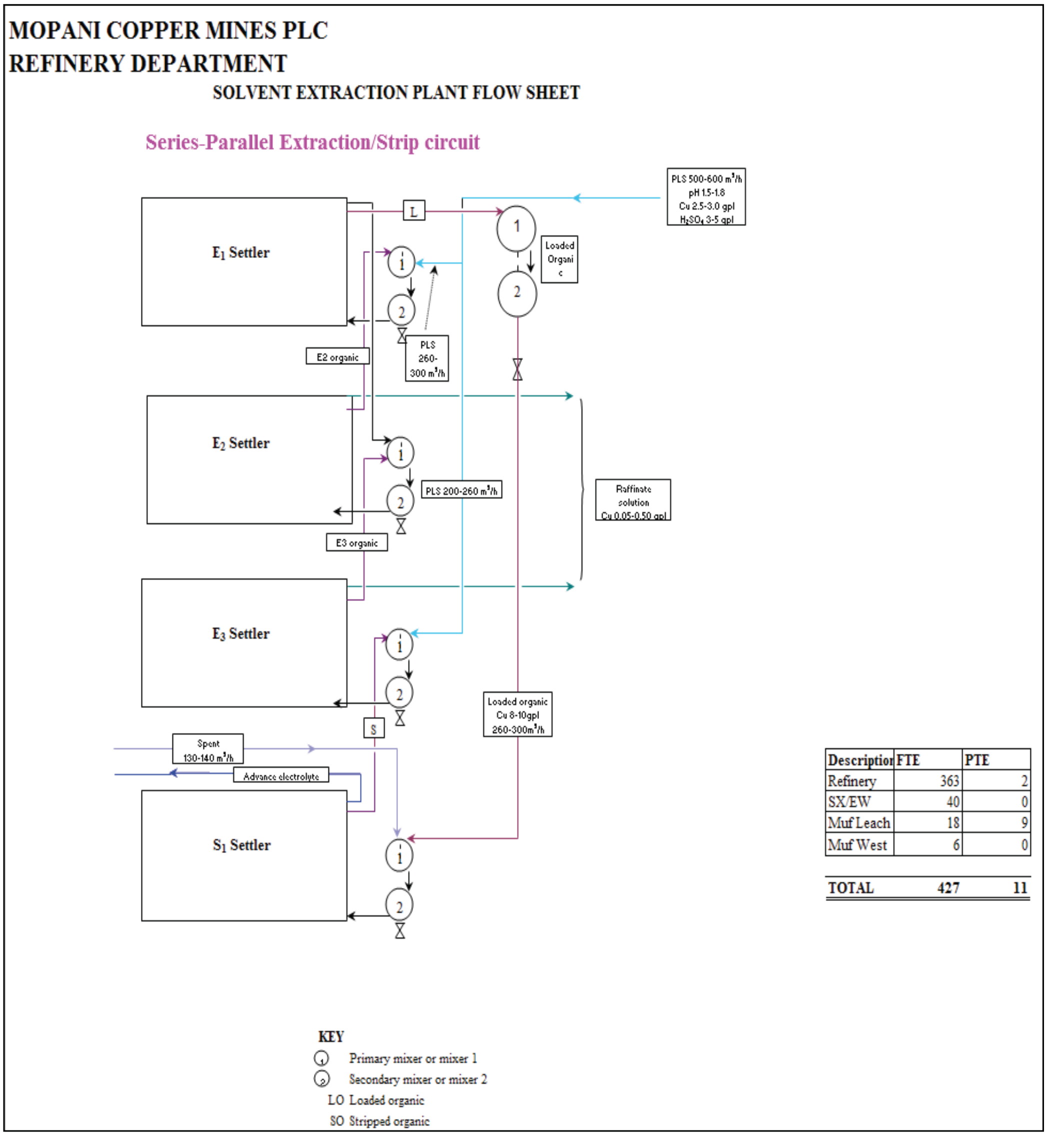
5.3.9 Other Processing

Mufulira also has an underground leach facility where the oxide ore or acid soluble copper is leached by contact with sulphuric acid in solution. This leached solution is then sent to the SX plant where the copper, in the Pregnant Leach Solution, (“PLS”) is extracted through the organic phase and then stripped into the spent electrolyte solution. At this point the solution becomes “advance electrolyte”. Advance electrolyte is taken to electrowinning plant to recover copper in a similar manner to the Nkana copper EW plant.

There is also a leaching facility at Mufulira, where Acid soluble copper in oxide ore is leached with acid by air agitation. PLS is sent to the SX plant and after recovering copper into advance electrolyte the copper is produced by EW.

A part of tank house 5 is used for EW with the majority of the tank house currently being used for the electro refining of cast anodes.

Figure 62: Leach Facility at Mufulira



Description	FTE	PTE
Refinery	363	2
SX/EW	40	0
Muf Leach	18	9
Muf West	6	0
TOTAL	427	11

Figure 63: Diagram showing the SX Circuit for Recovery of the Oxide “Acid Soluble” Copper

A portion of tank house 5 is used for the electro wining of the oxide ore or acid soluble copper with the majority of the tank house being used for the electro refining of the cast anodes.

Figure 64: Electro Winning Cells in the Tank House

5.3.10 Solvent Extraction (SX)

Three SX plants were installed to help to produce a cleaner copper rich solution more suitable for the EW circuit. In this circuit the PLS from the Leach and Mufulira west heap leach facility is contacted with an organic phase.

The copper extracted is loaded into organic, where the loaded organic then comes into contact with spent electrolyte from EW plant. During the process the copper dissolves back into the electrolyte due to high acid in electrolyte. This is called “advance” electrolyte and is used for EW.

5.3.11 Drawings and Annexures

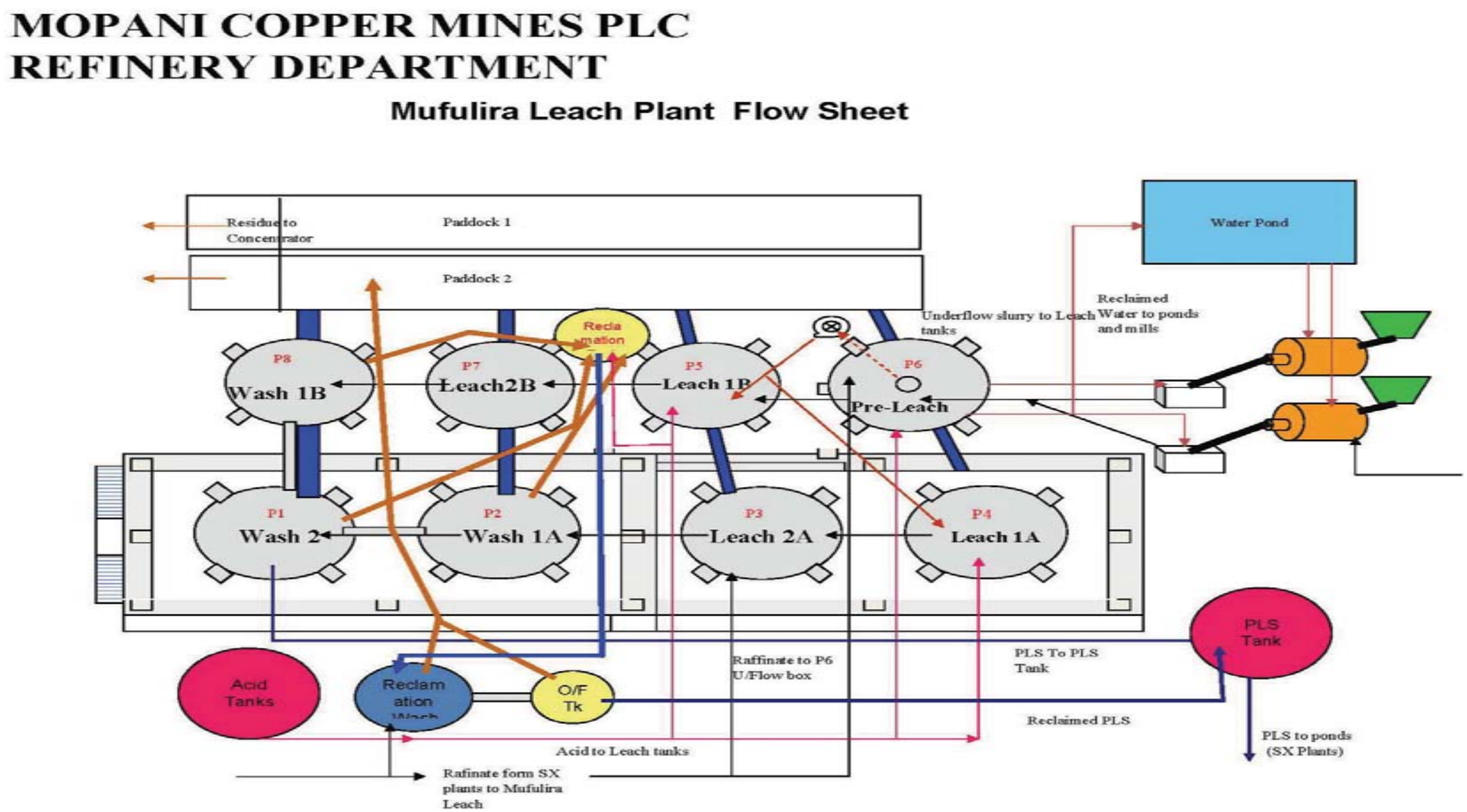


Figure 65: Mufulira Leach Plant Flow Sheet

5.3.12 Summary

Like Nkana, Mufulira is an old installation; however it remains a critical part of the Mopani operation as Nkana does not have any smelting capability.

While it is an old plant and would be replaced by a newer more modern flow sheet if it was to be built today it does what it has to with ease as it is not under pressure from the mining operation.

At the time of our visit, it gave the impression of a well run and well maintained operation with both management and the workforce capable and, more importantly, well motivated. When compared to one of its neighbours KCM it is head and shoulders above it in all respects.

6.0 TAILINGS AND WASTE

6.1 Phase 2 – Environmental, Health and Safety – Tailings Storage Compliance

6.1.1 Mufulira TD11 – Tailings Storage Dam

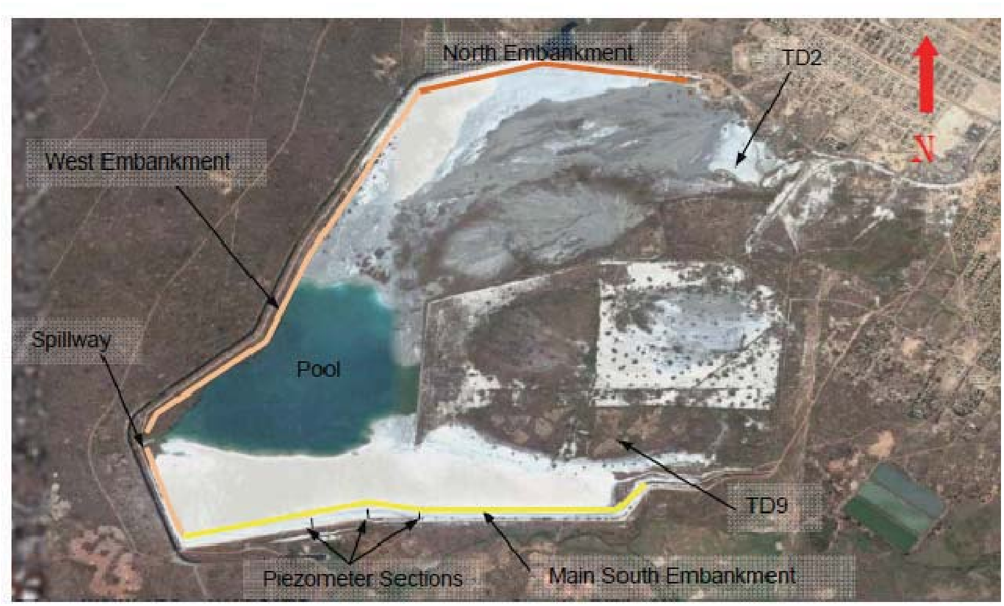


Figure 66: Mufulira tailings storage dam

The Mufulira tailings dam was commissioned in 1978. The original pre-deposition works consisted of two starter embankments on the northern and southern perimeter, see Figure 66. The facility has an annual deposition rate of 1.3 Mt. and a design life capacity of 90 million tonnes. The facility is expected to reach its capacity in 2030. The natural slope of the site is from north to south. There is a fresh water stream diversion along the western embankment, flowing to a southern direction. This facility is operated as a cyclone dam with the fines reporting to the basin area and the coarser tailings used as outer wall building material. Originally the supernatant water was decanted using a conventional penstock tower gravity system. With the demise of the original system, a trench / spillway decant system is now in operation for the remainder of the facility life. This facility is, and has always has been operated by the mine management team. This facility was originally designed by Scott Wilson Piesold Consulting Engineers England. The Zambian branch is the consultant of choice in technical support and auditing role on the mine.

6.1.2 Desk top review of available environmental reports for Mufulira TD11

The following reports were available for review:

- Environmental Management Plan for Mufulira Mine 2003 (Steffen, Robertson and Kirsten South Africa (Ltd).
- TD11 Slope Stability Analysis Report 2010 (Scott Wilson Piesold Zambia Ltd.)
- Emergency Preparedness and Response Plan 2006 (Scott Wilson Piesold Zambia Ltd.)
- Licence to own/operate Waste Disposal Site (ECZ/ND/WM4/103/9)
- Licence to discharge Waste Water (ECZ/ND/WP3/030/9)

6.1.3 Assessment of compliance with statutory requirements

Based on the reviewed bi-annual audit report January to June 2010, submitted to the Environmental Council of Zambia ("ECZ") and Mines Safety Department ("MSD") by Mopani Mine. The relevant license approvals have been obtained for the period 1st January 2010 to 31st December 2010. The above listed licences have conditions governing the compliance and monitoring protocol. Any non compliance to the conditions listed in these licences, may result in the aforementioned licences been revoked.

6.1.4 Identifying the main areas of environmental risks and performance

The main areas of environmental risk are as follows:

- **Dust:** Dust suppression on this facility is a major challenge due to the presence of a high percentage of fines reporting to the basin area. Special attention should be given to dampening the large dry beach area to the south of the facility. A sprinkler system could be introduced to mitigate this risk and encourage the introduction of vegetation.
- **Closure:** The southern downstream embankment area has been neglected from a rehabilitation perspective, such that this process is presently been accelerated by the mine management. Wind erosion and the formation of gullies may cause stability issues to the outer embankments. However no such gullies have formed to date.
- **Groundwater:** Monitoring boreholes are in place and all data is reported in the latest bi-annual report.
- **Surface Water:** Pool management and water discharge quality is well managed and reported within the licensing compliance regulations.
- **Seepage:** Drain flow and water quality is monitored at drain exit points along with seepage flow from the redundant penstock tower pipelines.
- **Freeboard:** There is a minimum vertical target height of 2m as set and maintained as a minimum by the design engineers, as reported in the listed stability analysis report. This has been achieved with a minimum of operational effort.
- **Stability:** The stability analysis report has to date reported a greater than 1.3 FOS on all analysis reporting by Zambia Ltd ("Scott Wilson").

6.1.5 Review of rehabilitation provisions and liabilities

A third party audit was conducted in 2008 as requested by the regulator in setting up a calculated contribution over five years as part of the government closure trust fund to the sum of USD 1,039,987, this is a consolidated cost for Mufulira mine site. Although this money is refundable post closure, it is also seen as an insurance policy to cover any environmental infringements not addressed by the mine. The costs associated with closure and long term post closure maintenance of the tailings dam were not available for review.

Monitoring boreholes are in place and water quality is measured as part of the EMP compliance as is with the discharge water quality. Seepage and drainage discharge points are well documented in the bi-annual reports. Dust is always going to be an environmental concern on this facility, a sprinkler system of sorts needs to be introduced to encourage dampening down of the dry beach. Although there are monitoring systems and management application in evidence, more mitigation needs to be evident in the day to day running of this facility.

6.1.6 Summary and assessment of the health and safety management programmes

- There is a comprehensive health and safety organizational structure and management plan with appropriate line structure as presented in the EIS report. There is also a health, safety and environmental policy in prominence at the mine.
- The Emergency Preparedness and Response Plan was developed and presented in 2006 by ("Scott Wilson")

6.1.7 Details of injury and fatality statistics

The mine has an approved and stated policy by the shareholders and corporate management structure regarding and injury or fatality. This policy covers all mine property and activities undertaken by mine employees. To date there have been no injuries or fatalities while operating the tailings facility.

Table 26: 31 December 2010 Mopani Headcount

December 2010 Mopani Headcount	
Mining	3,495
Engineering	747
Processing	2,228
General and administration	632
Corporate	420
Total	**7,522**
Contract employees MCM	488
Grand total	**8,010**

There are currently 6,413 contractors on site.

6.2 Nkana TD15a – Tailings Storage Dam

Figure 67: Nkana tailings dam

Nkana tailings dam was commissioned in 1978. The original pre-deposition works consisted of western and central starter embankments, see Figure 67. The facility has an annual deposition rate of 3.5 Mt, and a design life capacity of 181 Mt. The facility is expected to reach its capacity in the year 2030. The natural slope of the site is from west to east. There is a fresh water dam to the eastern side of the facility. This facility is operated as a cyclone dam with the fines reporting to the basin area and the coarser tailings used as outer wall building material. The supernatant water is decanted using a conventional penstock tower gravity system. This decant system is managed during peak flows, via the opening and sealing of numerous inlet points along the decant pipeline. The dam is operated by the mine management team. It was originally designed by Scott Wilson Piesold Consulting Engineers England. Their Zambian branch is the consultant of choice in technical support and auditing role on the mine.

6.2.1 Desk top review of available environmental reports for Nkana TD15a

The following reports were available for review:

- Environmental Management Plan for Nkana Mine 2003 (Steffen, Robertson and Kirsten, South Africa (Ltd).
- TD15a Slope Stability Analysis Report 2008 (Scott Wilson Piesold Zambia Ltd.)
- Emergency Preparedness and Response Plan 2006 (Scott Wilson Piesold Zambia Ltd.)
- Licence to own/operate Waste Disposal Site (ECZ/ND/WM4/084/9)
- Licence to discharge Waste Water (ECZ/ND/WP3/020/9)

6.2.2 Assessment of compliance with statutory requirements

The bi-annual audit report, for the period January to June 2010, submitted to the Environmental Council of Zambia ECZ and Mines Safety Department ("MSD") by Mopani Mine, was reviewed. The relevant license approvals have been obtained for the period 1st January 2010 to 31st December 2010. The above listed licences have conditions governing the compliance and monitoring protocol. Any non compliance to the conditions listed in these licences, may result in the aforementioned licences being revoked.

6.2.3 Identifying the main areas of environmental risks and performance

The main areas of environmental risk are as follows:

- **Dust:** Suppression on this facility appears manageable and required little dampening due to the presence of natural vegetation within the basin and dry beach area. This is partially due to the presence of higher percentage of coarser tailings reporting to the basin area. Special attention has been given to the outer slopes with the presence of robust vegetation as planted by the operation team. A sprinkler system could be introduced to mitigate any possible risk in the dry season.
- **Groundwater:** Monitoring boreholes are in place and all data is reported in the latest bi-annual report.
- **Surface Water:** Pool management is decanted through a multi inlet penstock gravity discharge system, and water discharge quality is well managed and reported within the licensing compliance regulations.
- **Seepage:** Drain flow and water quality is monitored at drain exit points into a well lined storm water channel system.
- **Freeboard:** The freeboard is well in excess of the minimum vertical target of 2m which is set and maintained by the design engineers and reported in the listed stability analysis report. This has been achieved with a minimum of operational effort.
- **Stability:** The stability analysis report has to date reported a greater than 1.3 factor of safety on all analysis reporting by Scott Wilson.
- **Closure:** Progressive rehabilitation for closure is well presented on all downstream flanks of this facility. The coarse material and flattish geometry combined with the selection of robust vegetation are proving sustainable in achieving the desired closure result.

6.2.4 A review of rehabilitation provisions and liabilities

A third party audit was conducted in 2008 as requested by the regulator in setting up a calculated contribution over five years as part of the government closure trust fund to the sum of USD 880,068, this is a consolidated total cost for Nkana mine site. Although this money is refundable post closure, it is also seen as an insurance policy to cover any environmental infringements not addressed by the mine. The costs associated with closure and long term post closure maintenance of the tailings dam were not available for review.

Monitoring boreholes are in place and water quality is measured a part of the EMP compliance as is with the discharge water quality. Seepage and drainage discharge points are well documented in the bi-annual reports. Dust is always going to be an environmental concern. A sprinkler system of sorts may need to be introduced to encourage dampening down of the dry beach areas. Although there are monitoring systems and management application in evidence, more mitigation may need to be evident should climatic conditions change drastically in the future.

6.2.5 Summary and assessment of the health and safety management programmes

- There is a comprehensive health and safety organizational structure and management plan with appropriate line structure as presented in the EIS report. There is also a health, safety and environmental policy in prominence at the mine.
- The Emergency Preparedness and Response Plan was developed and presented in 2006 by ("Scott Wilson")

6.2.6 Details of injury and fatality statistics

The mine has an approved and stated policy by the shareholders and corporate management structure regarding and injury or fatality. This policy covers all mine property and activities undertaken by mine employees. To date there have been no injuries or fatalities while operating the tailings facility.

7.0 CLOSURE

7.1 Nkana

7.1.1 Approach and Limitations to Closure Cost Review

7.1.1.1 Approach

An indicative closure cost estimate, based on available information, was conducted to serve as a basis for the review of the provided closure costs. The estimate also allows commenting on possible shortcomings with respect to the provided closure costs and additional financial provision required.

The approach followed is summarised as follows:

- Identification and delineation of the relevant mining areas and associated infrastructure, primarily from Google Earth imagery and available plans from Mopani;
- Identification of infrastructure and land use sub-categories within the above mining operations area characterised by similar conditions, for example light, medium or heavy infrastructural areas, waste rock and spoils stockpiles, and moderately or severely disturbed surface conditions;
- Interpretation of the type, nature and sizes of structures from available information and measurement of the delineated areas in AutoCAD;
- Determination/verification of unit rates for plant dismantling and demolition, as well as associated reclamation, as per recent tenders available to GAA, similar work conducted recently in Africa, as well as consultation with demolition practitioners;
- Application of the above unit rates and associated quantities in spreadsheets arranged into sub-categories to illuminate the respective closure cost components for the cost review;
- Objectively determining the indicative closure cost based on the approach and criteria adopted by GAA for this review and comparing the findings from this costing to the existing closure costs conducted by Scott Wilson consultants; and
- Compilation of a report reflecting the approach applied by GAA in determining the closure costs, as well as the cost comparison. Matters requiring attention to ensure that future closure costing is improved are included in this report.

7.1.1.2 Limitations

- This review of the existing closure costs was conducted as a desktop assessment based on available information and subject to time constraints. As a result the closure cost estimation provided by GAA is indicative only, acting as a basis for comparison of the available costs and to assess whether these are of an appropriate (order of magnitude);

- A site visit to the mine in support of the overall project was carried out in December 2010; and
- The quantum of information and documentation obtained during the site visit could not be confirmed with mine personnel at the time, however a meeting was held with management representatives from Mopani in January 2011 to verify matters relating to battery limits and certain Zambian approaches to closure.

7.1.2 Available information

The sources of information used for the closure cost estimate were as follows:

- Quantum spread sheet Nkanav3.xls, by Scott Wilson;
- Environmental Protection Fund Audit for Nkana Mine, Zambia. July 2010. Final Report (Report no. D131704_NKA), by Scott Wilson;
- Marked-up map entitled Nkana Plant Area and the Vicinity Dated 11-09-20000 (DRG. No. E/A/637/4;
- Map entitled Nkana Site – Nkana Mining License Area (Fig. 2) dated Oct 2010; and
- Marked-up map of Nkana mine entitled Revision 11 Mining Licence Updated 25-08-2000

The above-mentioned Scott Wilson report primarily focuses on the audit of the environmental conditions of the mine and related areas and contains information on the approach and methodology applied in the determination of the closure costs. The costing is primarily based on the Zambian guidelines issued under Statutory Instrument No.29 of 1997 by the Ministry of Mines and Minerals Development. Scott Wilson's estimated closure cost is based on the bills of quantities for the volumes requiring demolition and areas requiring rehabilitation as presented in SRK 2003, as well as additional Bills of Quantities that have been provided by Mopani Copper Mines ("MCM") for new facilities.

7.1.3 Battery Limits

The above reports and associated information do stipulate the battery limits for which the documented closure costs apply. However following a meeting held with Mopani on 20 January 2011, the battery limits were largely clarified from the available information and the interpreted Google Earth imagery.

These limits are described below and reflected on (Figure 68). The infrastructure description obtained from the available information is listed separately from those aspects inferred from the imagery.

The key surface areas obtained from the imagery and confirmed with Mopani can be summarised as follows:

- Overall mine site and infrastructural complex, including fugitive disturbed areas: 101.5ha. This area excludes tailings storage facilities and material dumps or stockpiles
- Main plant infrastructure complex and related areas : 69.3ha;
- Riverine areas requiring reclamation and reinstatement: 5.3ha;
- Tailings storage facilities with "installed" footprint area : 653.5ha; and
- Area of tailings storage facilities already filled with tailings: 522.8ha (assumed 80 percent coverage);

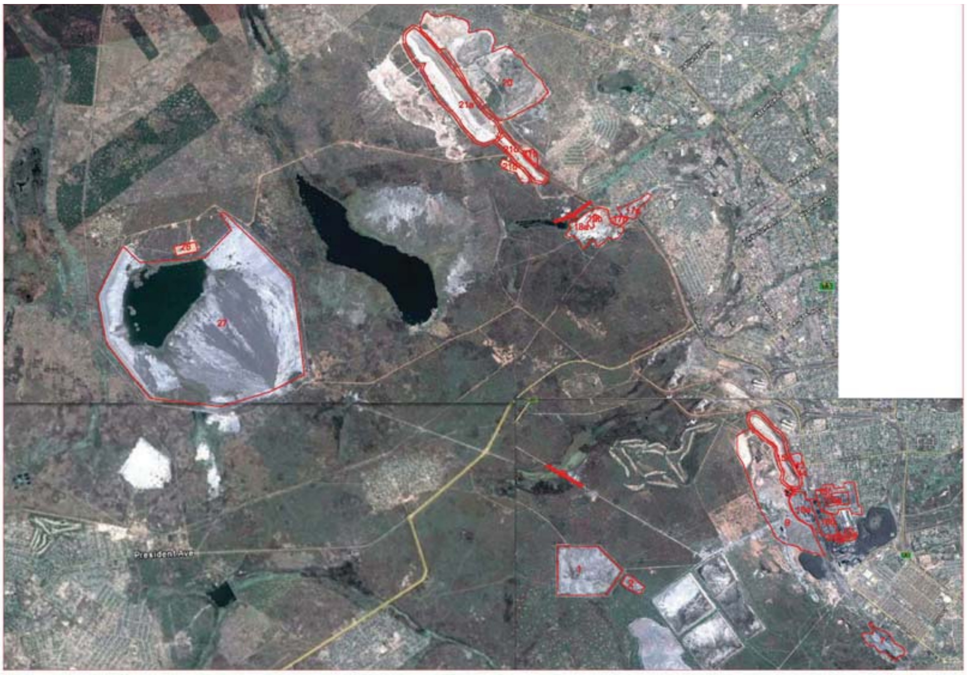


Figure 68: Battery limits assumed for GAA's cost review

7.1.3.1 Available information

The infrastructure inventory and description obtained from the existing closure cost documentation are as follows:

Nkana Mine operates four vertical shafts with associated head gear (Figure 2), namely:

- South Ore Body ("SOB"),
- Central Shaft,
- Mindola Sub-vertical; and
- Mindola North.

The following open pits are currently active and supply ore to the Nkana Leach Plant:

- Mindola North – an existing operation located within the centre of the mining area and being extended towards the north;
- Area A – a shallow pit extending to a depth of approximately 30m and is situated south of Mindola North. The pit is being extended towards the existing Mindola North pit; and
- Area E – Extension work being carried out at the end of the old pit.

The major processing facilities within the mine licence area for which Mopani are responsible comprise the following:

- Concentrator;
- Nkana Cobalt Plant; and

- Nkana Leach Plant.

There are currently four tailings storage facilities ("TSF") at Nkana Mine, namely TSF 15A; TSF 15; TSF 52 and TSF 68 and of the four tailings storage facilities only one is active with the other three being decommissioned.

The major ancillary and support facilities comprise the following:

- Engineering workshops;
- Analytical laboratory;
- Power and water supply systems;
- Rolling stock to support the mine operations;
- A mine hospital;
- Satellite clinics; and
- Primary school.

7.1.3.2 Additions by GAA

The following closure costing components and related activates were also considered by GAA in the determination of the indicative closure cost estimate:

- Collection, handling and disposal of demolitions waste;
- The reclamation and reinstatement of affected streams and drainage lines; and
- Reclamation of disturbed areas, including the collection, handling and disposal of contaminated soil as well as the removal and disposal of fugitive concrete.

Areas excluded

With the privatisation of the state-owned ZCCM the liability for a number of assets of the overall Nkana Mine were retained by the state through ZCCM-IH. These areas and activities were excluded from the Scott Wilson 2010 work and hence also from the GAA review. These include the following:

- The smelter complex and refinery that belong to other operators and not Mopani;
- The slag dumps that belong to other operators, i.e. KCM and Chambishi Metals;
- Overburden dumps (OB53 and OB54). OB53 has been identified and excluded from GAA's cost, however OB54 is not obvious from plans and aerial imagery;
- The South Downs tailings complex (TD 33c, 35, 36, 37, 38, 39, 40 and 41);
- The Nkana east tailings dams (TD 25, 26 and 27). None of these tailings dams are visible on plans provided but have not been included in the GAA cost;
- The burial site for toxic substances located west of TD 36;

In addition to the above all key surface infrastructure and associated services that could have a beneficial post closure use were also excluded by GAA. These typically include the hospital, schools and clinics, etc.

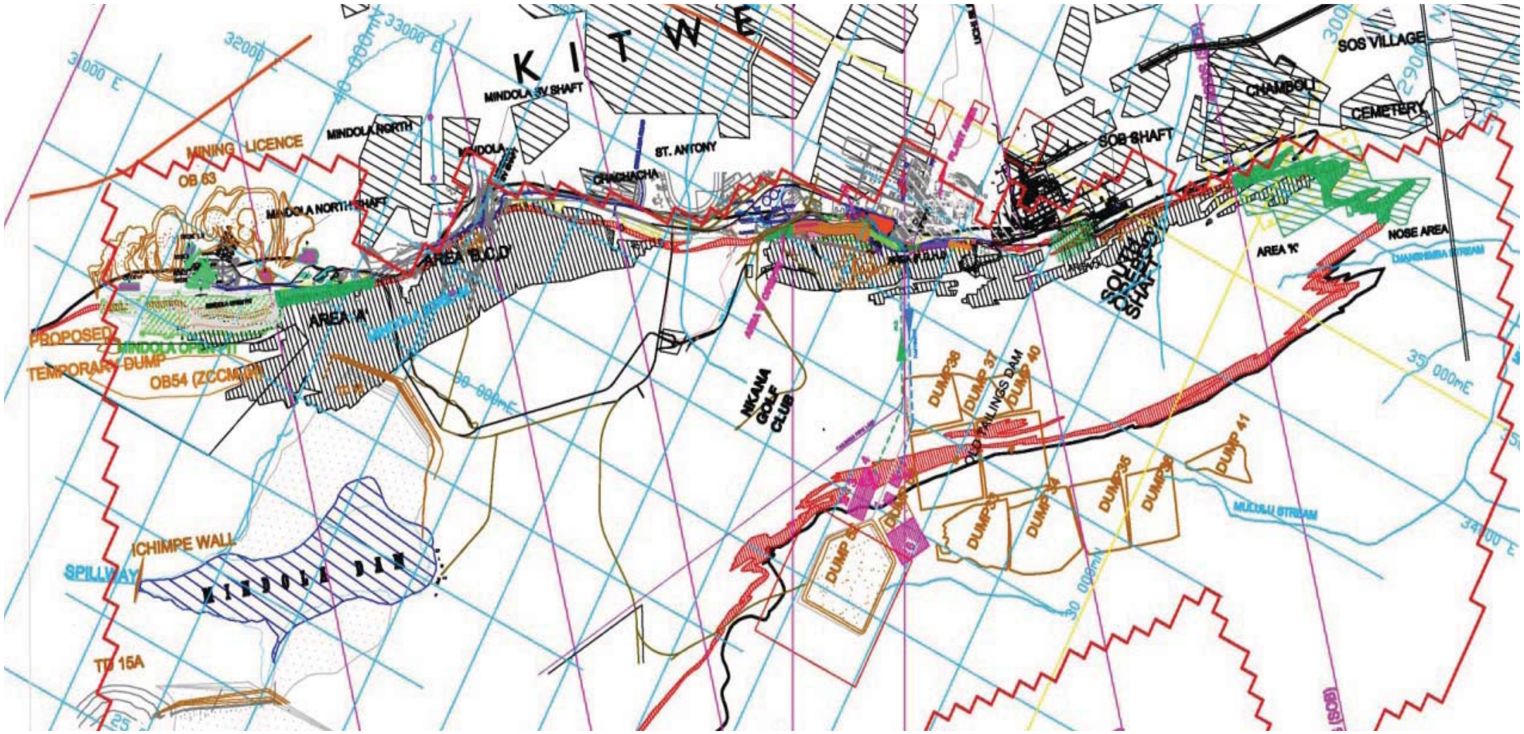


Figure 69: Nkana mine license area

7.1.4 Assumptions and Qualifications

The assumptions and qualifications listed below have been made with respect to the closure cost estimate.

7.1.4.1 General

- The closure costs for the plant site could comprise a number of cost components. This report only addresses the decommissioning and reclamation/restoration costs, equating to an outside (third party) contractor establishing on-site and conducting the decommissioning and reclamation-related work. Other components such as staffing of the plant site following decommissioning, the infrastructure and support services (e.g. power supply, etc.) for the staff, as well as workforce matters such as separation packages and re-training/re-skilling, are outside the scope of this report;

- Based on the above, dedicated contractors would be commissioned to conduct the demolition and work on the mining site and associated areas. This would *inter alia* require establishment costs for the demolition and reclamation contractors and hence, the allowance of preliminary and general ("P&Gs") in the cost estimate. Allowance has also been made for third party contractors and consultants to conduct post closure care and maintenance work, as well as compliance monitoring;

- It is foreseen that demolition waste, such as concrete and building rubble, would be largely inert and that the disposal of such waste would occur within one of the existing mining pits within the mine license area, which would subsequently be rehabilitated. In principle, this is permissible in terms of Zambian legislation and MCM may dispose of such waste lawfully in terms of its current waste disposal licence. Steel and related material from the plant demolition which has salvage value will remain on-site for sale to third parties; and all hazardous waste will be disposed of at an appropriately licensed facility;

- Although the existing plant and related surface infrastructure could have salvage or resale value at closure, no cost off-sets due to possible salvage values were considered in terms of accepted practice and thus only gross closure costs are reported;

- Concrete footings and bases would be demolished to a maximum of 1 000mm below the final surface topography; and

- All useable stockpiles of raw and/or saleable material would have been processed and removed off-site at closure and none of these would remain on site, thus requiring reclamation.

7.1.4.2 Site specific

It has been assumed that at mine closure the mine site and associated disturbed areas will be reclaimed to a sustainable predetermined final land use. This will not only require the dismantling of the physical infrastructure and addressing the aesthetic effects of the reclaimed mine site, but also addressing the residual impacts of the operations on the receiving environment. Therefore, the GAA closure cost estimate addresses, as far as reasonable, the possible latent and residual effects. In this regard the following site-specific closure measures have also been included in the cost estimate:

- Current best practice involves the covering of tailings storage facilities with a 900 mm thick vegetated soil cover to limit the ingress of rainfall into the tailings that could result in contaminated net percolation (waste load) over the TSF footprint area. However Mopani has indicated that due to the very high rainfall in this region, this method of evaporative cover is not used in Zambia and that tailings is often left as is upon closure, as natural vegetation establishment on the tailings itself frequently occurs. Hence GAA has not included any costs for covering of TSFs with a growth medium or evaporative cover; however allowance for the artificial re-establishment of grassland vegetation has been made. ;

- The rehabilitation of evaporation/pollution control ponds will include the following:
  - Removal of sediment up to a depth of 400mm;
  - Removal of synthetic liner;
  - Removal of contaminated soil that could have occurred in those places where the liner has leaked; and
  - Collection, transport and disposal of the contaminated sediment and soil.
- The final mining voids or remaining open pits will not be in-filled and allowed to become open lakes over time with the required access control whilst these are re-watering (flooding) – the only exception being if one of the pits is used for disposal of demolition waste after closure of the plant infrastructure. In order to limit access, an open rock enviro-bund to a height of at least 3 meters and its inside toe 20m from the long term break-back line of the pit/void. The bund will also serve the following purposes:
  - Safety measure to isolate the pit from people and animals by restricting access to the pit and voids;
  - Visual screening; and
  - Divert surface water runoff away from and around the pit, preventing erosion of pit or void lip/edge.
- All the shafts were assumed to be vertical shafts with associated head gear and related infrastructure such as winding houses;
- The existing waste rock and overburden dumps are understood to be currently stable but will be modified and landscaped in order to better integrate into the surrounding landscape;
- Different shaping, levelling and re-vegetation will apply for disturbed areas based on the nature, extent and severity of disturbance. The following categories have been assumed:
  - Generally disturbed areas characterised by transformation or partial absence of vegetation with limited erosion or soil contamination;
  - Areas from which infrastructure has been removed, characterised by severe transformation of the landscape and significant soil contamination and harmful material; and
  - Severely disturbed areas characterised by excessive erosion and complete transformation of the land cover.

  Dedicated rates for the shaping, levelling and reclamation have been applied for the above categories.
- Removal of contaminated soil from disturbed areas as part of general surface reclamation is required for approximately 20 percent of the reclaimed infrastructural footprint areas;
- Allowance has been made for a nominal amount of fugitive concrete to be removed and disposed of;
- Allowance has been made for the de-silting and re-instatement of specific areas of potentially contaminated stream beds and banks, over a 20m wide strip along the streams. An additional allowance has been included for general clean-up of fugitive contamination. Allowance has been made to remove contaminated sediment up to a depth of approximately 400mm as required; and

- Allowance has been made for care and maintenance as well as surface and groundwater quality monitoring to be conducted for a minimum period of 3 years to ensure and assess success of the implemented reclamation and closure measures.

7.1.4.3 Additional allowance

Fixed ratios for P&Gs (6 percent) and contingencies (10 percent) have been applied;

7.1.5 Closure Cost Comparison

To provide a structure for the cost comparison, the costs are presented in a format routinely used for closure cost determinations, addressing the following categories:

- Infrastructural areas;
- Mining areas;
- General surface reclamation;
- Water management;
- Post closure aspects; and
- Additional allowances.

Scott Wilson report primarily focuses on the audit of the environmental conditions of the mine and related areas and contains information on the approach and methodology applied in the determination of the closure costs. The costing is primarily based on the Zambian guidelines issued under Statutory Instrument No.29 of 1997 by the Ministry of Mines and Minerals Development. Scott Wilson's estimated closure cost is based on the bills of quantities for the volumes requiring demolition and areas requiring rehabilitation as presented in SRK 2003, as well as additional Bills of Quantities that have been provided by MCM for new facilities.

The closure costs determined by Scott Wilson and GAA are reflected Table 28. Table 28 provides a comparison of closure measures and related costs. The variations in costs could mainly be due to the following:

- The apparent variance in methodology used between Scott Wilson and GAA. Scott Wilson provided for the sealing of vertical shafts and inclines to the amount of 7200m^3, and although all four shafts were measured, only the Mindola main shaft appears to have been included in the costing. Provision was made for four vertical shafts, assumed to be 5.5 meter diameter, in the GAA costs;
- Further to the above, a level of discrepancy in the battery limits adopted for the respective closure cost estimates may still be in evidence;
- Reinstatement of damaged riverine environments to a level that could sustain acceptable aquatic health;
- Safe disposal of demolition waste and the creation and final reclamation of one of the existing open pits for this purpose; and
- Clean-up and safe disposal of contaminated soils and fugitive contamination.

Table 27: Overall cost comparison for Nkana

Closure component	Scott Wilson 2010 (USD Millions)	GAA 2010 (USD Millions)
1. Infrastructural areas	4.96	18.21
2. Mining areas	6.37	7.85
3. General surface reclamation	2.20	1.56
4. Water management	0.00	0.11
Subtotal 1 (for infrastructure and related aspects)	**13.53**	**27.73**
5. Post closure aspects	0.48	0.73
Subtotal 2 (for post-closure aspects)	**0.48**	**0.73**
6. Additional allowances	2.24	4.40
Subtotal 3 (for additional allowances)	**2.24**	**4.40**
GRAND TOTAL	**16.25**	**32.86**

Table 28: Detailed comparison of closure measures and related costs

Category with sub-categories	Evaluation
7.1.5.1 Infrastructural areas	
■ Dismantling of processing plant and related structures; ■ Demolition of steel buildings and structures; ■ Demolition of reinforced concrete buildings and structures; ■ Reclamation of access roads, railways and power lines; ■ Demolition of offices, workshops and residential buildings; ■ Fencing; and ■ Disposal of demolition waste.	■ The respective battery limits for the surface infrastructure are likely to be slightly different from those of the Scott Wilson assessment; ■ The GAA cost was based on identification of different zones of infrastructure namely light, medium and heavy infrastructure, which was done from Google aerial imagery and which may influence the total cost provision for dismantling of infrastructure; ■ At first it appears that the level of detail in the Scott Wilson costing for dismantling of processing plant is to a greater level of detail than the GAA costs. However, it appears that the respective quantities were taken from the 2003 Environmental Impact Statement by SRK (2003). The quantities in this document could not be verified. The GAA costing was based on the extrapolation/adaptation of verified costs for similar mining/industrial complexes; ■ The GAA costing includes the deposition of inert demolition waste in one of the opencast pits and has made provision for rehabilitation in this regard; and ■ The GAA costing for infrastructural areas is more expensive than the Scott Wilson costing mainly due to the waste collection, handling and disposal that has been included in the GAA costs.
7.1.5.2 Mining areas	
■ Opencast reclamation including final voids and ramps; ■ Excavations; ■ Sealing of shafts, adits and inclines; ■ Shaping of stockpiles, waste rock and overburden dumps;	■ The Scott Wilson costing allowed for reclamation of 79 hectares of overburden and spoils at a rate of USD 9193 per hectare; ■ The GAA costing allowed for shaping and vegetation of stockpiles footprint areas, assuming that the stockpiled material will be processed before decommissioning ; ■ The GAA costs allows for the sealing of three vertical and one sub-vertical

Category with sub-categories	Evaluation
■ Vegetation of stockpiles, waste rock and overburden dumps; ■ Reclamation of processing waste deposits and evaporation ponds; and ■ Reclamation of subsided areas.	shafts and the infilling of the associated excavation. The Scott Wilson costs make a nominal allowance for this. ■ The Scott Wilson costs do not include the reclamation of the tailings storage facilities whereas the GAA costs include the establishment of grassland vegetation on all TSFs; ■ GAA costs allow for the reclamation of generally disturbed areas and the clean-up of possible contamination over these areas; and ■ The GAA costing is slightly more expensive mainly due to inclusion of the reclamation of the tailings storage facilities, the additional provisions for sealing of shafts.

7.1.5.3 General surface reclamation

■ Shaping of disturbed areas; and ■ Vegetation of disturbed areas.	■ The Scott Wilson costs allow for the general surface reclamation of 302.5 ha at a rate of USD 7282 per hectare, whereas the GAA costs allow for the reclamation (shaping and vegetation) of 107.3 hectares; although this area does not include re-vegetation of the TSFs; ■ The GAA costs allow for clean-up of contaminated soils over 20 percent of the infrastructural area, which appears not to be included in the Scott Wilson costs; ■ In addition, the GAA costs allow for the removal and disposal of $500m^3$ of fugitive concrete; ■ The GAA cost is more expensive, which could be attributed to differences in reclamation assumptions.

Category with sub-categories	Evaluation
7.1.5.4 Water management	
■ Reinstatement of drainage lines; and ■ River reclamation.	■ The Scott Wilson costs do not allow for the reinstatement of drainage lines or the reclamation of contaminated rivers and stream; ■ The GAA cost allows for the reclamation of about 5.3 ha of riverbanks; and ■ The GAA cost allows for the reinstatement of the drainage lines over the full reclaimed areas; thus ■ The costs under this cost category cannot be compared, because these seem to be omitted from the Scott Wilson costs.
7.1.5.5 Post closure aspects	
■ Surface water quality monitoring; ■ Groundwater quality monitoring; ■ Reclamation monitoring; ■ Care and maintenance; and ■ Ongoing water treatment.	■ The Scott Wilson costs allows for 2 to 3 years of maintenance and after care over 700 ha, thus a rate of USD 969.15 per hectare; GAA cost allows for surface, groundwater and reclamation monitoring, as well as care and maintenance for a minimum period of 3 years over an area of 760.8 hectares; ■ Notwithstanding the differences in approach, the overall costs for this category are very similar; and ■ . There is no acid mine drainage at Nkana.
7.1.5.6 Additional allowances	
■ Preliminaries and general; and ■ Contingencies.	Both the Scott Wilson and GAA costs allow 6 percent for preliminaries and general and 10 percent for contingencies

7.1.6 Matters Requiring Further Attention

The following matters that potentially require attention in future closure cost updates have been identified:

- There could be a possibility for ongoing management of contaminated excess mine water arising from the reclaimed mining working, involving collection , handling , treatment and safe dispose of the treated mine water. If this is required, this could add a notable additional cost;
- Compilation of proper inventories of infrastructure and mining activities within the respective battery limits and obtain sign-off by the mine on these;
- Confirmation and documentation of battery limits for the closure costing and providing the motivations/reasons for the inclusion and exclusion of areas;
- On-site quantification and measurement of those closure cost components with uncertainty with respect to the closure measures required and/or which are not adequately addressed in the indicative closure costs;
- The possibility exists that there may be significant impact from mining related spillages on the local stream/river systems and these need to be confirmed by on-site assessment of potentially affected areas by a suitably qualified specialist. In the event that contamination, which can safely be removed without causing excessive damage to the streambeds, is identified, allowance has to be made for at least the de-silting and re-instatement of contaminated stream beds and banks. Other measures may also be required in order; to allow the natural aquatic ecosystems to as far as possible to return. This could have a notable cost and has been excluded from this cost estimate, mainly due to uncertainty on responsibility for this environmental liability and the fact that such areas may not be detected from aerial imagery.

7.1.7 Conclusion

The findings as reflected in this report have primarily been based on the interpretation of Google Earth images and a number of maps for Nkana Mine site and closure related information, provided by the mine. Clarification on a number of issues was obtained at a review meeting held with management from Mopani on 20 January 2011. Where the required information was not available, estimates were made based on experience. Unit rates for the purpose of the review were obtained from GAA's existing data base and/or from demolition practitioners. Where required, these were adapted to reflect site-specific conditions.

The review of the existing closure costs, as well as recommendations in this regard, has been completed from a risk-averse perspective and mainly errs on the side of caution. This approach allows for the costs to be refined as appropriate information becomes available, as opposed to possible under-estimation and associated provision that could lead to liability shortfalls.

This review concludes that the closure costs provided by Scott Wilson are too low. It is recommended that a fair and reasonable financial provision of at least **USD 24 million** be made.

7.2 Mufulira

7.2.1 Approach and Limitations to Closure Cost Review

7.2.1.1 Approach

An indicative closure cost estimate, based on available information, was conducted to serve as a basis for the review of the provided closure costs. The estimate also allows commenting on possible shortcomings with respect to the provided closure costs and additional financial provision required. The approach followed is summarised as follows:

- Identification and delineation of the relevant mining areas and associated infrastructure, primarily from Google Earth imagery and available plans;

- Identification of infrastructure and land use sub-categories within the above mining operations area characterised by similar conditions, for example light, medium or heavy infrastructural areas, waste rock and spoils stockpiles, and moderately or severely disturbed surface conditions;
- Interpretation of the type, nature and sizes of structures from available information and measurement of the delineated areas in AutoCAD;
- Determination/verification of unit rates for plant dismantling and demolition, as well as associated reclamation, as per recent tenders available to GAA, similar work conducted recently in Africa, as well as consultation with demolition practitioners;
- Application of the above unit rates and associated quantities in spreadsheets arranged into sub-categories to illuminate the respective closure cost components for the cost review;
- Objectively determining the indicative closure cost based on the approach and criteria adopted by GAA for this review and comparing the findings from this costing to the existing closure costs conducted by Scott Wilson; and
- Compilation of a report reflecting the approach applied by GAA in determining the closure costs, as well as the cost comparison. Matters requiring attention to ensure that future closure costing is improved are included in this report.

7.2.1.2 Limitations

- This review of the existing closure costs was conducted as a desktop assessment based on available information and subject to time constraints. As a result, the closure cost estimation provided by GAA is indicative only, acting as a basis for comparison of the available costs and to assess whether these are of an appropriate order of magnitude.
- A site visit to the mine site in support of the overall project, also addressing closure cost aspects, was conducted in December 2010;

The quantum of information and documentation obtained during the site visit could not be confirmed with mine personnel at the time of drafting the original report. However a meeting was held with Mopani in January 2011 to verify matters relating to battery limits and certain Zambian approaches to closure and this report amended accordingly.

Maps delineating the exact areas under control of the mine were made available during the review meeting with Mopani in January 2011 to inform the GAA estimates.

7.2.2 Available information

The sources of information used for the closure cost estimate were as follows:

- Quantum spread sheet Mufulirav4 FINAL.xls, by Scott Wilson;
- Environmental Protection Fund Audit for Mufulira Mine, Zambia Final Report July 2010 by Scott Wilson;
- Marked-up plan entitled Mufulira. East Plant & Works, dated 18 Jan 2011; and
- Map entitled Mining Licence and Surface Rights, dated 26th June 2009;

The above-mentioned Scott Wilson report primarily focuses on the audit of the environmental conditions of the mine and related areas and contains information on the approach and methodology applied in the determination of the closure costs. The costing is primarily based on the Zambian guideline issued under Statutory Instrument No. 29 of 1997 by the Ministry of Mines and Minerals Development.

7.2.3 Battery Limits

The above reports, site maps and associated information stipulate the battery limits for which the documented closure costs apply. These limits are described below and reflected on (Figure 68). The infrastructure description obtained from the available information is listed separately from those aspects derived from the imagery.

The key surface areas identified from the imagery and site plans can be summarised as follows:

- Overall mine site and related smelter complex, including fugitive disturbed areas: 1341.38ha;
- Main smelter complex and related areas:76.88ha;
- Riverine areas requiring reclamation and reinstatement: 9.5ha;
- Tailings storage facilities overall delineation: 711.4ha (excluding tailings dam no's 10 and 8); and

Tailings storage facilities already filled by tailings: 569.12 ha (assuming 80% coverage);

Figure 70: Battery limits assumed for GAA's cost review

7.2.3.1 Available information

The infrastructure inventory and description obtained from the existing closure cost documentation are as follows:

- Central conventional underground mine;
- Mufulira East Mine (underground with one shaft);
- Leach mining (carried out in upper Levels of old underground workings)
- Mufulira East heap leach, and Mufulira West heap leach;

- Mufulira West Mine and no. 11 and 12 vertical Shafts;
- Concentrator;
- Smelter;
- Refinery;
- Solvent extraction plants;
- Leach plant;
- Support facilities, including engineering workshops, analytical laboratory, supply chain infrastructure, hospital and school;
- Slag dumps;
- TSF's No. 3, 4, 5, and 11 while 6 and 7 are part of the TSF 11 Complex;
- Waste rock dumps;
- Surface water management infrastructure; and
- Historically disturbed and degraded areas as a result of mining-related activities.

Figure 69 below represents the surface and mining rights of the Mufulira Mine - 2009.

7.2.3.2 Additions by GAA

The following closure costing components and related activates were also considered by GAA in the determination of the indicative closure cost estimate:

- Collection, handling and disposal of demolitions waste;
- The reclamation and reinstatement of affected streams and drainage lines;
- Reclamation of disturbed areas, including the collection, handling and disposal of contaminated soil, as well as the removal and disposal of fugitive concrete; and
- Additional allowances, including preliminary and general ("P&Gs") and contingencies.

There is ongoing management of waste water arising from the mine workings.

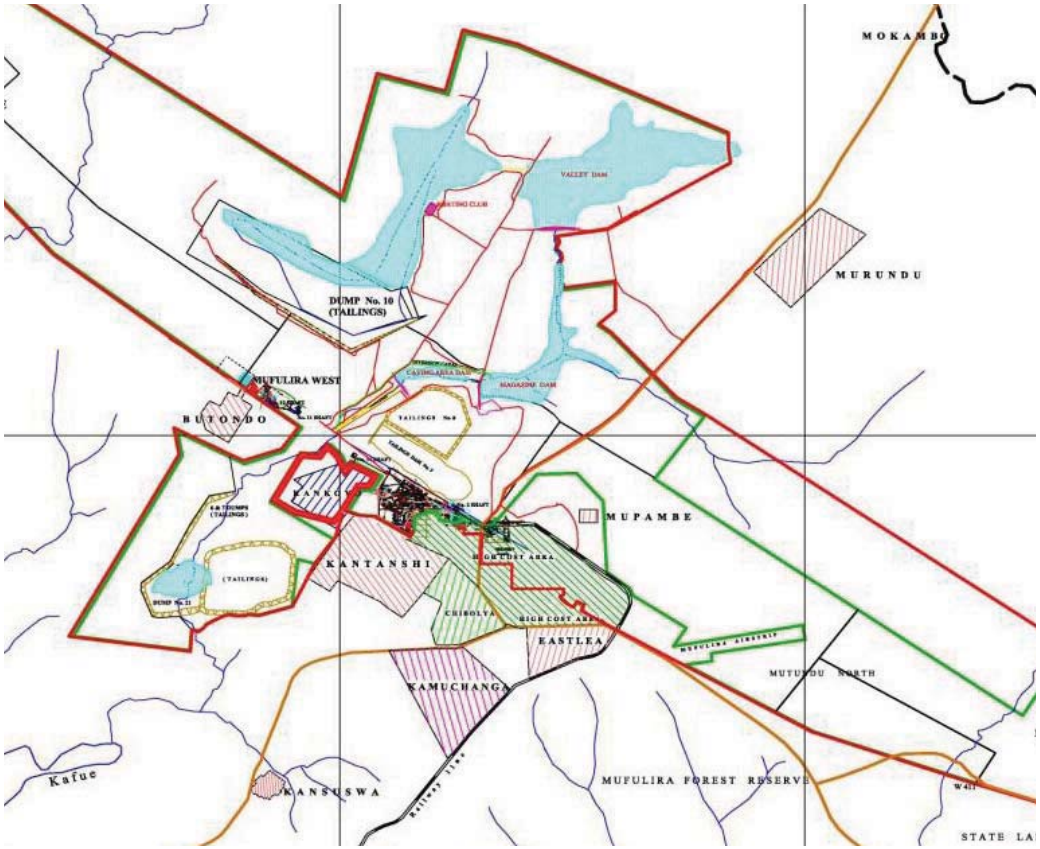


Figure 71: Surface and mining rights – Mufulira

7.2.4 Assumptions and Qualifications

The assumptions and qualifications listed below have been made with respect to the closure cost estimate.

7.2.4.1 General

- The closure costs for the plant site could comprise a number of cost components. This report only addresses the decommissioning and reclamation/restoration costs, equating to an outside (third party) contractor establishing on-site and conducting the decommissioning and reclamation-related work. Other components such as staffing of the plant site following decommissioning, the infrastructure and support services (e.g. power supply, etc.) for the staff, as well as workforce matters such as separation packages, re-training/re-skilling, etc., are outside the scope of this report;

- Based on the above, dedicated contractors would be commissioned to conduct the demolition and work on the mining site and associated areas. This would *inter alia* require establishment costs for the demolition and reclamation contractors and hence, the allowance of P&Gs in the cost estimates. Allowance has also been made for third party contractors and consultants to conduct post closure care and maintenance work, as well as compliance monitoring;

- It is foreseen that demolition waste, such as concrete and building rubble, would be largely inert and that the disposal of this waste (or a portion thereof) would occur within one or more of the existing ventilation shafts within the mine licence area, which would subsequently be sealed, covered and re-vegetated. At the time of writing, GAA could not confirm whether this practice is allowable under Zambian legislation, although Mopani stated that it is and is not uncommon. Steel and related material from the plant demolition which has salvage value will remain on-site for sale to third parties; and all hazardous waste will be disposed of at an appropriately licensed facility;

- Although the existing plant and related surface infrastructure could have salvage or resale value at closure, no cost off-sets due to possible salvage values were considered in terms of accepted practice and thus only gross closure costs are reported;

- Concrete footings and bases would be demolished to a maximum of 1 000 mm below the final surface topography and;

- All useable stockpiles of raw and/or saleable material would have been processed and removed off-site at closure and none of these would remain on site, thus requiring reclamation.

7.2.4.2 Site specific

It has been assumed that at mine closure the mine site and associated disturbed areas will be reclaimed to a sustainable predetermined final land use. This will not only require the dismantling of the physical infrastructure and addressing the aesthetic effects of the reclaimed mine site, but also addressing the residual impacts of the operations on the receiving environment. Therefore, the GAA closure cost estimate addresses, as far as reasonable, the possible latent and residual effects. In this regard the following site-specific closure measures have also been included in the cost estimate:

- Current best practice involves the covering of tailings storage facilities with a 900 mm thick vegetated soil cover to limit the ingress of rainfall into the tailings that could result in contaminated net percolation (waste load) over the TSF footprint area. However Mopani has indicated that due to the very high rainfall in this region, this method of evaporative cover is not used in Zambia and that tailings is often left as is upon closure, as natural vegetation establishment on the tailings itself frequently occurs. Hence GAA has not included any costs for covering of TSFs with a growth medium or evaporative cover; however allowance for the artificial re-establishment of grassland vegetation has been made. In the event that provision of a growth medium and/or dedicated cover is required, this will have a significant additional cost implication for closure which is not currently reflected.

- There are no historical heap leach dumps at Mufulira. Mopani has indicated that due to the high-temperature smelting process that is conducted at Mufulira, the slag that is produced is inert and does not cause the mobilisation of metals such as copper that could have adverse environmental consequences. Mopani have further indicated that monitoring results confirm this statement. Based on the above information, GAA omitted from its costs the provision of dedicated hazardous waste covers for the slag dumps, as would typically be the case of where metal related contamination is possible. Only allowance has been made for the landscaping of the dumps at closure to improve their appearance and cause less of a visual impact.

- The rehabilitation of evaporation/pollution control ponds will include the following:

  - Removal of sediment up to a depth of 400 mm;
  - Removal of synthetic liner;
  - Removal of contaminated soil that could have occurred in those places where the liner has leaked; and
  - Collection, transport and disposal of the contaminated sediment and soil.

- Different shaping, levelling and re-vegetation methods will apply for disturbed areas based on the nature, extent and severity of disturbance. The following categories have been assumed:

  - Generally disturbed areas, characterised by transformation or partial absence of vegetation with limited erosion or soil contamination;
  - Areas from which infrastructure has been removed, characterised by severe transformation of the landscape and significant soil contamination and harmful material; and
  - Severely disturbed areas characterised by excessive erosion and complete transformation of the land cover.

  Dedicated rates for the shaping, levelling and reclamation have been applied for the above categories.

- Removal of contaminated soil from disturbed areas as part of general surface reclamation is required for approximately 20 percent of the reclaimed infrastructural footprint areas;

- Allowance has been made for a nominal amount of fugitive concrete to be removed and disposed of;

- Allowance has been made for the de-silting and re-instatement of specific areas of potentially contaminated stream beds and banks over a 20m wide strip along the streams. An additional allowance has been included for general clean-up of fugitive contamination. Allowance has been made to remove contaminated sediment up to a depth of approximately 400 mm as required; and

- Allowance has been made for care and maintenance, as well as surface and groundwater quality monitoring, to be conducted for a minimum period of 3 years to ensure and assess success of the implemented reclamation and closure measures.

Fixed ratios for P&Gs (6 percent) and contingencies (10 percent) have been applied.

7.2.5 Closure Cost Comparison

To provide a structure for the cost comparison, the costs are presented in a format routinely used for closure cost determinations, addressing the following categories:

- Infrastructural areas;
- Mining areas;
- General surface reclamation;
- Water management;
- Post closure aspects; and
- Additional allowances.

Scott Wilson report primarily focuses on the audit of the environmental conditions of the mine and related areas and contains information on the approach and methodology applied in the determination of the closure costs. The costing is primarily based on the Zambian guidelines issued under Statutory Instrument No.29 of 1997 by the Ministry of Mines and Minerals Development. Scott Wilson's estimated closure cost is based on the bills of quantities for the volumes requiring demolition and areas requiring rehabilitation as presented in SRK 2003, as well as additional Bills of Quantities that have been provided by MCM for new facilities.

The closure costs determined by Scott Wilson and GAA are reflected in Table 30. Table 30 provides a comparison of closure measures and related costs. The differences could be due to the following;

- The inclusion of the re-vegetation of the no.3, 6 and 7 TSFs in the GAA costs that appears to have been omitted from the Scott Wilson costs, although allowance has been made (by Scott Wilson) for rehabilitation of 244ha of process waste deposits;
- Further to the above, a general discrepancy in the battery limits adopted for the respective closure cost estimates;
- Re-shaping and limited landscaping of the existing slag dumps in order to improve their appearance, which does not seem to have been taken into consideration in the Scott Wilson costing;
- Reinstatement of an area of potentially damaged riverine environment to a level that could sustain acceptable aquatic health;
- Safe disposal of demolition waste into one or more of the ventilation shafts and the final reclamation of the affected area; and
- Clean-up and safe disposal of contaminated soils and fugitive contamination.

Table 29: Overall cost comparison for Mufulira

Closure component	Scott Wilson 2010 (USD Millions)	GAA 2010 (USD Millions)
1. Infrastructural areas	10.05	19.53
2. Mining areas	4.97	3.32
3. General surface reclamation	0.87	5.37
4. Water management	0.00	0.73
Subtotal 1 (for infrastructure and related aspects)	**15.89**	**28.95**
5. Post closure aspects	0.68	1.03
Subtotal 2 (for post-closure aspects)	**0.68**	**1.03**
6. Additional allowances	2.65	4.80
Subtotal 3 (for additional allowances)	**2.65**	**4.80**
GRAND TOTAL	**19.22**	**34.87**

Table 30: Detailed comparison of closure measures and related costs

Category with sub-categories	Evaluation
7.2.5.1 Infrastructural areas	
■ Dismantling of processing plant and related structures; ■ Demolition of steel buildings and structures; ■ Demolition of reinforced concrete buildings and structures; ■ Reclamation of access roads, railways and power lines; ■ Demolition of offices, workshops and residential buildings; ■ Stream diversions; ■ Fencing; and ■ Disposal of demolition waste.	■ The respective battery limits for the surface infrastructure appear to be somewhat different from those of the Scott Wilson assessment. ; ■ The GAA cost was based on identification of different zones of infrastructure namely light, medium and heavy infrastructure, which was done from Google aerial imagery and which may influence the total cost provision for dismantling of infrastructure; ■ At first it appears that the level of detail in the Scott Wilson costing for dismantling of processing plant is to a greater level of detail than the GAA costs. However, it appears that the respective quantities were taken from the 2003 Environmental Impact Statement by SRK. The quantities in this document could not be verified. The GAA costing was based on the extrapolation/adaptation of verified costs for similar mining/industrial complexes; ■ The GAA costing includes the deposition of inert demolition waste in one or more of the ventilation shafts within the mine license area and has made provision for rehabilitation in this regard; and ■ The GAA costing for infrastructural areas is more expensive than the Scott Wilson costing mainly due to the waste collection, handling and disposal that has been included in the GAA costs.
7.2.5.2 Mining areas	
■ Opencast reclamation, including final voids and ramps; ■ Excavations;	■ The Scott Wilson costing allowed for reclamation of 194 ha of overburden and spoils at a rate of USD 9193 per hectare. Since the site has no open pit mining

Category with sub-categories	Evaluation
■ Sealing of shafts, adits and inclines; ■ Shaping of stockpiles, waste rock and overburden dumps; ■ Vegetation of stockpiles, waste rock and overburden dumps; ■ Reclamation of processing waste deposits and evaporation ponds; and ■ Reclamation of subsided areas.	these quantities and associated costs are unclear; ■ The GAA costing allowed for shaping and vegetation of stockpiles footprint areas, assuming that the stockpiled material will be processed before decommissioning; ■ The GAA costs allows for the sealing of all the incline shaft and the infilling of the associated excavation. The Scott Wilson costs make a nominal allowance for this. ■ The GAA costs make allowance for the reclamation of the slag dumps by providing for limited re-profiling and landscaping of the dumps to be more natural in appearance. During the meeting held on 20 January 2011, Scott Wilson indicated that their costs does not address this aspect; ■ The Scott Wilson costs allows for the reclamation of 50 ha of subsided area at a rate of USD 7697 per hectare. ■ GAA costs allow for the reclamation of all generally disturbed areas and the clean-up of possible contamination over these areas; and ■ The GAA costing is slightly less expensive, presumably due to certain aspects having been addressed under other sections of the costing and differences in the reclamation approach.
7.2.5.3 General surface reclamation	
■ Shaping of disturbed areas; and ■ Vegetation of disturbed areas.	■ The Scott Wilson costs allow for the general surface reclamation of 120 ha at a rate of USD 7282 per hectare, whereas the GAA costs allow for the reclamation (shaping and vegetation) of approximately 630 ha which excludes the TSFs; ■ The GAA costs allow for clean-up of contaminated soils over 20 percent of the

Category with sub-categories	Evaluation
	infrastructural area, which appears not to be included in the Scott Wilson costs; ■ In addition, the GAA costs allow for the removal and disposal of 500m³ of fugitive concrete; and ■ The GAA cost is more expensive, which is may be attributed to the much larger area of generally disturbed land that was included for rehabilitation as well as possible differences in reclamation assumptions.
7.2.5.4 Water management	
■ Reinstatement of drainage lines; and ■ River reclamation.	■ The Scott Wilson costs appear not to have provided for the reinstatement of drainage lines or the reclamation of contaminated rivers and stream; ■ The GAA cost allows for the reclamation of about 9.5 ha of riverbanks; ■ The GAA cost allows for the reinstatement of the drainage lines over the full reclaimed areas; thus ■ This item cannot be compared due to the category being omitted from the Scott Wilson costs.
7.2.5.5 Post closure aspects	
■ Surface water quality monitoring; ■ Groundwater quality monitoring; ■ Reclamation monitoring; ■ Care and maintenance; and	■ The Scott Wilson costs allows for 2 to 3 years of maintenance and after care over 700 ha, thus a rate of USD 969.15 per hectare; ■ The GAA costing allows for surface water, groundwater and reclamation monitoring, as well as care and maintenance for a minimum period of 3 years over an area of 1341.38 hectares; ■ Notwithstanding the differences in approach, the overall costs for this category

Category with sub-categories	Evaluation
■ Ongoing water treatment.	are relatively similar; and ■ GAA has not made any allowance for ongoing water treatment. (There is no mine drainage at Mufulira)
7.2.5.6 Additional allowances	
■ Preliminaries and general; and ■ Contingencies.	Both the Scott Wilson and GAA costs allow 6 percent for preliminaries and general and 10 percent for contingencies.

7.2.6 Matters Requiring Further Attention

The following matters that potentially require attention in future closure cost updates have been identified:

- There is an ongoing management of waste water from the mine workings and water management may require further attention from time to time.
- Compilation of proper inventories of infrastructure and mining activities within the respective battery limits and obtain sign-off by the mine on these;
- Confirmation and documentation of battery limits for the closure costing and providing the motivations/reasons for the inclusion and exclusion of areas;
- On-site quantification and measurement of those closure cost components with uncertainty with respect to the closure measures required and/or which are not adequately addressed in the indicative closure costs;
- The possibility that significant impact by mining related spillages on the local stream/river systems may exist and needs to be confirmed by on-site assessment of potentially affected areas by a suitably qualified specialist. In the event that contamination that can safely be removed without causing excessive damage to the streambeds is identified, allowance has to be made for at least the de-silting and re-instatement of contaminated stream beds and banks. Other measures may also be required in order; to allow the natural aquatic ecosystems to as far as possible to return. This could have a notable cost and has been excluded from this cost estimate, mainly due to uncertainty on responsibility for this environmental liability and the fact that such areas may not be detected from aerial imagery.

7.2.7 Conclusion

The findings as reflected in this report have primarily been based on the interpretation of Google Earth images and a number of maps of the respective mine sites. Clarification on a number of issues was obtained at the review meeting held with Mopani on 20 January 2011. Where the required information was not available, estimates were made based on experience. Unit rates for the purpose of the review were obtained from GAAs' existing data base and/or from demolition practitioners. Where required, these were adapted to reflect site-specific conditions.

The review of the existing closure costs, as well as recommendations in this regard, has been completed from a risk-averse perspective and mainly errs on the side of caution. This approach allows for the costs to be refined as appropriate information becomes available, as opposed to possible under-estimation and associated provision that could lead to liability shortfalls.

This review concludes that the closure costs provided by Scott Wilson are too low, even only addressing the most limited decommissioning and restoration requirements. It is recommended that a fair and reasonable financial provision of at least **USD 26 million** be made.

8.0 ENVIRONMENTAL, HEALTH AND SAFETY

8.1 Nkana

8.1.1 Terms of Reference

The key objective of this audit was to identify major environmental or social impacts and stakeholder concerns associated with Nkana Mine operations.

Specifically this involved assessing the following items:

- The scope and content of the Environmental and Social Impact Assessment ("ESIA") and Environmental Management Programme ("EMP").
- The status of environmental authorisations.

- Compliance with permit and statutory conditions.
- Compliance with the Equator Principles where sufficient site information was available to do so.
- Major environmental and social risks and liabilities, specifically in regards mine closure.

The geographical extent of the audit was limited to mining-related facilities and activities in the Nkana Mine Concession Area.

8.1.2 The Nkana Mine Concession Area

8.1.2.1 Mining infrastructure

Nkana Mine operates four shafts which supply the concentrator with ore, namely:

- SOB,
- Central,
- Mindola Sub-vertical; and
- Mindola North.

The following open pits are currently active and supply ore to the Nkana Leach Plant:

- Mindola North – an existing operation exposing ore in the centre and being extended towards the north;
- Area A – a shallow pit extending to a depth of approximately 30m and is situated south of Mindola North. Laterally the pit is being extended towards the existing Mindola North pit.
- Area E – Extension work being carried out at the end of the old pit.
- Area D open pit, mining in progress.
- Area J development of the open pit in progress and mining of the ore to commence before year end.

A review process is currently being undertaken for proposed open pit operations in Area K and Nose.

Leach operations are carried out in old mined out upper levels at Central Shaft and the leach solution is pumped to a solvent extraction plant on surface. This operation is now on care and maintenance, which was triggered by depressed copper prices on the world market. It is planned to resume operations before year end.

Mine dewatering water is pumped to surface at both Central Shaft and Mindola Sub-vertical Shaft at a daily rate of approximately 37 000m^3 and 45 000m^3 respectively. The bulk of the water from Central Shaft is used as process water by the metallurgical plants (Cobalt Plant, Concentrator and Nkana Leach Plants). Excess water is combined with plant site effluent and discharged into Uchi Stream under licence. Water from Mindola Sub-vertical Shaft is discharged into Mindola Stream under licence.

8.1.2.2 Waste Rock Dumps

There are currently three Waste Rock Dumps (“WRDs”) and three overburden dumps in operation at Nkana Mine, namely:

- WRD 14 - This is the depository for waste rock from Mindola SV and Mindola North Shafts. A portion of the mineralised waste rock is currently being reclaimed for processing through the concentrator;
- WRD 28 – for waste rock from Central Shaft, a significant portion of which has been reclaimed for use as construction aggregate;

- WRD 42 – for waste rock from the SOB Shaft, a significant portion of which has been reclaimed for use as construction aggregate;
- Overburden Dump 63 – For overburden material from Mindola open pit;
- Overburden dump 70 – for overburden material from Area D open pit; and
- Overburden Dump 53C - holds overburden material from Area E open pit extension.

Overburden material from Area A pit is dumped into the mined out section of Mindola Open Pit as backfill. Top soil from Areas A, D and J is stockpiled onto temporary dumps for use in post closure rehabilitation of the respective pits areas.

8.1.2.3 Tailings storage facilities

There are currently four TSFs at Nkana Mine, namely:

- TSF 15A - Tailings from the concentrator are combined with leach residues from leach operations and deposited via three delivery pipelines into TD15A by either cycloning to build dam walls or by open ending onto the dam beach. TD15A contains a cumulative tailings mass, since its inception of 128,730,519 tonnes as at November 2010.
- TSF 15 - The dam is decommissioned and no deposition has taken place since 1978. The dam requires constant monitoring by security personnel to prevent illegal removal of crushed stone from the retaining wall across the Mindola Stream on the eastern side of the dam. Backfilling of pits left by illegal crushed stone excavators and closing of some access routes is carried out regularly. The total tonnage in the dam is approximately 33,930,000 tonnes.
- TSF 52 - The dam is decommissioned and no deposition has taken place since 2002 when the dump was last used as an emergency depository. The dam is considered a resource for copper. The total tonnage in the dump is approximately 6,604,000 tonnes. A project to process the tailings is being implemented.
- TSF 68 - The dam is decommissioned and no deposition has taken place since 1986. The dam is considered a cobalt resource as most of the material on it was generated from processing of smelter slag by the previous owners of Nkana Mine. The total tonnage in the dump is approximately 549,000 tonnes.

8.1.2.4 Processing facilities

Mopani operates the following three metallurgical processing facilities at Nkana:

- The concentrator treats underground ore to produce copper and cobalt concentrates. The copper concentrate is trucked to Mufulira Smelter and the Cobalt concentrate is routed to the Cobalt Plant for processing.
- The Nkana Cobalt Plant produces cobalt metal via a Roaster, Leach and Electrowin metallurgical process. The cobalt sulphide feedstock to the plant has a copper / cobalt ratio of 4:1. In order to produce cobalt metal the copper is initially stripped as a by-product from the cobalt bearing process solution by EW. To improve the efficiency of the copper and cobalt recoveries a solvent extraction plant was added to the Cobalt Plant in 2007. This enabled both export grade cobalt and copper to be produced, as previously the copper produced at the plant was of low quality and had to be transported to the Mufulira Smelter for smelting and refining.
- The Nkana Leach Plant processes copper oxide ores from the open pits, with the leach solution routed to the Cobalt Plant for processing together with the Cobalt Plant's own copper/cobalt solutions and Central Shafts' leach solutions.

The leach residues from both the Cobalt Plant and Nkana Leach Plant operations are pumped to the concentrator for disposal into TSF15A, together with concentrator tailings. Wastewater from the metallurgical plants is mainly recycled before being discharged. However some of the combined process wastewater is discharged, under license, into North Uchi drain through the concentrator tailings thickener facility or a portion pumped to TSF15A whenever feasible.

8.1.2.5 Additional site infrastructure

The major ancillary and support facilities comprise of:

- Engineering workshops;
- Analytical laboratory;
- Power and water supply systems;
- Rolling stock to support the mine operations;
- Water treatment plant for production of potable water for plant area use;
- A mine hospital;
- Satellite clinics; and
- Primary and Secondary Schools.

8.1.3 Information Sources Reviewed

The information sources on which the audit was based included:

- Site documentation provided to GAA;
- Interviews which GAA conducted with site personnel on 6th December 2010; and
- GAA observations during the site visit of 6th December 2010.

These sources are discussed further below.

8.1.3.1 Site documentation

Site documents which provided background to the Nkana Mine audit included:

- Nkana Mine Bi-Annual Environmental Reports compiled by Mopani SHE Department between January-June 2008 until January-June 2010.
- Various Stakeholder Complaints Reports including Mine Responses.
- Permits and Licences (94 in total) issued to Nkana Mine by the ECZ
- Nkana Mine Emergency Preparedness and Response Plan compiled by Scott Wilson Piésold Zambia Limited Ltd. (January 2006).
- Nkana Mine Site Updated Global Environmental Management Plan compiled by Scott Wilson Ltd (June 2009).
- Nkana Mine Environmental Impact Statement compiled by SRK (July 2003) and including:
  - Volume 1: Assessment of Impacts; and
  - Volume 2: Environmental Management Plan
- The following monitoring data and reports for Nkana Mine:

- Acid monitoring data for the Cu and Co tank houses, leach plant and Central Shaft leach;
- Gravimetric (dustfall) data collected on 6th August 2010for Mindola SV Shaft Main Ore Tip;
- Noise Survey Report for Area "K and Nose" Open Pit Ore Mining compiled by Mopani SHE Department in November 2010; and
- Daily water quality monitoring reports (collated monthly) for 2010.

- ECZ Environmental Audit Follow-up Report and Letter dated 9th December 2009 (being follow-up on non-compliances recorded in the ECZ environmental audit of Nkana Mine conducted in 2007).
- Procedure for the Management of Hazardous Substances at Mopani Copper Mine (Nkana and Mufulira): MCM Procedure PRO012 Rev 1, dated 18th January 2005.
- Procedure for the Management of Wastes at Mopani Copper Mine (Nkana and Mufulira): MCM Procedure PRO016 Rev 1, dated 18th April 2005.

8.1.3.2 Interviews with site personnel

The following site personnel participated in the audit interviews and site visit:

- Mine Technical Manager;
- Environmental Superintendent (Nkana and Mufulira Mines);
- Security Manager;
- Manager Corporate Affairs; and
- Manager Safety, Health and Environment.

8.1.3.3 Site areas visited

A site visit of the Nkana Mine Concession was conducted on 6th December 2010. Emphasis was placed on visiting specific areas and facilities of the concession which were identified in the site documentation and/or site interviews as presenting potentially significant environmental liabilities of concern.

8.1.4 Limitations of the Audit

This report is based on a high level overview of the Nkana Mine operations by experienced GAA Associates staff. The review involved a day visit to the mine with the time divided between travel, the identification and review of available documents, discussion with key personnel and a brief visit to areas of greatest concern on site. The review therefore focuses only on critical environmental and social issues, so as to identify risks that could be major liabilities. Wherever possible, existing documentation has been used as a basis for conclusions drawn.

8.1.5 Results of the Audit

The results of the environmental audit of Nkana operations and activities are presented in the subsections that follow.

8.1.5.1 Compliance against statutory conditions

The ECZ conducts periodic licensing inspections of the mine. Typically, these are done annually. The 2009 inspection included a review of corrective actions taken by Mopani to address major findings of the 2007 and 2008 inspections. At the time of the site visit, no inspections had occurred for 2010. Subsequently we were advised that ECZ site inspections were to take place in late December 2010, the outcome of which would then be used to assess 2011 license applications. The ECZ report on their annual inspection carried out in December has since been received (report dated 7th February 2011 reference No. ECZ/FAC/103/12/M/5).

There were no major adverse comments. ECZ letter of 3rd February 2011 confirmed that Mopani had been issued with all the 2011, permits applied for.

The environmental license conditions for Nkana Mine are fairly extensive and include eight specific requirements, namely:

- Importation, transportation and storage of chemicals;
- Management of mining waste (tailings, waste rock and overburden);
- Management of domestic / industrial waste (generation, storage and transportation);
- Transportation of tailings;
- Management of hazardous waste (used oil, used fluorescent tubes, used batteries and used oil filters);
- Healthcare waste management;
- Air emissions; and
- Discharge of effluent

A review of the ECZ inspection report for 2009 showed that most of the findings had been addressed. Scott Wilson Ltd (July 2010) carried out an audit in respect of Environmental Protection Fund of Nkana Mine performance against EMP commitments and ECZ approval conditions. A review of the report showed that the mine was compliant with the vast majority of its commitments. The areas of non compliance in the Scott Wilson Ltd audit which may represent risk to Nkana Mine operations and to meeting Equator Principles and IFC include;

- At times some exceedences of permitted effluent discharge limits for some parameters at two of the six lic enced outlets
- Exceedences for SO_2 emissions limits at the Cobalt Plant Roaster on account of the Acid Plant being shutdown.

8.1.5.2 Impact of effluent discharges on river quality

The industrial water requirement at Nkana Mine is met primarily through underground dewatering via the Central Shaft, although there is abstraction of water from the Kafue River to meet hardness-sensitive process requirements. Excess water from Central Shaft and water from Mindola SV Shaft are discharged to the Uchi and Mindolo streams respectively.

Table 31 (after Scott Wilson, 2010) indicates the location of surface water discharges from the Nkana Mine to local streams, together with an indication of whether effluent quality monitoring data supports compliance with regulatory limits prescribed in the Third Schedule to the Water Pollution Control (Effluent and Waste Water) Regulations (S172 of 1993).

- The effluent discharge from the acid plant and Cobalt Plant areas to the North Uchi Stream represents a risk to Nkana Mine in terms of possible contamination of both the North Uchi stream and the receiving Kafue River. It would appear that a significant component of this risk could be removed by ensuring that tailings thickener overflow pH is at least 8.5 and that the Cobalt Plant concentrates is stored under cover prior to slurrying and roasting.
- As mitigation a dedicated lime plant for the Nkana Leach Plant has been installed to ensure effective neutralisation of leach residue disposed through concentrator tailings thickener (“TT”). It is envisaged that this will ensure that TT overflow wastewater into North Uchi is in compliance as regards dissolved copper, cobalt and manganese.
- As mitigation spilled tailings have been cleaned and deposited in the operating tailings dump (TD15A).

Table 31: Summary of surface water discharges at Nkana Mine

Principal water source	Receiving water resource	Monitoring observations
North open pit, North Shaft, Mindola SV Shaft	Mindola Stream	Generally compliant with limits
Central Shaft, concentrator	Frikers Lake outlet to Luanshimba Stream	Compliant with limits
Acid Plant, Cobalt Plant	Harrison Street Drain / North Uchi Stream to Kafue River	Non compliant on numerous occasions. Main exceedences are elevated concentrations of Cu and Co.
Leach Plant	Kitwe Stream	Generally compliant with limits
TD15	Ichimpe Stream	Compliant with limits
TD15A	Fikondo Stream	Compliant with limits

8.1.5.3 Tailings pipeline spillages

Time limitations prevented GAA from identifying areas of tailings spillage from the 15km tailings pipeline, booster pump station and/or tailings bleed points. These spillages have, however, been previously identified as a risk area by ECZ in terms of the siltation of the two adjacent streams. Discharge of tailings supernatant water was observed at the northwest corner of the TSF into the Fikondo Stream and silt loads appeared to be small.

8.1.5.4 Impact of SO_2 emissions from the Cobalt Plant

The venting of flue gas from the Cobalt Plant direct to the atmosphere rather than routing the gas to the acid plant, due to low sulphur feed to the roaster, results in SO_2 emissions consistently exceeding the long term limit of 1 000 mg/Nm^3. This represents a significant risk to Nkana Mine operations, particularly as the deadline issued by ECZ to resolve this problem has passed.

Table 32: Compliance of Nkana Mine operations with Equator Principles and IFC requirements

Equator Principle	Requirement	Compliance Rating	Reasons for Compliance /Non Compliances
Principle 1: Review and Categorisation	Projects are categorised on the basis of the magnitude of potential impacts and risks	Compliant	Nkana is an operating mine. The environmental license and permit conditions for the mine are based upon the EIA prepared by SRK (2003). For the purposes of this EIA, the mine was correctly classified as a Category A project and the assessment was prepared accordingly.
Principle 2: Social and Environmental Assessment	Social and Environmental Assessment Process required to address impacts and risks of construction, operation and closure. Mitigation required which is appropriate and implementable	Compliant	Category A EIA and various EMPs completed, including the most recent updated Global EMP by Scott Wilson, 2009. A Social Management Plan was prepared by the Copperbelt University, Department of Urban and Regional Studies, in 2007, providing a detailed management framework as a basis for promoting sustainable development and poverty alleviation. The updated EMP and SMP provide an appropriate foundation on which to base the company's interaction with communities and commitments to sustainable development practices.
Principle 3: Applicable Social and Environmental Standards	IFC PS 1: Social and Environmental Management System	Non compliant	EMS in progress but not complete and implemented. The company has significant capacity for social impact management under the Corporate Affairs Manager.
	IFC PS 2: Labour and worker conditions	-	Labour practices are dealt with in the Employment, Retirement and Retrenchment Action Plan. The plan deals with: ■ Retrenchment benefits and counselling (requirements for counselling prior to retrenchment) ■ Multi skilling and training (training in order to assist retrenched and/or retired workers to remain economically active)(■ Local employment (local employment strategy including an 'expatriate replacement strategy' and a plan which ensures the development of its own workforce as well as contractor labour) Specific performance criteria are set in order to monitor effectiveness of the plan. These include number of people employed by Mufulira, number of people employed in different categories, number of expatriates replaced by Zambian labour, implementation of a Human Resources Development Plan.
	IFC PS3: General requirements	N/A	-N/A
	IFC PS 4: Community Health, Safety and Security – Community Health and Safety	Compliant	The Nkana SMP includes a Health and Welfare Action Plan. The plan provides for company involvement in combating HIV/AIDS among workers and in surrounding communities. Provision is made for verifying that contractors employed by the company comply with its HIV/AIDS policy.

			Other community health management commitments are made in the Scott Wilson (2009) EMP. These are mainly related to malaria interventions.
	IFC PS 4: Community Health, Safety and Security – Security	-Compliant	Access control in place
	IFC PS 5: Land Acquisition and Involuntary Resettlement – general requirements	Compliant	The Nkana SMP includes a Land Use and Settlement Action Plan. The plan has a number of components: ■ Demarcation and communication of boundaries of mine surface area to communities and ongoing communication to permit safe use of designated areas within the MSA for community use ■ Limitation of the growth of informal settlements around the mine ■ Protection of communities from mining hazards (including requirements for signage, access control, education, awareness raising, patrols etc) ■ Management of seasonal cultivation in the MSA through a permitting system ■ Community-based natural resource management (“CBNRM”) with settlements and current land users on the MSA to assist in the conservation of woodlands. The programme is conducted in cooperation with the Government’s Forestry Research Division and includes awareness raising, networking and patrols. ■ Management of use of MSA water bodies including monitoring of use and signage warning people about hazards of fishing in potentially contaminated areas (e.g.: tailings dams) ■ Maintenance and demarcation of access roads in the MSA ■ Sustainable land use management. This includes networking with DACO and FRD regarding training and awareness programmes to develop A monitoring plan is set out which includes tracking of a large number of performance indicators
	IFC PS 7: Protection of Indigenous Peoples	N/A	■ Indigenous peoples are not affected by the mining activities
	IFC PS 8: Cultural Heritage – protection of cultural heritage in project design and execution	Compliant	■ Heritage assessment has not been undertaken for the proposed new development sites such as the Far West Tailings Dam

	IFC PS 8: Cultural Heritage – project's use of cultural heritage	Compliant	■ The mine does not use cultural heritage resources
Principle 4: Action Plan and Management System	Environmental and Social Action Plan	Compliant	The SMP for the mine includes a series of Action Plans that set out the specifics of required social management activities, together with roles and responsibilities, time frames and monitoring and evaluation schedules. The Action Plans are as follows: ■ Employment (Medical Discharge, Retirement and Retrenchment) Action Plan ■ Local Business Development Plan ■ Health and Welfare Plan ■ Physical Infrastructure Plan ■ Land Use and Settlement Plan ■ Community Management Support Plan ■ Disclosure and Consultation Plan
Principle 5: Consultation and Disclosure	Ongoing consultation with affected communities in a structured and appropriate manner	Compliant	■ The Nkana SMP includes a Disclosure and Consultation Action Plan. The objective of the plan is to develop good relationships between Nkana mine and the public, to ensure transparency between the mine and stakeholders.
Principle 6: Grievance Mechanism	Formal grievance mechanism required as part of the management system	Compliant	■ A formal grievance procedure is in place
Principle 7: Independent Review	Independent social or environmental expert not directly associated with the borrower to review the assessment, consultation process and Equator Principle compliance	Compliant	■ Independent reviews/audits are undertaken. Recent audits include: JA Consultants (2008); MCM (2009) Scott Wilson (2010);
Principle 8: Covenants	The following covenants to be included in financing documentation: The borrower will: • Comply with all host country social and environmental laws, regulations and	Potentially Compliant	If the Environmental Management Plan and Social Management Plan are fully implemented, the project appears to be capable of meeting Equator Principle requirements. Environmental authorization is in place, with a permit issued by the Environmental Council of Zambia in April 2004. All other environmental and social permits appear to be in place and are meticulously documented in Table 3-3 of

	permits; • Comply with the action plan during construction and operation in all material respects; • Provide reports (not less than annually) to document compliance with laws, regulations and permits; and • Decommission the facilities in accordance with an agreed decommissioning plan		the Nkana updated EMP (Scott Wilson, 2009). The EMP also sets out all of the environmental requirements that are conditions of approval of the Environmental Council of Zambia, together with the management action necessary to meet each condition and whether it was once off or ongoing. Updating of the EMP is being done.
Principle 9: Independent Monitoring and Reporting	An idependent, experienced external expert to verify monitoring information on a regular basis	Compliant	■ Third party audits of EMP carried out by approved independent auditors (African Mining Consultants in 2009 & Scott Wilson in 2010). Compliance could be improved via the implementation of an EMS.

8.1.6 Nkana key social aspects and risks

With reference to compliance with the social elements of the plans described in Table 32, the following comments are made, based on the brief discussions held with Nkana staff and the recent audit by Scott Wilson (2009):

- **Social Assessment (Equator Principle 2):** The Social Management Plan is not audited and while some of the components of the plan are included in the updated EMP, there are specific monitoring requirements that are not. The SMP needs to be included in future audits or fully incorporated within the EMP in the next annual update.

- **Social / Environmental permits (Equator Principle 2):** Mopani appears to be fully compliant with respect to permitting, with a comprehensive and updated list of permits available for review (sixty seven permits listed in the recent Scott Wilson, 2010 audit).

- **Community Health Safety and Security (Equator Principle 3, IFC PS 4):** Mopani operates one hospital and three clinics in the former mine townships, as well as four plant site clinics at a cost of around USD 8 mill per annum. Clinic services are available to all members of staff and their families and to children under five at no charge and to other members of the surrounding communities for a fee.

  The company supports an on-going malaria control programme that extends beyond the protection of its own employees into surrounding communities. It involves Integrated Vector Management ("IVM"), which is a comprehensive malaria programme that targets mosquitoes at every stage of their life cycle. The company coordinates its' malaria programme with Government and NGO initiatives. It is company policy that all malaria complaints are verified with blood tests, and malaria monitoring and reporting is conducted. The company's malarial control commitments cost an average of around USD 1 million per year. Malarial incidence among patients at the company's medical facilities has dropped to around 30 cases/ 1000 treated in 2010 (Zambian National average is 250 cases/ 1000 treated). The data were obtained from Mopani clinics that treat patients from within a catchment of 60 000 people (Kitwe).

  The company also implements a comprehensive HIV AIDS Management Programme. This involves a full range of initiatives from prevention through treatment, care and support. An HIV AIDS policy has been submitted to Government. An extensive training program has been implemented which trains trainers, peer educators, palliative care providers and psychosocial councilors in the workplace and the community. Work includes partnering with NGOs such as the Catholic Relief Services and Comprehensive HIV AIDS Management Programme ("CHAMP") who have experience in this field.

  Regarding community safety, there has been no loss of life in surrounding communities as a direct result of mining and mining related activities. One significant incident has arisen since privatisation in which a pump failure caused an acid leak that contaminated the company's supply of water to the community. This resulted in hospitalization and treatment of a number of people. No-one was seriously injured although the incident necessitated a considerable amount of work to rebuild community trust.

  A company procedure is in place to manage emergencies, supported by professional risk assessments.

- **Resettlement (Equator Principle 3, IFC PS 5):** No resettlement has been necessary since the start of Mopani operations. Any resettlement that is to be done in the future will be planned and implemented with the assistance of experts, according to international standards. Regarding the management of existing settlements, a significant number of compliance requirements are set out in the SMP, together with specific performance standards for monitoring. These are not referred to in detail in either the SRK (2007) audit or the recent Scott Wilson (2010) audit and no information has been provided to the reviewers to demonstrate whether they are being systematically implemented.

- **Corporate Social Responsibility (Equator Principles 3 and 4):** An appropriate organisational structure and staffing for social impact management on the mine has been set up under the Manager Corporate Affairs. The company is involved in a number of programmes to encourage and facilitate local business development.

- **Consultation and Disclosure** (**Equator Principle 5**): A comprehensive ongoing process is implemented by the company. Community liaison officers have been appointed for each mine site and are responsible for liaison with townships and for providing feedback, requests and grievances from the community to the Corporate Affairs Manager. Feedback forms are at various convenient locations for stakeholders to provide the company with comment. These are collected regularly and entered into a central database.

- **Community Grievances (Equator Principle 6):** The EMP and SMP are being implemented in the context of the social issues arising from the privatisation of the mine, resulting in many services previously provided by ZCCM no longer being available or not being available without charge to members of the local communities not employed by the mine. The Manager Corporate Affairs is aware that there are legacy issues associated with the privatization of certain government services, such as health, housing and education. The community may expect that in future the mine will supply these services. The community expectations need to be appropriately managed.

- **Overall compliance (social):** Compliance with the EMP has been audited several times in the past 5 years. Most recently, the Scott Wilson (2010) audit included a review of the findings of the previous audits and is consequently the most current independent view of compliance with the EMP. It may be seen that Mopani's performance is rated highly, with the company achieving a 100% compliance rating for all of the listed social items.

  The above evidence provides the assurance that Mopani is complying with its commitment to manage social issues and promote sustainable development within the limits that could reasonably be expected of a private company. The management of community expectations driven by the legacy issues referred to above is a critical factor affecting the long term relationship between the mine and the community. The view of the Manager Corporate Affairs is that the mine, through its social investment programme, will gradually improve its relationship with local communities.

8.1.7 Health and Safety

The organisational structure for Mopani provides that the Chief Executive Officer ("CEO") bears the overall responsibility for the management of Safety, Health and Environmental ("SHE") matters.

Operating responsibility lies with the respective chief officers and their respective line managers, superintendents and heads of departments as the case may be. In this the principal guiding policy is the SHE Policy (Pol 002).

The operationalisation of the policy is coordinated by the SHE Department headed by the SHE Manager.

The primary functions for the SHE Department can be summarised to include the following;

- Provide expert advice and guidance To various departments as regards acceptable/ appropriate safety, occupational hygiene and environmentally sound practices;

- Ensure compliance with the relevant SHE legislation and in their absence use international best practices as the standard;

- Ensure that new projects are developed in accordance with legislative provisions o in their absence international best practices;

- Provide in-house training in requisite SHE guidelines in respect of Mopani operations to new employees prior to their deployment to their work departments; and

- Drive the continuous improvement programme on SHE matters such as those in respect to the requirements of ISO14001 and OHSAS18001 standards;

  The health and safety statistics for Nkana are set out below, the results suggest a reduction in the number of Lost Time Injuries ("LTI") and fatalities between 2008 to 2010.

Table 33: Nkana Injury Trends: 2008 – 2010

	2008	2009	2010
LTI	175	106	97
NLTI	119	75	65
Fatalities	1	3	4

8.1.8 Industrial Relations

There have been no labour disputes including strikes and work stoppages since 2008. There are two recognised labour unions organised on the mine: Mine Workers Union of Zambia ("MUZ") and the National Union of Mine and Allied Workers ("NUMAW"). In general annual wage and condition of service negotiations proceed to conclusion without incident.

8.1.9 Concluding Statements

After reviewing of existing site documentation, conducting brief interview of site personnel and visiting areas of the site of known potential environmental impact, the following conclusions were reached from the audit of environmental and social management at Nkana Mine:

- The environmental performance of Nkana Mine is substantively compliant with its environmental licence and EMP conditions;
- Environmental impacts which generally exceed licence conditions and pose a risk to Nkana Mine operation in terms of compliance to statutory requirements and the Equator Principles include:
  - Effluent discharge to the environment, particularly from the Cobalt Plant (below pH 8.5), high Cu and Co concentrations) to the North Uchi Stream which drains to the Kafue River. It would appear that a significant component of this risk could be removed by ensuring that tailings thickener overflow pH is at least 8.5 and that the Cobalt Plant concentrates is stored under cover prior to slurrying and roasting;
  - Spillage of tailings from the tailings pipeline, booster pump station and/or tailings bleed points to the adjacent two streams; and
  - Venting of flue gas from the Cobalt Plant direct to the atmosphere rather than routing them to the acid plant. This results in SO_2 emissions consistently exceeding the long term limit of 1 000 mg/Nm^3.
- Mopani is complying with its commitment to manage social issues and promote sustainable development within the limits that could reasonably be expected of a private company.
- The management of community expectations is a critical factor affecting the long term relationship between the mine and the community.

8.1.10 References

- ECZ (2009). ECZ Environmental Audit Follow-up Report and Letter dated 9th December 2009 (being follow-up on non-compliances recorded in the ECZ environmental audit of Nkana Mine conducted in 2007).
- Mopani Copper Mine (2005a). Procedure for the Management of Hazardous Substances at Mopani Copper Mine (Nkana and Mufulira): MCM Procedure PRO012 Rev 1, dated 18th January 2005.
- Mopani Copper Mine (2005b). Procedure for the Management of Wastes at Mopani Copper Mine (Nkana and Mufulira): MCM Procedure PRO016 Rev 1, dated 18th April 2005.

- Mopani SHE Department, (2008 to 2010). Nkana Mine Bi-Annual Environmental Reports compiled between January-June 2008 until January-June 2010.
- Scott Wilson Piésold Zambia Limited Ltd. (January 2006). Nkana Mine Emergency Preparedness and Response Plan.
- Scott Wilson Ltd (June 2009). Nkana Mine Site Updated Global Environmental Management Plan.
- SRK (July 2003). Nkana Mine Environmental Impact Statement.
- Baseline studies (2001) by SRK which was also used in determining which mine assets were transferred to Mopani and which remained with the previous owners as historical liabilities.
- TD15a Slope Stability Analysis Report by Scott Wilson Piesold Zambia Limited
- Emergency Preparedness and Response Plan 2006 for TD15a, by Scott Wilson Piesold Zambia Limited.
- TD15a Operating and Maintenance Manual 2006 by Scott Wilson Piesold Zambia Limited
- Third Party Audit Reports for the period 2007, 2008, 2009 and 2010.

8.2 Mufulira

8.2.1 Terms of Reference

The key objective of this audit was to identify major environmental or social impacts and stakeholder concerns associated with Mufulira Mine operations.

Specifically this involved assessing the following items:

- The scope and content of the ESIA and EMP.
- The status of environmental authorisations.
- Compliance with permit and statutory conditions.
- Compliance with the Equator Principles where sufficient site information was available to do so.
- Major environmental and social risks and liabilities, specifically in regards mine closure.

The geographical extent of the audit was limited to mining-related facilities and activities in the Mufulira Mine Concession Area.

8.2.2 Mufulira Mine Facilities

Mining infrastructure in the Mufulira Mine concession consists of:

- Central Mine;
- Mufulira East Mine;
- Mufulira West Mine; and
- Leach mining.

Processing facilities in the Mufulira Mine concession include:

- Mufulira concentrator;
- Mufulira Smelter;

- Mufulira refinery;
- Three SX plants;
- Leach plant;
- Mufulira East heap leach plant (decommissioned); and
- Mufulira West heap leach.

Mine residue deposits in the Mufulira Mine concession include:

- WRD 11;
- WRD 13 (considered as an ore resource for the Mufulira West heap leach);
- WRD 14 (being reworked by a private contractor for construction aggregate);
- WRD 17 (the current main active disposal site of waste rock from conventional underground operations);
- Slag dump 1 (nearing capacity and used for emergency dumping only);
- Slag dump 2 (currently operational);
- Tailings Dump 3 (TD 3) (no deposition currently);
- TD 4 and TD 5 (currently inactive);
- TD 11 (currently the only active tailings dump at Mufulira)

Support infrastructure associated with mining and processing operations at Mufulira includes:

- Workshops;
- Central stores;
- Laboratory;
- Salvage yard; and
- Hospital and satellite clinics within the plant area and in the local township.

8.2.3 Information Sources Reviewed

The information sources on which the audit was based included:

- Site documentation provided to GAA;
- Interviews with site personnel on 7th December 2010; and
- GAA observations during the site visit of 7th December 2010.

These sources are discussed further below.

8.2.3.1 Site documentation

Site documents which provided background to the Mufulira Mine audit included:

- Mufulira Mine Environmental Impact Statement compiled by SRK (July 2003) and including:
  - Volume 1: Assessment of Impacts; and

    - Volume 2: Environmental Management Plan.

- Mufulira Mine Site Updated Global Environmental Management Plan compiled by Scott Wilson Ltd (June 2009).
- Permits and Licences issued to Mufulira Mine by the ECZ.

8.2.3.2 Interviews with site personnel

The following site personnel participated in the audit interviews and site visit:

- Mine Technical Manager;
- Environmental Superintendent (Nkana and Mufulira Mines);
- Chief Processing Officer;
- Manager Safety, Health and Environment;
- Security Manager; and
- Manager Corporate Affairs.

8.2.3.3 Site areas visited

A site visit of the Mufulira Mine Concession was conducted on 7th December 2010. Emphasis was placed on visiting specific areas and facilities of the concession which were identified in the site documentation and/or site interviews as presenting potentially significant environmental liabilities of concern.

8.2.4 Limitations of the Audit

This report is based on a high level overview of the Mufulira Mine operations by GAA Associates staff. The review involved a one day visit to the mine, with the time divided between travel, the identification and review of available documents, discussion with key personnel and a brief visit to areas of greatest concern on site. The review therefore focuses only on critical environmental and social issues, so as to identify risks that could be major liabilities. Wherever possible, existing documentation has been used as a basis for conclusions drawn.

8.2.5 Results of the Audit

The results of the environmental audit of Mufulira operations and activities are presented in the subsections that follow:

8.2.5.1 Compliance to license conditions

The Environmental Council of Zambia conducts periodic licensing inspections of the mine. Typically, these are done annually. The 2010 inspections are currently (December 2010) in progress the findings will be used in issuing 2011 licenses. The 2009 inspection included a review of corrective actions taken by Mopani to address major findings of the 2007 and 2008 inspections.

The environmental license conditions for Mufulira Mine are fairly extensive and include eight specific requirements, namely:

- Importation, transportation and storage of chemicals;
- Management of mining waste (tailings, waste rock and slag (overburden)).
- Management of domestic / industrial waste (generation, storage and transportation);
- Transportation of tailings;
- Management of hazardous waste (used oil, used fluorescent tubes, used batteries and used oil filters);

- Healthcare waste management;
- Air emissions; and
- Discharge of effluent

The risk areas at the two sites should be in respect of effluent discharges which at some outlets are at time outside the limits in some parameters and SO_2 emissions at both mine sites. At Nkana SO_2 emissions are due to poor quality roaster offgas which cannot be treated in the existing acid plant. At Mufulira capture of SO_2 is currently at 51% (2010 average) against a target of 50%, and capture is expected to increase to 97% when phase 3 of the Smelter Upgrade Project is completed in 2015. This project will incorporate installation of a second Acid Plant.

- SO_2 exceed the long term statutory limit;
- Effluent discharge quality exceedance of the limit, particularly in regards Mn concentrations in TD 11 discharge. The quality of the combined effluent streams exiting the mine boundary is compliant; and
- One additional neutralising tank has been installed to increase the pH of solution above 9 in order to precipitate more Mn and hence to reduce in the effluent discharge. Currently it is in operation.

Scott Wilson Ltd (July 2010) conducted an Environmental Protection Fund audit of Mufulira Mine performance against EMP commitments and ECZ approval conditions. The mine was compliant with the vast majority of these commitments.

The areas of non-compliance identified in the Scott Wilson Ltd audits which represent sufficient risk to Mufulira Mine operations and to meeting Equator Principles and IFC requirements include:

- Mine effluent discharge quality exceeds the mine permit conditions in some instances, although final mine discharge (at the mine boundary) is compliant. Scott Wilson (July 2010) reported 80% compliance against this requirement/commitment;
- The high volume of raffinate reporting to the neutralisation plant has resulted in some bleed with low pH (less than pH of 8.5) and elevated Mn concentration levels reporting to the tailings stream (80% compliance) resulting in low compliance (80%) of the dam discharge; and
- As stated above the additional neutralising tank will improve the pH and will reduce Mn level in the effluent. We should able to meet compliance more than 80%
- Smelter SO_2 emissions exceeding the stipulated long term emission levels (60% compliance). Mufulira has embarked on a substantial smelter upgrade project which aims to reduce SO_2 and dust emissions to acceptable levels. Implementation of phase 3 of the Smelter upgrade project will address the SO_2 and dust in Smelter emissions ex converters. Project completion is due by 2015.

The impacts and risk areas are discussed further in the next subsection.

8.2.5.2 Mufulira key environmental aspects and risks

Impact of effluent discharges on river quality

The majority of process water used at Mufulira is obtained from dewatering of its underground operations, although water is also piped from three surface dams located on the Mufulira Stream. These dams retain water upstream of the sensitive mine caving area. Some of the water piped across the caving area is abstracted for use on the mine, as process water as well as for local potable use after treatment by the Mulonga Water and Sewerage Company ("MWSC").

Plant surface water is managed within a network of concrete lined open channels, which drain into the Kankoyo and Norries drains which then combine to form the main mine drain. The main mine drain passes through a cascade of rock gabion settling structures before finally discharging into the Mufulira Stream, downstream of the mine caving area diversion system. The Mufulira Stream flows in a southerly direction towards the Kafue River. Each of these outlets is monitored daily and exceedences are reported biannually to ECZ and MSD.

Figure 72: Solids settling ponds for wastewater leaving plant area

On the basis of the observations of Scott Wilson Ltd (July 2010) and our own limited observations within the time frame of this audit, it would appear that effluent is relatively well managed at Mufulira. Concentrates are stored under cover, spillage is minimised and silt loads are maintained at a relatively low level.

Scott Wilson Ltd reviewed site surface water monitoring results over the 12 month period prior to the audit and confirmed that the quality of the final mine discharge water from the mine consistently meets the Zambian limits as required under the Third Schedule to the Water Pollution Control (Effluent and Waste Water) Regulations (SI 72 of 1993). It is important to note, however, that individual monitoring locations with the mine boundary show some exceedances, particularly in regards total suspended solids ("TSS"), Fe, Cu and Mn. These exceedances should be investigated as they represent a risk to Mufulira Mine.

As mitigation of the risks associated with the discharge into the rivers the Mulonga Water Treatment Plant facility provides for pumping of backwash which is currently discharged into plant drains to concentrator Tailings Thickener for disposal to TD11 is due for completion by end of February 2011. This is also expected to improve the quality of wastewater discharged into Mufulira Stream from the plant.

Impact of tailings and raffinate management

The only operational tailings dam is TD11 which encompasses a series of smaller, older dams. The discharge from this is via a spillway in the south-west corner.

Monitoring of the discharge water quality indicates (Scott Wilson Ltd, July 2010) that the quality generally conforms to the licence discharge consent limits, with the exception of Mn.

The source of elevated Mn has been attributed to high volumes of raffinate bleed being discharged to TD11 and the lack of capacity of the neutralising plant to ensure metal precipitation in the tailings solids. GAA is aware, that the mine has commenced with remedial actions to address this impact.

The additional neutralising tank should help in reducing the Mn level in effluent discharge.

In order to mitigate these risks Mufulira has:

- Initiated a process to install automatic pH control system for the Raffinate bleed off to enhance effectiveness of neutralisation (due in 2011); and
- commenced a process of planting of vegetation on areas of TD11 dump which will not be deposited with tailings in the future e.g. the southern embankment. Rate and extending of annual planting is being intensified since the last two rainy seasons.

Impact of Mufulira Smelter SO_2 and dust emissions

The Mufulira Smelter is in the process of a major phased upgrade programme to achieve the double benefit of removing process bottlenecks and reducing air quality emissions to an acceptable level. A formal decision made by ECZ in 2007 grants Mufulira a revision of the SO_2 capture limit for the Smelter Upgrade Project from the initially approved target of between 55% and 59% to 50%. This revision (or stability) period ends in 2015. Monitoring data provided to the auditors shows the capture of SO_2 is on average compliant.

Phases 1 and 2 of the Mufulira Smelter Upgrade Project have already been implemented. These upgrades included the installation of a new Isasmelt Smelter, electrostatic precipitator ("ESP"), upgrade of the concentrate shed, oxygen plant, matte settling electric furnace, acid plant (single-contact single absorption), an upgrade of anode furnaces and casting areas, and an upgrade of plant services. The Isasmelt furnace was commissioned in 2006.

Phase 3 will incorporate upgrades to the converters (a new converter is scheduled for December 2011 and a second new converter by December 2012) and the installation of a second (double-contact) acid plant. A gas cleaning hood on the new converters will collect fugitive gas which will then report to the off-gas system for gas cleaning and cooling.

Zambian Air Pollution Control Legislation (Schedule 1 of SI 141 of 1996) sets ambient air guideline limits for SO_2 of 125 $\mu g/m^3/24$ hr which are applicable to areas outside the Mufulira Mine plant. Daily ambient air monitoring is undertaken at four long established locations (clinics) outside the plant site boundary. Instances of exceedances are at times recorded at three of the four clinics but monthly averages remain below the limit.

As mitigation of these environmental risks:

- a Smelter Flocculant system for the feed to the solids settling ponds on Main Mine Drain is being constructed and due for completion by end of April 2011. This is expected to improve the quality of wastewater discharged into Mufulira Stream;
- a process of planting of vegetation on areas of TD11 dump has been initiated which will mean that no tailings will be there in future e.g. the southern embankment. The rate and extension of annual planting is being intensified since the last two rainy seasons. There is an operating and maintenance manual for the dump which guides the concentrator on the management of the dump. Regular meetings are also held with the external dumps consultant; and
- Mopani is compliant with emissions capture under the EMP approved with the ECZ. All ECZ permits applied for 2011 have been issued by the ECZ and processing of the same by the ECZ is in progress.

In summary, Mopani has responded in a proactive manner to the significant risk posed by SO_2 and dust generation from its' Mufulira Smelter and associated activities. The introduction of the new converters and second acid plant should achieve significant further reduction in emission levels and bring the mine into compliance with long term emission limits.

Table 34: Compliance of Mufulira Mine operations with Equator Principles and IFC requirements

	Requirement	Compliance Rating	Reasons for Compliance /Non Compliances
Principle 1: Review and Categorisation	Projects are categorised on the basis of the magnitude of potential impacts and risks,	Compliant	Mufulira is an operating mine. The environmental license and permit conditions for the mine are based upon the EIA prepared by SRK (2003). For the purposes of this EIA, the mine was correctly classified as a Category A project and the assessment was prepared accordingly.
Principle 2: Social and Environmental Assessment	Social and Environmental Assessment Process required to address impacts and risks of construction, operation and closure. Mitigation required which is appropriate and implementable.	Compliant	Category A EIA and various EMPs completed, including the most recent updated Global EMP by Scott Wilson, 2009. A Social Management Plan was prepared by the Copperbelt University, Department of Urban and Regional Studies, in 2007, providing a detailed management framework as a basis for promoting sustainable development and poverty alleviation. The updated EMP and SMP provide an appropriate foundation on which to base the company's interaction with communities and commitments to sustainable development practices.
Principle 3: Applicable Social and Environmental Standards	IFC PS 1: Social and Environmental Management System	Non compliant	EMS in progress but not complete and implemented. The company has substantial capacity for social impact management under the Corporate Affairs Manager.
	IFC PS 2: Labour and worker conditions	-	Labour practices are dealt with in the Employment, Retirement and Retrenchment Action Plan. The plan deals with: Retrenchment and/or Retiree benefits and counselling (requirements for counselling prior to retrenchment) Multi skilling and training (training in order to assist retrenched workers to remain economically active) Local employment (local employment strategy including an 'expatriate replacement strategy' and a plan which ensures the development of its own workforce as well as contractor labour) Specific performance criteria are set in order to monitor effectiveness of the plan. These include number of people employed by Mufulira, number of people employed in different categories, number of expatriates replaced by Zambian labour, implementation of a Human Resources Development Plan.
	IFC PS3: General requirements	N/A	-N/A
	IFC PS 4: Community Health, Safety and Security – Community Health and Safety	Compliant	The Mufulira SMP includes a Health and Welfare Action Plan. The plan provides for company involvement in combating HIV/AIDS among workers and in surrounding communities. Provision is made for verifying that contractors employed by the company

			comply with its HIV/AIDS policy. Other community health management commitments are made in the Scott Wilson (2009) EMP. These are mainly related to malaria interventions.
	IFC PS 4: Community Health, Safety and Security – Security	N/A-	Not evaluated.
	IFC PS 5: Land Acquisition and Involuntary Resettlement – general requirements	Compliant	The Mufulira SMP includes a Land Use and Settlement Action Plan. The plan has a number of components: Demarcation and communication of boundaries of mine surface area to communities and ongoing communication to permit safe use of designated areas within the MSA for community use; Limitation of the growth of informal settlements around the mine; Protection of communities from mining hazards (including requirements for signage, access control, education, awareness raising, patrols etc.); Management of seasonal cultivation in the MSA through a permitting system; Community-based natural resource management (“CBNRM”) with settlements and current land users on the MSA to assist in the conservation of woodlands. The programme is conducted in cooperation with the Government’s Forestry Research Division and includes awareness raising, networking and patrols. Management of use of MSA water bodies including monitoring of use and signage warning people about hazards of fishing in potentially contaminated areas (e.g.: tailings dams). Maintenance and demarcation of access roads in the MSA. Sustainable land use management. This includes networking with DACO and FRD regarding training and awareness programmes to develop. A monitoring plan is set out which includes tracking of a large number of performance indicators.
	IFC PS 7: Protection of Indigenous Peoples	N/A	Indigenous peoples are not affected by the mining activities.
	IFC PS 8: Cultural Heritage – protection of cultural heritage in project design and execution	Compliant	No heritage resources impacted.
	IFC PS 8: Cultural Heritage – project’s use of cultural heritage	Compliant	The mine does not use cultural heritage resources.

Principle 4: Action Plan and Management System	Environmental and Social Action Plan	Compliant	The SMP for the mine includes a series of Action Plans that set out the specifics of required social management activities, together with roles and responsibilities, time frames and monitoring and evaluation schedules. The Action Plans are as follows: Employment (Medical Discharge, Retirement and Retrenchment) Action Plan; Local Business Development Plan; Health and Welfare Plan; Physical Infrastructure Plan; Land Use and Settlement Plan; Community Management Support Plan; Disclosure and Consultation Plan.
Principle 5: Consultation and Disclosure	Ongoing consultation with affected communities in a structured and appropriate manner.	Compliant	The Mufulira SMP includes a Disclosure and Consultation Action Plan. The objective of the plan is to develop good relationships between Nkana mine and the public, to ensure transparency between the mine and stakeholders.
Principle 6: Grievance Mechanism	Formal grievance mechanism required as part of the management system.	Compliant	A formal grievance procedure is in place.
Principle 7: Independent Review	Independent social or environmental expert not directly associated with the borrower to review the assessment, consultation process and Equator Principle compliance.	Compliant	Independent reviews/audits are undertaken. Recent audits include: JA Consultants (2008); MCM (2009); Scott Wilson (2010)
Principle 8: Covenants	The following covenants to be included in financing documentation: The borrower will: Comply with all host country social and environmental laws, regulations and permits; Comply with the action plan during construction and operation in all material respects; Provide reports (not less than annually) to document compliance	Potentially Compliant	If the Environmental Management Plan and Social Management Plan are fully implemented, the project appears to be capable of meeting Equator Principle requirements. Environmental authorization is in place, with a permit issued by the Environmental Council of Zambia in April 2004. All other environmental and social permits appear to be in place and are meticulously documented in Table 3-3 of the Mufulira updated EMP (Scott Wilson, 2009). The EMP also sets out all of the environmental requirements that are conditions of approval of the Environmental Council of Zambia, together with the management action necessary to meet each condition and whether it was once off or ongoing.

	with laws, regulations and permits; and Decommission the facilities in accordance with an agreed decommissioning plan		Updating of the EMP is required annually and the updating process for 2010 was in progress.
Principle 9: Independent Monitoring and Reporting	An idependent, experienced external expert to verify monitoring information on a regular basis.	Partially compliant	Independent audits cover general compliance but are not fully comprehensive. This should be resolved through the implementation of an EMS. Third party audits of EMP carried out by approved independent auditors (AMC in 2009 & Scott Wilson in 2010).

8.2.5.3 Mufulira key social aspects and risks

Two main documents drive social impact management at Mufulira mine:

- The Updated Global Environmental Management Plan, prepared by Scott Wilson (2009), which includes all relevant commitments from previous EMPs;
- The Life of Mine Social Management Plan (2007), prepared by the Copperbelt University, Department of Town and Regional Planning.

With reference to compliance with the social elements of the plans described in Table 1 above, the following comments are made, based on the brief discussions held with Mufulira staff and the recent audit by Scott Wilson (2009):

- **Social Assessment (Equator Principle 2):** The Social Management Plan is not audited and while some of the components of the plan are included in the updated EMP, there are specific monitoring requirements that are not. The SMP needs to be included in future audits or fully incorporated in the EMP in the next annual update.
- **Social / Environmental permits (Equator Principle 2):** Mufulira appears to be fully compliant with respect to permitting, with a comprehensive and updated list of permits available for review (sixty seven permits listed in the recent Scott Wilson, 2010 audit).
- **Community Health Safety and Security (Equator Principle 3, IFC PS 4):** Mufulira operates one hospital and three clinics in the former mine townships, as well as four plant site clinics at a cost of around USD 8 million per annum. Clinic services are available to all members of staff and their families and to children under five at no charge and to other members of the surrounding communities for a fee.

  The company supports an on-going malaria control programme that extends beyond the protection of its own employees into surrounding communities. It involves Integrated Vector Management ("IVM"), which is a comprehensive malaria programme that targets mosquitoes at every stage of their life cycle. The company coordinates its malaria programme with Government and NGO initiatives. It is company policy that all malaria complaints are verified with blood tests, and malaria monitoring and reporting is conducted. The company's malarial control commitments cost an average of around USD 1 million per year. Malarial incidence among patients to the company's medical facilities has dropped from 90 cases/1000 in 2001 to around 30 cases/ 1000 treated in 2010 (Zambian National average is 250 cases/ 1000 treated). The data were obtained from Mopani clinics that treat patients from within a catchment of 60 000 people (Kitwe).

  The company also implements a comprehensive HIV AIDS Management Programme. This involves a full range of initiatives from prevention through treatment, care and support. An HIV AIDS policy has been submitted to Government. An extensive training program has been implemented which trains trainers, peer educators, palliative care providers and psychosocial councilors in the workplace and the community. Work includes partnering with NGOs such as the Catholic Relief Services who have experience in this field.

  Regarding community safety, there has been no loss of life in surrounding communities as a direct result of mining and mining related activities. One significant incident has arisen since privatization in which a pump failure caused an acid leak that contaminated the company's supply of water to the community. This resulted in hospitalization and treatment of a number of people. No-one was seriously injured although the incident necessitated a considerable amount of work to rebuilt community trust.

  A company procedure is in place to manage emergencies, supported by professional risk assessments.
- **Resettlement (Equator Principle 3, IFC PS 5):** No resettlement has been necessary since the start of the Mufulira operations. Any resettlement that is to be done in the future will be planned and implemented with the assistance of experts according to international standards. Regarding the management of existing settlement, a significant number of compliance requirements are set out in the

SMP, together with specific performance standards for monitoring. These are not referred to in detail in either the SRK (2007) audit or the recent Scott Wilson (2010) audit and no information has been provided to the reviewers to demonstrate whether they are being systematically implemented.

- **Corporate Social Responsibility (Equator Principles 3 & 4):** An appropriate organizational structure and staffing for social impact management on the mine has been set up under the Manager Corporate Affairs. The company is involved in a number of programmes to encourage and facilitate local business development. These include a range of projects including infrastructure (e.g. water supplies) and agricultural projects motivated under the Employment, Retirement and Retrenchment Action Plan in the SMP. These projects include a variety of initiatives, including training of retirees to farm effectively, financial training and assistance in the financing of stock and infrastructure. A good example is Makumbi Farm.

- **Consultation and Disclosure** (**Equator Principle 5**): A comprehensive, ongoing process is implemented by the company. Community liaison officers have been appointed for each township and are responsible for liaison with villagers and for providing feedback, requests and grievances from the community to the Corporate Affairs Manager. Feedback forms are at various convenient locations for stakeholders to provide the company with comment. These are collected regularly and entered into a central database.

- **Community Grievances (Equator Principle 6):** The EMP and SMP are being implemented in the context of the social issues arising from the privatization of the mine, resulting in many services previously provided by ZCCM no longer being available or not being available without charge to members of local communities not employed by the mine. The Manager Corporate Affairs is aware that there are legacy issues associated with the privatization of certain government services, such as health, housing and education. The community may expect that in future the mine will supply these services. The community expectations need to be appropriately managed.

- **Overall compliance (social):** Compliance with the EMP has been audited several times in the past 5 years. Most recently, the Scott Wilson (2010) audit included a review of the findings of the previous audits and is consequently the most current independent view of compliance with the EMP. It may be seen that Mopani's performance is rated highly, with the company achieving a 100% compliance rating for all of the listed social items. It is, however, not clear from the existing documentation whether the company is fully compliant with all of the commitments made to manage social impacts included in the SMP. This needs to be rectified in the required annual update of the EMP.

  The above evidence provides the assurance that Mopani is complying with its commitment to manage social issues and promote sustainable development within the limits that could reasonably be expected of a private company. The management of community expectations driven by the legacy issues referred to above is a critical factor affecting the long term relationship between the mine and the community. In the Corporate Affairs Manager's view, the mine, through its social investment programme, will gradually improve its relationship with local communities. This appears to be a realistic appraisal, although no evidence was presented to the reviewers that could verify the extent to which disillusionment with the privatization of the mine is ubiquitous and how deep these sentiments run. Nevertheless, various complaints have been logged using the company's community feedback system, such as minutes of community meetings. There have been no cases of concerted civil action relating to this issue, which suggests that dissatisfaction is not at a level at which mine stoppages or similar outbreaks of anger or disillusionment with a perceived lack of benefits flowing from the mine are likely.

8.2.6 Health and Safety

The organisational structure for Mopani provides that the CEO bears the overall responsibility for the management of SHE matters.

Operating responsibility lies with the respective chief officers and their respective line managers, superintendents and heads of departments as the case may be. In this the principal guiding policy is the SHE (Pol 002).

The operationalisation of the policy is coordinated by the SHE Department headed by the SHE Manager.

The primary functions for the SHE Department can be summarised to include the following;

- Provide expert advice and guidance. To various departments as regards acceptable/ appropriate safety, occupational hygiene and environmentally sound practices
- Ensure compliance with the relevant SHE legislation and in their absence use international best practices as the standard.
- Ensure that new projects are developed in accordance with legislative provisions or in their absence international best practices.
- Provide in-house training in requisite SHE guidelines in respect of Mopani operations to new employees prior to their deployment to their work departments.
- Drive the continuous improvement programme on SHE matters such as those in respect to the requirements of ISO14001 and OHSAS18001 standards.
- The health and safety statistics set out below for Mufulira suggest a significant reduction in the number of Lost Time Injuries (LTIs) between 2008 (151) and 2010 (82); and fatalities between 2008 (5) to 2010 (3).

Table 35: Mufulira Injury Trends: 2008 - 2010

	2008	2009	2010
LTI	151	73	82
NLTI	152	74	96
Fatalities	5	1	3

8.2.7 Industrial Relations

The company maintained sound industrial relations since 2008 to date as the only recorded unconstitutional industrial action took place in 2003 and 2007 respectively at Nkana Mine Site over pay related issues during the bargaining process. There are two recognised Labour Unions operating under Mopani namely: Mine Workers Union of Zambia ("MUZ") and the National Union of Mine and Allied Workers ("NUMAW"). The last recorded incident of non-procedural industrial action occurred in 2007 over salary issues during the bargaining process.

8.2.8 Concluding Statements

After reviewing of existing site documentation, conducting brief interview of site personnel and visiting areas of the site of known potential environmental impact, the following conclusions were reached from the audit of environmental and social management at Mufulira Mine:

- The environmental performance of Mufulira Mine is largely compliant with its EMP and licence conditions;
- Environmental impacts which generally exceed licence conditions and pose a risk to Mufulira Mine operations in terms of compliance to statutory requirements and the Equator Principles include:
  - The quality of several effluent streams within the mine boundary at times exceeds mine permit conditions, although final mine discharge (at the mine boundary) is compliant;
  - Stream quality impacts resulting from the tailings facility due to below critical limit (pH 8.5) neutralisation of raffinate bleed of to tailings ; and

- Smelter SO_2 and (to a lesser extent) particulate emissions.

- Mopani is complying with its commitment to manage social issues and promote sustainable development within the limits that could reasonably be expected of a private company.

- The management of community expectations driven by legacy (historical liabilities) issues is a critical factor affecting the long term relationship between the mine and the community.

8.2.9 References

- Mopani Copper Mine (2005a). Procedure for the Management of Hazardous Substances at Mopani Copper Mine (Nkana and Mufulira): MCM Procedure PRO012 Rev 1, dated 18th January 2005.

- Mopani Copper Mine (2005b). Procedure for the Management of Wastes at Mopani Copper Mine (Nkana and Mufulira): MCM Procedure PRO016 Rev 1, dated 18th April 2005.

- Scott Wilson Ltd (June 2009). Mufulira Mine Site Updated Global Environmental Management Plan.

- SRK (July 2003). Mufulira Mine Environmental Impact Statement.

- TD11 Slope Stability Analysis Report by Scott Wilson Piesold Zambia Limited

- Emergency Preparedness and Response Plan 2006, by Scott Wilson Piesold Zambia Limited.

- TD11 Operating and Maintenance Manual 2008 by Scott Wilson Piesold Zambia Limited

- Third Party Audit Reports for the period 2007, 2008, 2009 and 2010.

- Procedure for the Management of Hazardous Substances at Mopani Copper Mine (Nkana and Mufulira): MCM Procedure PRO012 Rev 1, dated 18th January 2005.

- Procedure for the Management of Wastes at Mopani Copper Mine (Nkana and Mufulira): MCM Procedure PRO016 Rev 1, dated 18th April 2005.

- Mufulira Mine Environmental Impact Statement compiled by SRK (July 2003) and including:
  - Volume 1: Assessment of Impacts; and
  - Volume 2: Environmental Management Plan.

Baseline studies (2001) by SRK which was also used in determining which mine assets were transferred to Mopani and which remained with the previous owners as historical liabilities.

9.0 MARKET OVERVIEW

9.1 Copper

Copper is a major industrial metal (ranking third after iron and aluminium by consumption) because it is highly conductive (electrically and thermally), highly ductile and malleable, and resistant to corrosion. Electrical applications of copper include power transmission and generation; building wiring; motors; transformers; telecommunications; electronics and electronic products; and renewable energy production systems. Copper and brass (an alloy of copper) are the primary metal used in plumbing pipes, taps, valves and fittings. Further applications of copper include decorative features; roofing; marine applications; heat exchangers; and in alloys used for gears, bearings and turbine blades.

Global copper mine production was 15.7Mt in 2009, with 5.4Mt (or 35%) produced in Chile, by far the largest producer. Zambia and the DRC produced 0.6Mt (3.8%) and 0.3Mt (1.9%) respectively. Global refinery production in 2009 was 18.4Mt, including 2.9Mt of secondary refined production. Global consumption was slightly lower at 18.2 Mt. The International Copper Study Group (1 October 2010) estimates global mine production for 2011 at 17Mt, with global consumption at 19.7Mt. Table 36 shows the historical and 2011 forecast global refined copper market balance.

Table 36: Global refined copper market balance (Source: USGS):

Thousand Tonnes	2006	2007	2008	2009	*2010 Jan-Sept*	2010 forecast	2011 forecast
Global Mine Production	14,991	15,474	15,528	15,754	11,853	16,235	17,076
Primary Refined Production	14,678	15,191	15,399	15,466	11,729	-	-
Secondary Refined Production	2,613	2,743	2,823	2,911	2,513	-	-
World Refined Production	17,291	17,934	18,222	18,377	14,242	19,278	20,498
Consumption	17,058	18,239	18,056	18,198	14,678	18,882	19,729
LME Copper Price (avg)	6,727	7,126	6,952	5,164	7,175	7,543	-

The copper price has demonstrated significant volatility in the last 5 years, as shown in Figure 73. The price was USD4,585/tonne on 1 January 2006, at that point a near-record high. The price rapidly increased, reaching a high of USD8,800 /tonne in May 2006. By February 2007 it had declined to USD5,302 /tonne, the price of copper increased along with commodities generally, reaching a new high of USD8,900 /tonne by July 2008. Thereafter, as the financial crisis took effect on the global economy, the price declined to USD2,810 /tonne in December 2008, the lowest level in almost 5 years. Since then, the price has generally trended upward, reaching a new record high of USD9,695 /tonne on 12 January 2011.

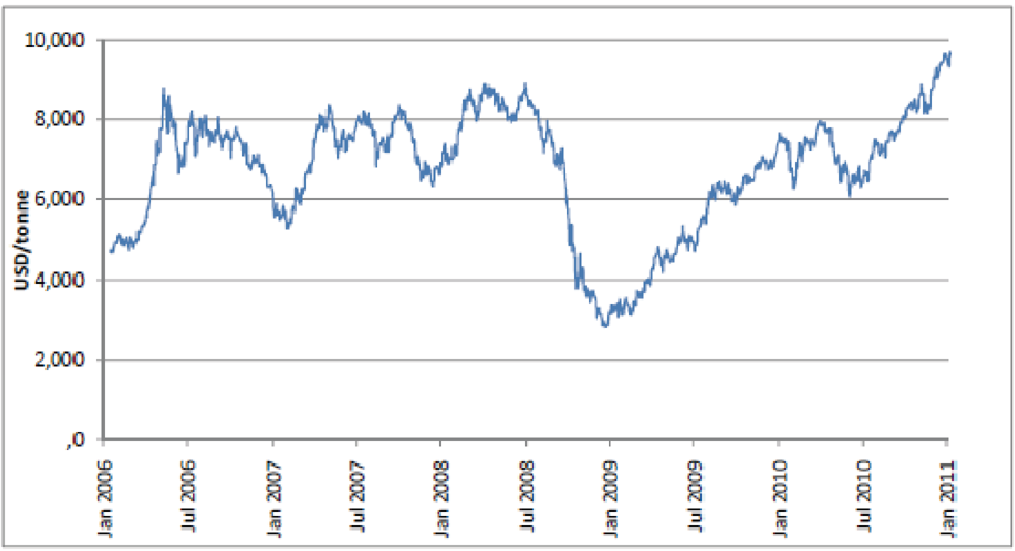


Figure 73: The London Metal Exchange copper price from January 2006 to date (Source: LME)

The copper price forecast used in the economic evaluation of the project is shown in Table 37. The forecast is based on published London Metal Exchange ("LME") monthly futures prices, using the June contracts as the basis for each respective year through to 2019. These publicly available prices are quoted in nominal terms. The financial model used for the economic evaluation is in real terms (2011 USD), and the real copper price forecast is derived from the nominal prices using the US CPI estimates in Table 37. The forecast nominal average price for 2011 is USD9 600 /tonne, declining to USD6 800 /tonne in 2019.

Table 37: Copper price forecast

Copper price (USD/Tonnes)	2011	2012	2013	2014	2015	2016	2017	2018	2019	Long Term
Nominal	9,600	9,300	9,000	8,600	8,200	7,800	7,500	7,100	6,800	6,861
Real	9,600	9,208	8,822	8,347	7,880	7,240	6,859	6,397	6,036	6,000
US CPI	1.0%	1.0%	1.0%	1.0%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%

9.2 Cobalt

Cobalt has many commercial, industrial and military applications. The leading use of cobalt is in rechargeable battery electrodes. The temperature stability and heat and corrosion-resistance of cobalt-based superalloys make them suitable for use in turbine blades for jet turbines and gas turbine engines. Other uses of cobalt include vehicle airbags; catalysts for the petroleum and chemical industries; cemented carbides and diamond cutting and abrasion tools; drying agents for paints, varnishes, and inks; dyes and pigments; ground coats for porcelain enamels; high-speed steels; magnetic recording media; magnets; and steel-belted radial tyres.

Far less cobalt is produced than copper: global mine production of cobalt was 62 000 tonnes in 2009, with 25 000 tonnes (or 40%) produced in the DRC, the largest producer. Australia, China and Russia each produced about 6 200 tonnes (10%). Global refinery production in 2008 was 57 600 tonnes, with global consumption slightly higher at 60 654 tonnes. Table 38 shows the historical global refined cobalt market balance. Roskill Information Services, a mineral industry information research group, has forecast cobalt demand of 72 500 tonnes in 2011 (October 2010).

Table 38: Global refined cobalt market balance

Metric tonnes	2004	2005	2006	2007	2008	2009
Global Mine Production	60,300	66,200	69,800	72,600	75,900	62,000
World Refined Production	48,500	54,100	53,800	53,300	57,600	No data
Consumption	51,400	54,685	54,685	56,250	60,654	59,000
Cobalt Price (avg)	2,277	1,456	1,535	2,831	3,616	1,589

The cobalt price reached a record of USD48.63 /pound in March 2008, falling in line with other commodities to a 5-year low of USD11.00/pound in December 2008. The price has recovered, and since cobalt started trading on the LME in May 2010, the price has averaged USD17.55 /pound, with a maximum of USD19.64 /pound and a minimum of USD15.94 /pound. See Figure 74

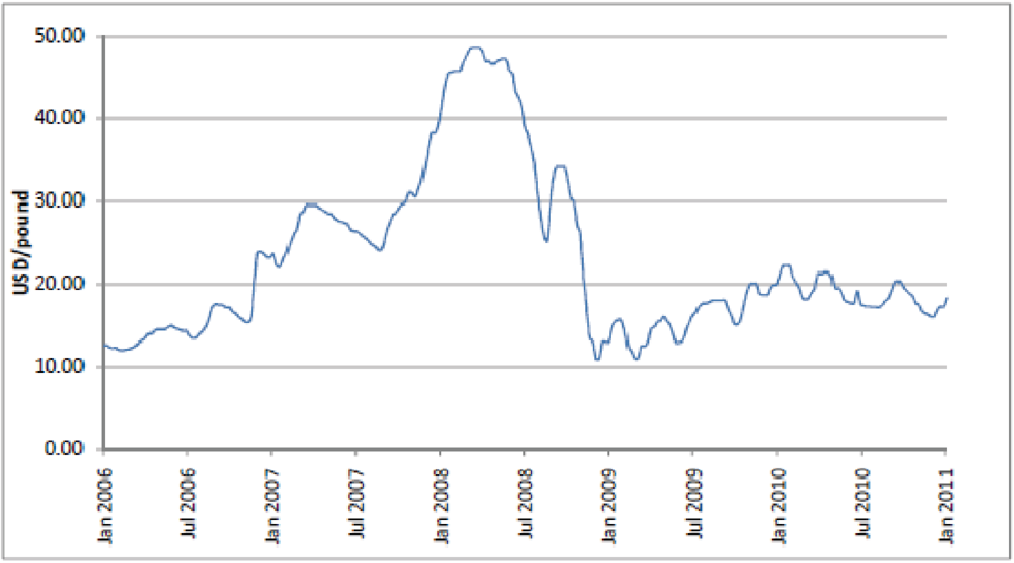


Figure 74: The cobalt price from January 2006 to date (Source: Inet Bridge)

The cobalt price forecast used in the economic evaluation of the project is shown in Table 39. The forecast is based on the Metal Bulletin 99.8%Co USD/pound price (in nominal terms) available for the next spot delivery. The forward curve is assumed to gradually decline for the next three years, before falling to its long term value. The financial model used for the economic evaluation is in real terms (2011 USD), and the real cobalt price forecast is derived from the nominal prices using the US CPI estimates in Table 39. The forecast average price for 2011 is USD17.24 /pound, declining to USD13.00 /pound in 2019.

Table 39: Cobalt price forecast

Cobalt price (USD/pound)	2011	2012	2013	2014	2015	2016	2017	2018	2019	Long Term
Nominal	17.24	16.78	16.00	15.00	15.00	15.00	13.00	13.00	13.00	13.00
Real	17.24	16.62	15.68	14.56	14.41	13.92	11.89	11.71	11.54	11.00
US CPI	1.0%	1.0%	1.0%	1.0%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%

10.0 TECHNICAL AND ECONOMIC ASSUMPTIONS

10.1 Revenue assumptions

MCM has entered into off-take agreements with Glencore, pursuant to which Glencore will buy 100% of the quantities of Cu and Co produced by MCM over the life of the mine. The off-take agreements are negotiated at arm's length at standard market terms.

10.2 Capital Cost Estimate

A summary of the capital cost estimate by major cost items is presented in Table 40 below. The capital expenditure items are as follows:

- **Primary Development:** Capital expenditure in order to gain access to the ore bodies. As a result of the economic crisis in 2008/09, during which copper prices decreased significantly, MCM reduced the level of primary development. Subsequently, when prices recovered, MCM required significant primary development in the mines; a primary focus in 2010 and 2011 in order to achieve sustainable levels. Primary development includes preparation of haulages to access the ore body, raise boring for ventilation of ore passes, and rehabilitation of older haulages;

- **Mining:** Capital expenditure related to sustaining the current operations and expenditure on vehicles;
- **Processing:** Capital covers mostly sustaining expenditure on current processing plants;
- **Engineering:** Firstly, the supply of infrastructure and general mine wide services not directly linked to the mines or processing plants, such as water, air and electrical reticulation and general workshops. Secondly, the supply of engineering services to the mines and process plants;
- **Services:** Capital expenditure for environmental, medical and corporate social investment projects;
- **Corporate:** Capital expenditure on IT and security projects;
- **Special Projects:** Capital expenditure for numerous projects across mining, plant and services, including:
  - Major overhauls such as the rebuilding of the tank house at the refinery, the rebricking of ISA every 2 years and rebricking of the MSEF every 4 years.
  - New operating assets, such as ISA Smelt, MSEF, Acid Plant, Anode Furnaces and Casting Wheels, Converters, Smelter water pipeline to the Kafue.
  - Expansion Projects such as Synclinorium Shaft and related infrastructure, Area J open pit stripping, leach mine and process plants.

Table 40: Capital Expenditure

USD Millions	2010 Actual	2011	2012	2013	2014	2015	2016 - 2035	Total 2011 – 2035
Primary Development (“PD”)								
Mufulira	0.5	6.2	2.9	3.4	1.1	1.4	6.0	21.0
Nkana	8.8	13.3	11.4	11.0	5.1	19.2	81.7	141.7
PD Subtotal	**9.3**	**19.5**	**14.3**	**14.4**	**6.2**	**20.6**	**87.7**	**162.7**
Mining								
Mufulira	8.4	8.2	14.5	7.2	6.1	6.6	30.1	72.7
Nkana	24.6	12.7	18.4	18.2	10.9	10.1	228.1	298.4
Technical	1.0	4.9	2.9	1.2	1.1	1.0	5.4	16.5
Mining subtotal	**34.0**	**25.8**	**35.8**	**26.6**	**18.1**	**17.7**	**263.6**	**387.6**
Processing								
Mufulira	0.2	1.2	0.8	0.8	0.8	0.5	4.8	8.9
Mkana	1.5	3.6	2.4	1.1	1.2	0.8	26.2	35.3
Smelter	21.9	4.1	1.7	1.3	0.5	0.3	20.9	28.8
Refinery	7.1	5.7	1.4	0.7	0.4	0.6	23.1	31.9
Cobalt Plant	2.5	4.3	2.8	2.4	1.8	2.0	47.1	60.4
Other	2.6	0.6	0.4	0.6	0.3	0.2	3.9	6.0
Processing subtotal	**35.8**	**19.5**	**9.5**	**6.9**	**5.0**	**4.4**	**126.0**	**171.3**
Other Cost Centres								
Engineering	9.7	19.6	13.7	10.1	6.9	7.6	112.5	170.4
Services	0.6	0.6	1.4	0.7	0.5	0.4	7.3	10.9
Corporate	1.7	1.1	0.6	0.5	0.5	0.5	6.8	10.0
Other subtotal	**12.0**	**21.3**	**15.7**	**11.3**	**7.9**	**8.5**	**126.6**	**191.3**
Special Projects								
Synclinorium	8.2	45.7	70.3	61.2	87.5	22.0	49.5	336.2
Smelter	1.8	28.4	31.0	28.1	30.0	0.0	65.5	183.0
Other	28.5	22.4	1.4	2.6	2.5	1.4	14.4	44.7
Special Projects subtotal	**38.5**	**96.5**	**102.7**	**91.9**	**120.0**	**23.4**	**129.4**	**563.9**
Total capital expenditure	**129.6**	**182.5**	**178.0**	**151.1**	**157.2**	**74.6**	**733.3**	**1,476.8**

10.3 Operating Cost Estimate

In general, the operating costs of MCM are split 70% fixed and 30% variable. Mining costs decrease from 2012 due to a decrease in secondary development, which is expected to stabilise from that point onwards. Similarly, processing costs decrease from 2012, due to a decrease in the processing of certain ore sources as per the mine plan, and due to an improvement in efficiencies as a result of plant upgrades. The operating costs are as follows:

- **Open Pit and Underground Mining:** these costs include:
  - **Mufulira Mine:** the costs are based on current and budgeted costs. The weighted average cost applied over the LOM is USD 67.55/t ore mined;
  - **Nkana Mine:** the costs are based on current and budgeted costs as an owner operation. The weighted average cost applied over the LOM is USD 28.71/t ore mined;
- **Processing**
  - **Mufulira concentrator:** The weighted average cost applied over the LOM, including fixed costs, is USD 13.12/t ore treated;
  - **Nkana concentrator:** The weighted average cost applied over the LOM, including fixed costs, is USD 6.95/t ore treated;
  - **Smelter:** The weighted average cost applied over the LOM, including fixed costs, is USD 87.33/t concentrate treated;
  - **Refinery:** The weighted average cost applied over the LOM, including fixed costs, is USD 76.62/t final copper;
  - **Cobalt Plant:** The weighted average cost applied over the LOM, including fixed costs, is USD 11,015/t final cobalt;

The major operating items are detailed on an annual basis in Table 41 below.

Table 41: Operational Expenditure

USD Million	2010 Actual	2011	2012	2013	2014	2015	2016 - 2035	Total (2011 – 2035)
Operating Costs								
Mining	259	267	215	214	213	212	2,899	4,020
Processing	172	190	174	175	175	171	2,987	3,871
Engineering	16	17	17	17	17	16	307	390
Corporate	31	34	33	33	33	32	642	807
Admin	19	7	6	6	6	6	103	135
Other	17	32	32	32	32	32	528	688
Total Operating Costs	514	547	477	478	476	469	7,465	9,912

11.0 TAXATION AND ROYALTIES

The major parameters which govern royalties, applicable to the project are shown in Table 42.

Table 42: Royalty and tax assumptions

Description	Application	Rate
Copper and Cobalt Royalties	Revenue	3.0%
Zambia Corporate Tax	Earnings	30%

12.0 ECONOMIC ANALYSIS

12.1 Introduction

This section presents a valuation of MCM. Glencore owns 73.1% of MCM. The valuation presented here is a valuation of Glencore's Interest in MCM, being the sum of the 73.1% Equity Value in MCM and Shareholder Loans provided to MCM.

12.2 Valuation Methodology

MCM is an operational mining company with several active mines and processing plants. Its resources and reserves are well-defined, and a comprehensive body of technical and financial information on its current and planned operations is available. An analysis of this information allows the future cash flows of MCM throughout the life of the mine to be projected. This is compatible with the discounted cash flow ("DCF") methodology, which determines the value of an asset by calculating the net present value of the future cash flows generated over the useful life of that asset.

The DCF valuation approach provides a "going concern" valuation, which is the value indicated by a company's future economic capabilities. Using this technique, value is calculated by the summation of the present value of projected cash flows, both income and expenditure, for a determined period. When using the DCF technique, the following four key areas must be assessed for accuracy and appropriateness:

- The assumptions underlying the projection of cash flow;
- The length of the projection period, in this case the life of mine; and
- The discount rate, in this case the risk adjusted weighted average cost of capital ("WACC") of the project.

The input assumptions of the model were checked against historical performance, contracts and the results of the studies by the Competent Persons who produced this report to ensure that the assumptions are reasonable. Additional analysis was done on the model results output to produce some of the results, graphs and tables presented in this report.

12.3 Valuation Assumptions

The following assumptions were used in the valuation model:

- The valuation date is 1 January 2011;
- The discount rate is set at 10% in real terms, which is the discount rate used by Glencore across its portfolio;
- The financial model produces a 20 year cash flow (2011 to 2030), while LOM projections are made to 2035;
- Mining and processing production rates, head grades and recoveries are as described in Section 4.1.4 and 4.2.4.
- Commodity prices are as described in section 9.1 and 9.2;
- Capital expenditure is as described in section 10.2;
- Operating expenditure is as described in section 0;
- Royalties and tax are as described in section 0;
- Glencore's equity share in MCM is 73.1%; and

- Glencore's attributable economic interest in MCM consists of the equity value in MCM and shareholder loans provided to MCM.

12.4 The Valuation of Glencore's Interest in MCM

The results of the DCF model are shown in Table 43, presenting the free cash flow attributable to MCM. The cash flow projections are based on expected future mining, production, metal sales, capital expenditure, operating costs and other expenses over the life.

Table 43: Cash flows over the LOM

	Unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Revenue	MUSD	1,449	1,195	1,145	1,133	1,089	995	968	942	928	921
Realisation costs	MUSD	(35)	(27)	(26)	(28)	(27)	(27)	(27)	(30)	(30)	(31)
Purchased Cu	MUSD	(207)	(62)	(59)	(55)	(51)	(46)	(43)	(40)	(37)	(36)
Net Revenue	***MUSD***	***1,207***	***1,106***	***1,061***	***1,050***	***1,011***	***922***	***897***	***873***	***861***	***854***
Operating Costs	MUSD	(547)	(477)	(478)	(476)	(469)	(467)	(469)	(443)	(446)	(444)
EBITDA	***MUSD***	***660***	***629***	***583***	***574***	***542***	***454***	***428***	***430***	***415***	***410***
Taxation	MUSD	(6)	(120)	(115)	(111)	(127)	(104)	(103)	(107)	(101)	(98)
Capital Expenditure	MUSD	(183)	(178)	(151)	(157)	(75)	(68)	(54)	(46)	(54)	(58)
Royalties	MUSD	(33)	(30)	(28)	(28)	(26)	(24)	(23)	(23)	(22)	(22)
Net Free Cash	**MUSD**	**439**	**301**	**289**	**277**	**315**	**258**	**250**	**254**	**239**	**232**
	Unit	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Revenue	MUSD	923	813	797	787	805	795	711	684	698	684
Realisation costs	MUSD	(39)	(33)	(32)	(32)	(32)	(32)	(27)	(26)	(26)	(26)
Purchased Cu	MUSD	(36)	(36)	(36)	(36)	(36)	(36)	(36)	(36)	(36)	(36)
Net Revenue	***MUSD***	***847***	***743***	***729***	***719***	***737***	***727***	***648***	***621***	***635***	***621***
Operating Costs	MUSD	(444)	(371)	(368)	(366)	(368)	(365)	(343)	(321)	(323)	(321)
EBITDA	***MUSD***	***403***	***372***	***361***	***353***	***368***	***361***	***305***	***300***	***313***	***300***
Taxation	MUSD	(102)	(95)	(91)	(86)	(95)	(92)	(79)	(75)	(82)	(77)
Capital Expenditure	MUSD	(39)	(35)	(36)	(46)	(32)	(33)	(24)	(32)	(21)	(26)
Royalties	MUSD	(22)	(19)	(18)	(18)	(18)	(18)	(15)	(15)	(15)	(15)
Net Free Cash	**MUSD**	**240**	**224**	**216**	**203**	**224**	**218**	**187**	**178**	**195**	**183**

12.4.1 Base Case Valuation

The base case valuation of the Glencore Interest in MCM, at the 1st January 2011, is USD 1 922 million. The valuation of the Glencore Interest is Glencore's Equity Value in MCM and the Value of Shareholder Loans provided to MCM. The upper limit of the valuation is USD 2 261 million (discount rate of 7.5%) and a lower limit of USD 1 671 million (discount rate of 12.5%).

Table 44 to Table 46 present the sensitivity of Glencore's Interest to changes in the discount rate applied and metal prices, capital expenditure and operating costs respectively.

Table 44: Sensitivity of Glencore's Interest in MCM to discount rate and changes in metal prices

Glencore Interest **(USD million)**		*Change in metal prices*				
		-20%	**-10%**	**0%**	**10%**	**20%**
Discount Rate	**7.5%**	1,306	1,784	2,261	2,737	3,212
	10.0%	1,114	1,519	1,922	2,324	2,725
	12.5%	972	1,322	1,671	2,017	2,363

Table 45: Sensitivity of Glencore's Interest in MCM to discount rate and changes in operating costs

Glencore Interest **(USD million)**		*Change in operating costs*				
		-20%	**-10%**	**0%**	**10%**	**20%**
Discount Rate	**7.5%**	2,752	2,507	2,261	2,015	1,769
	10.0%	2,331	2,127	1,922	1,717	1,512
	12.5%	2,018	1,844	1,671	1,496	1,321

Table 46: Sensitivity of Glencore's Interest in MCM to discount rate and changes in capital expenditure

Glencore Interest **(USD million)**		*Change in capital expenditure*				
		-20%	**-10%**	**0%**	**10%**	**20%**
Discount Rate	**7.5%**	2,354	2,308	2,261	2,215	2,168
	10.0%	2,005	1,964	1,922	1,881	1,840
	12.5%	1,745	1,708	1,671	1,634	1,596

The sensitivity of the base case valuation to all three factors is shown graphically in Figure 75.

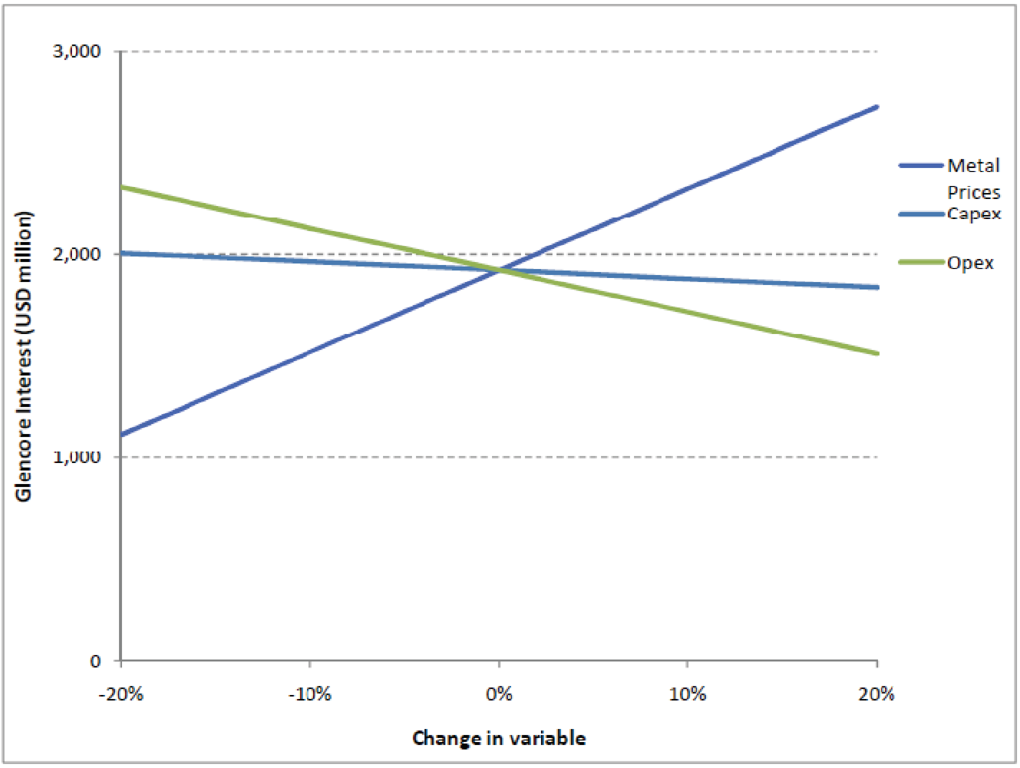


Figure 75: The sensitivity of Glencore's Interest in MCM to changes in metal prices, opex and capex

Glencore's Interest in MCM is most sensitive to metal prices – a 1% increase/decrease in metal prices causes a USD 40 million increase/decrease. A 1% increase/decrease in operating costs causes a USD 20 million increase/decrease. The project is least sensitive to changes in capital expenditure – a 1% increase/decrease causes a USD 4 million decrease/ increase.

13.0 RISK ANALYSIS

The Competent Persons involved in the technical analysis of the project were briefed to identify and document project risks during the course of their work. The project risks are summarised in this section.

13.1 Resource risk

Exploration:

Most of Mopani's measured and Indicated Resources have been converted to reserves. An active exploration programme is required to find further resources and convert Inferred Resources to Measured and Indicated. However, underground drilling is expensive.

13.2 Mining risks

Area J underground:

To bring production from Area J as far forward as possible, Area J underground is to be developed while the Area J open pit is being mined. There is a risk that additional technical work will be required to develop the pit to the underground portal access position earlier than normal. There is also a geotechnical risk presented by blasting in the open pit in proximity to the underground development. There may also be a safety risk of collisions between open pit haul trucks and underground LHDs if mining operations are not well managed. The risk should be well defined and managed, and different access roads provided for open pit haul trucks and underground LHDs.

New shafts:

New vertical shafts and infrastructure are required to access new sections at Mufulira and Nkana. The bulk of future production comes from these areas, and this production will be lost if the shafts are not sunk. Deeper areas cause an increase in the costs of mining, hoisting and ventilation.

Eventually, most of the mining at Mopani comes from the single Synclinorium Shaft, at a rate of 4 Mtpa, which is a very high rate for one shaft. Although the shaft's design capacity is sufficient, a disruption in the capacity of the shaft will disrupt the entire production of the mine.

13.3 Processing risks

Back-up power supply:

The Nkana plant does not have a significant emergency power generation capability and should the power fail for an extended period without prior notification production and orderly shutdown of the plant will be severely affected. However at Luano there are back-up generators for the central shaft winders. In 2011, another back-up generator for the concentrator mill will be commissioned at Mindola.

13.4 Capital risks

Escalation of Costs:

Projects in the mining industry world-wide have recently experienced unpredictable capital cost overruns due to various macroeconomic and microeconomic factors that cannot be predicted with any reliable degree of certainty. Capital cost overruns require more funding and reduce project returns. This risk is rated as high, but could be managed through regular review of capital cost estimates by the MCM project team.

13.5 Sovereign Risk

The Republic of Zambia could be subject to developments that individually or in combination could create instability, whether economic or political. Such developments are outside MCM's control and could, should they occur, adversely affect MCM's operations in this region.

13.6 Economic and Market Risk

Commodity prices:

Copper and cobalt market prices are significant drivers of the profitability and valuation of MCM. These prices are subject to wide fluctuations beyond the control of the company due to factors such as demand for the commodities caused by global economic conditions and prospects, supply from various sources, currency and interest rate changes, and speculative activities. Sustained commodity prices below the costs of production may cause the curtailment or suspension of operations. There is some scope to manage market risk through hedging, but this may lead to loss of upside during periods of high commodity prices.

Operating costs:

Project operating costs also affect the profitability of MCM and the value of the Mopani project. These are subject to a wide range of pressures such as energy prices, oil prices, chemical prices, labour costs and inflation.

13.7 Environmental and Social Risks

Post-closure water treatment:

After mine closure, ongoing management of contaminated excess mine water arising from the reclaimed mining workings may be required. This would involve the collection, handling, treatment and safe disposal of the treated mine water. This cannot be quantified now and has not been included in the closure cost, but may require significant expenditure.

Mining related spillages:

There is a risk that mining related spillages may have had a significant impact on the local stream and river systems. This may require the de-silting and re-instatement of contaminated stream beds and banks, and other measures to allow the natural aquatic ecosystems to return as far as possible. This cannot be quantified now and has not been included in the closure cost, but may require significant expenditure.

Effluent discharge:

Effluent discharge from the Nkana Cobalt Plant in to the North Uchi Stream which drains to the Kafue River exceeds licence conditions. This risk could be mitigated by managing the pH of the tailings thickener overflow and adequate storage of Cobalt Plant concentrates. Several effluent streams within the mine boundary at Mufulira sometimes exceed mine permit conditions, although final mine discharge (at the mine boundary) is compliant.

SO_2 emissions:

Flue gas from the Nkana Cobalt Plant is vented directly to the atmosphere, resulting in SO_2 emissions consistently exceeding the long term limit of 1 000 mg/Nm3. The deadline issued by ECZ to resolve this problem has passed. At Mufulira, smelter SO2 and particulate emissions exceed licence conditions, but the introduction of new converters and second acid plant should achieve significant further reduction in emission levels and bring the mine into compliance with long term emission limits.

Tailings:

At Nkana, tailings from the tailings pipeline, booster pump station and/or tailings bleed points spill into the adjacent two streams. At Mufulira, insufficient neutralisation of raffinate bleed to tailings results in stream quality impacts.

Dust:

The high percentage of fines reporting to the basin area of the Mufulira TD11 TSF results in high dust levels. A sprinkler system could be introduced to mitigate this risk and encourage the introduction of vegetation.

GOLDER ASSOCIATES AFRICA (PTY) LTD.

Frank Wimberley
Project Director

Willem van der Schyff
Competent Person

SE/PO/kf

APPENDIX A

Glossary and Abbreviations

LIST OF ABBREVIATIONS

Abbreviations

3D	Three Dimensional
AAS	Atomic Absorption Spectroscopy
AGES	Africa Geo-Environmental Services
ASCu	Acid Soluble Copper
DIMA	The Dikuluwe-Mashamba
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EW	Electro-winning
FOB	Free On Board
GEC	Global Enterprises Corporate Ltd.
GECL	Global Enterprises Corporate Limited
HG	High Grade
HSSE	Health Safety Social and Environment
HV	High voltage
IRR	Internal Rate of Return
LG	Low Grade
LME	London Metal Exchange
LOM	Life of Mine
NPV	Net Present Value
QA/QC	Quality Assurance and Quality Control
QC	Quality control
SAG	Semi-Autogenous Grinding
SAMREC	South African Minerals and Resources Committee
SG	Specific Gravity
SI	International System of Units
SRK	SRK Consulting (South Africa) (Proprietary) Limited
SX/EW	Solvent Extraction/Electro-winning
TAP	Trans-Africa Projects
UG	Underground
USD	United States Dollar

Units

%	percentage
%ASCu	percentage acid soluble copper
%CaO	percentage calcium oxide
%Cu	percentage copper
%CuO	percentage copper as oxide
%TCo	percentage total cobalt
%TCu	percentage total copper

°	Degrees
±	plus or minus
bcm	bank cubic metre
bn	billion
c/lb	cents per pound
dBA	decibels
GPa	Giga Pascal
ha	hectare
ha/yr	hectares per year
kg	kilogram
kg/t	kilograms per tonne
km	kilometer
km/h	kilometers per hour
km^2	square kilometers
kPa	kilo Pascal
kt	kilo tonne
ktpa	kilo tonnes per annum
ktpm	kilo tonnes per month
kV	kilo Volt
kV AC	kilo Volt Alternating Current
kWh	kilowatt-hour
l	litre
l/hr	litres per hour
l/sec	litres per second
lb	pound
m	metre
m/d	metres per day
m/s	metres per second
m^2	square metre
m^2/day	square metres per day
m^3	cubic metres
m^3/d	cubic metres per day
m^3/ha/d	cubic metres per hectare per day
m^3/hr	cubic metres per hour
m^3/s	cubic metres per second
mamsl	metres above mean sea level
mbgl	metres below ground level
mg/l	milligrams per litre
mm	millimetre
mm/year	millimeters per year
Mm^3	Million cubic metres
MPa	Mega Pascal

Mt	Million tonnes
Mtpa	Million tonnes per annum
MVA	Mega Volt Ampere
MW	Mega Watt
MWh	Mega Watt hour
pH	Measure of the acidity or alkalinity of a solution
sec	second
sq. km	square kilometers
T	tonne (1000 kg)
t/m^3	tonnes per cubic metre
tpa	tonnes per annum
tpd	tonnes per day
tphr	tonnes per hour
tpvm	tonnes per vertical metre
USD/bcm	United States Dollars per bank cubic metre
USD/h	United States Dollars per hour
USD/t	United States Dollars per tonne
USD/t/km	United States Dollars per tonne per kilometer
USDm	United States Dollar million
vmpa	vertical metres per annum

Chemical Elements

$(Co,Cu)_2S_4$	carrolite
(Co,Cu,Mn,Fe)O(OH)	heterogenite
$(Cu,Co)_2(CO_3)(OH)_2$	kolwezite
(Fe,Co)O(OH)	goethite
$(Mg,Fe)_5Al(Si_3Al)O_{10}(OH)_8$	chlorite
As	arsenic
$Ca,Mg(CO_3)_2$	Dolomite
$CaCO_3$	limestone
CuO	copper oxide
CaO	lime
Co	cobalt
$Co(OH)_2$	cobalt hydroxide
Cr	chrome
Cu	copper
$Cu_2(OH)PO_4$	liberthenite
$Cu_2CO_3(OH)_2$	malachite
Cu_2O	cuprite
Cu_2S	chalcocite
$Cu_3(PO_4)(OH)_3$	cornetite
$Cu_5(PO_4)_2(OH)_4.H_2O$	pseudomalachite
Cu_5FeS_4	bornite

CuS	covellite
Fe	iron
H²S	hydrogen sulphide
H² SO4	sulphuric acid
K-Al-Mg-Fe silicate hydroxides	clay
$KMg_3Si_3AlO_{10}(F,OH)_2$	Mica
MgO	magnesium oxide
Mn	manganese
NaHS	sodium hydrogen sulphide
Ni	nickel
NO_2	nitrogen dioxide
Pb	lead
Se	selenium
SiO_2	silica/quartz
SO_2	sulphur dioxide

GLOSSARY OF TECHNICAL TERMS AND DEFINITIONS

Argillaceous	Term describing sedimentary rock with modal grain size in the silt fraction
Assay	The chemical analysis of mineral samples to determine the metal content
Assaying	The chemical analysis of mineral samples to determine the metal content
Basal Conglomerate	A conglomerate formed at the earliest portion of a stratigraphical unit
Bateman or Bateman Engineering	Bateman Project Limited
Capital expenditure	All other expenditure not classified as operating costs
Concentrate	A metal-rich product resulting from a mineral enrichment process such as gravity concentration or flotation, in which most of the desired mineral has been separated from the waste material in the ore
Crushing	Initial process of reducing ore particle size to render it more amenable for further processing
Dip	Angle of inclination of a geological feature/rock from the horizontal
Dolomite	The name of a sedimentary carbonate rock and a mineral, both composed of calcium magnesium carbonate
Drill hole	Method of sampling rock that has not been exposed
Effective Date	Effective date of the Technical Report
Fault	The surface of a fracture along which movement has occurred
Flotation	Process by which the surface chemistry of the desired mineral particles is chemically modified such that they preferentially attach themselves to bubbles and float to the pulp surface in specially designed machines. The gangue or waste minerals are chemically depressed and do not float, thus allowing the valuable minerals to be concentrated and separated from the undesired material
Grade	The measure of concentration of copper or cobalt within mineralized rock
Hanging wall	The overlying side of an ore body or slope
Haulage	A horizontal underground excavation which is used to transport mined ore or the transport of mined ore from an open pit to a treatment plant
Indicated Mineral Resource	The part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence. It is based on exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are too widely or inappropriately spaced to confirm geological and/or grade continuity but are spaced closely enough for continuity to be assumed
Inferred Mineral Resource	That part of a mineral resource for which tonnage, grade and mineral content can be estimated with a low level of confidence. It is inferred from geological evidence and assumed but not verified geological and/or grade continuity. It is based on information gathered through appropriate techniques from locations such as outcrops, trenches, pits,

	workings and drill holes which may be limited or of uncertain quality and reliability
Intrusives	A body of igneous rock which has forced itself onto pre-existing rocks, either along some definite structural feature or by defamation or cross-cutting of the invaded rocks
Lithology or Lithogical	Geological description pertaining to different rock types
LoM plans	Life of mine plans
Measured Mineral Resource	The part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence. It is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are spaced closely enough to confirm geological and grade continuity
Mica	Layer-lattice minerals of the three-layer type, and may be divided into the dioctahedral muscovite group and the trioctahedral phlogopite-biotite group
Milling	A general term used to describe the process in which the ore is crushed and ground and subjected to physical or chemical treatment to extract the valuable metals to a concentrate or finished product.
Mineral Reserve	The economically mineable material derived from a Measured Mineral Resource and/or Indicated Mineral Resource. It is inclusive of diluting materials and allows for losses that may occur when the material is mined. Appropriate assessments, which may include feasibility studies, have been carried out, including consideration of, and modification by, realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction is reasonably justified. Mineral reserves are sub-divided in order of increasing confidence into probable mineral reserves and proved mineral reserve
Mineral Resource	A concentration or occurrence of material of economic interest in or on the earth's crust in such form, quality and quantity that there are reasonable and realistic prospects for eventual economic extraction. The location, quantity, grade, continuity and other geological characteristics of a Mineral Resource are known, estimated from specific geological evidence and knowledge, or interpreted from a well constrained and portrayed geological model. Mineral Resources are sub-divided in order of increasing confidence, in respect of geoscientific evidence, into inferred, indicated and measured categories
Orogeny	An orogeny is a period of mountain building leading to the intensely deformed belts which constitute mountain ranges
Probable mineral reserve	The economically mineable material derived from a Measured Mineral Resource and/or Indicated Mineral Resource. It is estimated with a lower level of confidence than a Proved Mineral Reserve. It is inclusive of diluting materials and allows for losses that may occur when the

	material is mined. Appropriate assessments, which may include feasibility studies, have been carried out, and including consideration of, and modification by, realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction is reasonably justified.
Proved mineral reserve	The economically mineable material derived from a Measured Mineral Resource. It is estimated with a high level of confidence. It is inclusive of diluting materials and allows for losses that may occur when the material is mined. Appropriate assessments, which may include feasibility studies, have been carried out, including consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction is reasonably justified
Roches Argilleuses Talceuse (RAT)	The RAT is considered the boundary between the R2 and R1 units and consists of an upper RAT Grises (R2) and a lower RAT Lilas (R1)
Roches Silicieuses Cellulaires or Siliceous Rocks with Cavities (RSC)	Vuggy and infilled massive to stromatolitic silicified dolomites
Schist/s	A regionally metamorphased rock characterised by a parallel arrangement of the bulk of the constituent minerals
Sedimentary	Rocks formed by the accumulation of sediments, formed by the erosion of other rocks
Tailings	Finely ground waste rock from which valuable minerals or metals have been extracted
Volcanics	One of three groups into which rocks have been divided. The volcanic assemblage includes all extrusive rocks and associated intrusives.
Volcanoclastics	One of the three groups into which rocks have been divided. The volcanic assemblage includes all extrusive rocks and associated intrusives.

APPENDIX B

Plant and Processing Aerial Maps

Met Plants at Nkana Aerial Map

Figure 76: Nkana Aerial Maps (Photograph 1)

Cu Oxide Leach, SX Plant & In-Situ SX Aerial Map

Figure 77: Nkana Aerial Maps (Photograph 2)

Co, Cu Roaster, Leach SX &EW Plant Aerial Map

Figure 78: Nkana Aerial Maps (Photograph 3)

Copper,Cobalt Sulphide Concentrator Aerial Map

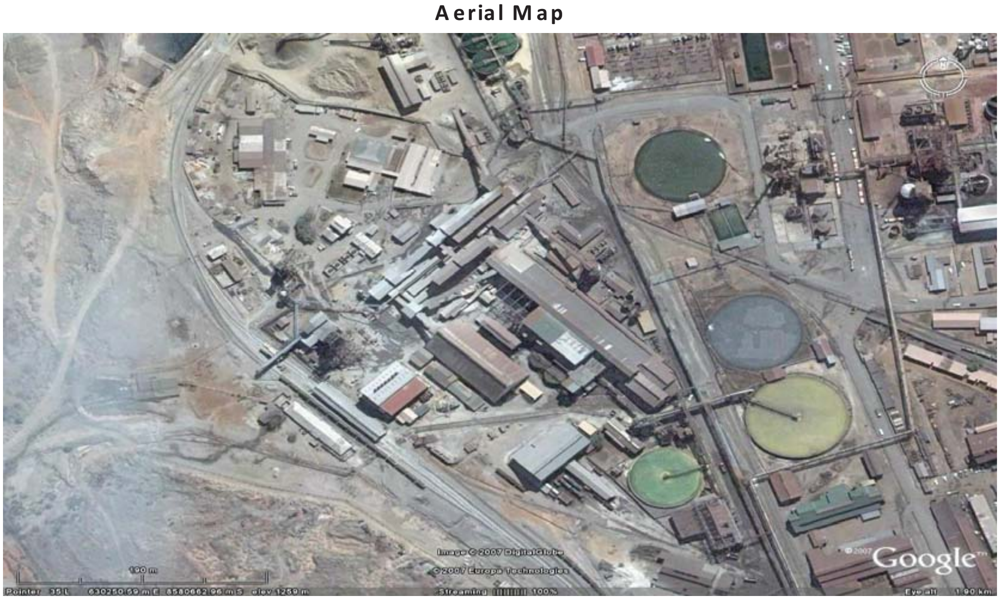


Figure 79: Nkana Aerial Maps (Photograph 4)

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