Appendix 14

Greenhouse Gas & Energy Assessment

GREENHOUSE GAS AND ENERGY ASSESSMENT

Northparkes Mines Step Change Project

July 2013

GREENHOUSE GAS AND ENERGY ASSESSMENT

Northparkes Mines Step Change Project

July 2013

Prepared by
Umwelt (Australia) Pty Limited

on behalf of
North Mining limited

Project Director:	**Barbara Crossley**
Project Manager:	**Tim Crosdale**
Report No.	**2949/R13/FINAL**
Date:	**July 2013**

Newcastle

PO Box 3024
75 York Street
Teralba NSW 2284

Ph. 02 4950 5322

www.umwelt.com.au

Executive Summary

Northparkes Mines (NPM) are seeking approval for the Step Change Project (the Project) which encompasses the continuation of underground block cave mining in two existing ore bodies, the development of underground block cave mining in the E22 resource, additional campaign open cut mining located in existing mining leases and an extended mine life of seven years until 2032.

The Project also provides the opportunity for the integration, update and consolidation of existing approvals for underground mining, open cut mining and infrastructure within the Project Area.

Approval for the Project is being sought under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This report has been prepared as part of the environmental assessment process required under the EP&A Act, and it includes greenhouse gas (GHG) emission projections, and an evaluation of the climate change impacts and mitigation options. The scope of the following greenhouse gas and energy assessment (GHGEA) includes:

- estimating the total GHG emissions and energy use associated with the Project;
- qualifying how the Project may contribute towards climate change;
- estimating the impact of the Project's emissions on national and international GHG emission targets; and
- assessing reasonable and feasible measures to minimise the GHG emissions and ensure energy use efficiency.

The GHGEA found that the Project's major operational component can be associated with the following GHG emission classes.

	Life of Mine Emissions	
Scope	**(t CO_2-e)**	**(%)**
Scope 1	174,000	4
Scope 2	3,210,000	74
Scope 3	940,000	22
TOTAL	**4,324,000**	**100**

The Project is forecast to produce approximately 174,000 t CO_2-e Scope 1 emissions. NPM has a direct influence over Scope 1 emissions and these emissions will be subject to management and mitigation plans.

The Project is forecast to consume approximately 3650 Gigawatt Hour (GWh) of electricity, which will generate approximately 3,210,000 t CO_2-e Scope 2 emissions. NPM can influence reductions in Scope 2 emissions by driving electricity reduction and efficiency initiatives.

Approximately 940,000 t CO_2-e Scope 3 emissions can be associated with the Project. The majority of Scope 3 emissions associated with the Project will be generated by third parties providing product transport and energy. NPM has limited operational control over Scope 3 emissions, as they will be generated by the activities of other organisations.

The Project's GHG inventory is dominated by Scope 2 emissions. Approximately 96 per cent of the Project's GHG emissions occur upstream and downstream of the Project, and are generated by third parties. NPM is in direct control of approximately 4 per cent of the GHGs associated with the Project.

The Project's contribution to national GHG emissions (i.e. its scope 1 emissions), will average approximately 9200 t CO_2-e per annum. Australia's national GHG emissions are approximately 564,000,000 t CO_2-e per annum (National Greenhouse Gas Inventory 2011). The Project may contribute approximately 0.0017 per cent to annual national emissions. The Project is unlikely to impact national GHG policy objectives due to its relatively small contribution to national emissions.

TABLE OF CONTENTS

FIGURES

APPENDICES

1.0 Introduction

Northparkes Mines (NPM) is an existing copper-gold mine located approximately 27 kilometres north-west of Parkes in the central west region of NSW. NPM has been operational since 1993 and has included the development of open cut and underground mining operations targeting a number of ore bodies, as well as associated ore processing and tailings storage infrastructure. The existing operations have been developed in accordance with a number of development consents and project approvals, the most recent of which being PA06_0026 (as modified), which provides for continued mining operations through to 2025.

NPM are seeking approval for the Step Change Project (the Project) which encompasses the continuation of underground block cave mining in two existing ore bodies, the development of underground block cave mining in the E22 resource, additional campaign open cut mining located in existing mining leases and an extended mine life of seven years until 2032.

Approval for the Project is being sought under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The following Greenhouse Gas and Energy Assessment (GHGEA) report has been prepared as part of the environmental assessment process required under the EP&A Act.

1.1 The Project

The Project consists of existing and proposed mining operations and associated infrastructure. The major components of the Project include:

- continuation of approved underground block cave mining in the E48 and E26 ore bodies, and associated underground infrastructure;
- development of underground block caving in the E22 resource beneath the E22 open cut void;
- campaign open cut mining through development of five open cut resources including:
  - development of four small open cut pits E31, E31N, E28, E28N;
  - proposed E26 open cut which is located in an area of previous underground block cave subsidence (existing vertical extent of subsidence void is approximately 200 metres);
- amendments to the configuration of tailings storage facilities (TSFs) including:
  - continuation of tailings disposal to the existing and approved TSFs (TSF 1 and 2, infill between TSF 1 and 2, and Estcourt) to an approved height of 28 metres;
  - provision for additional raises on Estcourt TSF to provide for an increased height from the approved 25 metres to up to approximately 28 metres above ground surface;
  - development of a new TSF 3, which will extend to the south and from the southern embankment of TSF 2 to a height of approximately 28 metres above ground surface, which incorporates the approved Rosedale TSF;
- development of new waste dumps for the management of E28/E28N and E26 open cut waste rock. Waste rock from E31 and E31N open cut mining areas will be utilised in the development of TSF 3;

- continuation of approved ore processing infrastructure up to 8.5 Million tonnes per annum (Mtpa) capacity, and road haulage of copper concentrate to the existing Goonumbla rail siding;
- continued use of existing site infrastructure including administration buildings, workshop, internal access roads and service infrastructure;
- continued use of surface mining infrastructure including ventilation shafts, hoisting shaft and ore conveyors;
- continuation of existing approved water supply and management processes;
- development of an amended access road to service all mine related traffic entering the site;
- establishment of new visitor car parking facilities and access control to support the amended mine site access;
- continuation of approved mining operations for an extended life of an additional seven years until end of 2032; and
- rehabilitation and closure of the mine site will be carried out after the end of the operational life of the Project in accordance with relevant approvals.

The key features of the Project are summarised in **Table 1.1**:

Table 1.1 – Overview of the Project

Major Project Components/ Aspects	Existing and Approved Operations	Proposed Operations
Mining Areas	• Underground block cave mining of E26 and E48 ore bodies; and • Open cut mining of E27 and E22 (ceased in 2010).	• Continued block caving of the E26 and E48 ore bodies (as per current approval). • Development of block cave mining in the E22 resource (previously subject to open cut mining). • Development of open cut mining area in existing mine subsidence zone for E26. • Development of four small open cuts to extract ore from E28, E28N, E31 and E31N. • All proposed open cut mining areas are located within the existing PA 06_0026 Project Area and existing Mining leases.
Ore Processing	• Up to 8.5 Mtpa of ore, sourced from underground and open cut mining areas.	• Continuation of processing up to 8.5 Mtpa of ore through the existing processing plant sourced from underground and open cut mining areas.
Mine Life	• Until 2025.	• Extension of mining by seven years until end of 2032.
Operating Hours	• 24 hours a day, seven days per week.	• No Change.

Table 1.1 – Overview of the Project (cont.)

Major Project Components/ Aspects	Existing and Approved Operations	Proposed Operations
Number of Employees	• Approximately 700 full time equivalents.	• No Change.
Mining Methods	• Multiple Underground Block Cave. • Campaign open cut mining yielding up to 2 Mtpa for stockpiling and processing as required.	• Multiple Underground Block Cave. • Campaign Open cut mining of up to 7 Mtpa for stockpiling and processing as required.
Infrastructure	**Operation of:**	**Construction and Operation of:**
	• TSF 1-4. • Ore processing plant including surface crusher, crushed ore stockpiles, active grinding mills, froth flotation area and concentrate storage. • Site offices, training rooms and workshop facilities. • Road haulage of concentrate to the Goonumbla rail siding for transport to Port Kembla. • An overland conveyor to transport ore from the hoisting shaft to the ore processing plant stockpiles. • Operation of four wastewater treatment plants.	• TSF to be augmented to connect existing and approved tailings facilities, through the development of TSF 3 southward from the existing southern embankment of TSF 2. The proposed TSF 3 will substantially include the approved TSF 3 (known as Rosedale). • Establishment of new waste stockpiles to store waste material generated during open cut mining campaigns, including a vehicle wash down area. • Continued operation of existing processing plant, site offices, underground access, water supply infrastructure and logistics connections. • Continued road haulage of concentrate to Goonumbla rail siding for transport to Port Kembla. • Closure of the existing site access road through the development of TSF3. • Provision of an upgraded site access road along a new alignment from McClintocks Lane. • Development of an access control and visitors car parking at the intersection of the proposed site access and McClintocks Lane. • Upgrade/sealing of McClintocks Lane between the NPM access road and Bogan Road. • Upgrades as required to the intersection of McClintocks Lane and Bogan Road.
Block Cave Knowledge Centre	• Onsite Rio Tinto Block Cave Knowledge Centre operates for the domestic and international training of underground block cave mining methodology.	• Continued operation of the Rio Tinto Block Cave Knowledge Centre.

2.0 Assessment Framework

2.1 Objectives

The objective of this assessment is to evaluate the greenhouse gas (GHG) and energy use implications of the Project, in a manner that satisfies the Director-General's stated environmental assessment (EA) requirements for the Project. In relation to GHG and energy, the Director-General has requested that the EA includes:

- a quantitative assessment of potential Scope 1, 2 and 3 emissions;
- a qualitative assessment of the potential impacts of these emissions on the environment; and
- an assessment of reasonable and feasible measures to minimise the GHG emissions and ensure energy use efficiency.

2.2 Scope

The scope of the GHGEA includes:

- estimating the total GHG emissions and energy use associated with the Project;
- assessing how the Project may contribute towards climate change;
- estimating the impact of the Project's emissions on national and international GHG emission targets; and
- assessing reasonable and feasible measures to minimise the GHG emissions and ensure energy use efficiency.

2.3 Definitions and Sources

The GHGEA assessment framework is based on the methodologies and emission factors contained in the National Greenhouse Accounts (NGA) Factors (2012*).* The assessment framework also incorporates the principles of The Greenhouse Gas Protocol 2004 (World Resources Institute/World Business Council Sustainable Development 2004) (The Protocol).

The NGA Factors draw on the National GHG and Energy Reporting System (Measurement) Determination 2008, however, the NGA Factors have a general application to the estimation of a broader range of GHG inventories (Department of Climate Change and Energy Efficiency (DCCEE) 2011) that are more suited to environmental impact assessment.

The Protocol provides an internationally accepted approach to GHG accounting. The Protocol provides guidance on setting reporting boundaries, defining emission sources and dealing with issues such as data quality and materiality.

Table 2.1 contains concepts and a glossary of terms relevant to this GHGEA.

Table 2.1 – Glossary of Terms (The Greenhouse Gas Protocol 2004)

Concept	Definition
GHGs	The GHGs covered by the Kyoto Protocol and referred to in this GHGEA include: • Carbon dioxide; • Methane; • Nitrous oxide; • Hydrofluorocarbons; • Perfluorocarbons; and • Sulphur hexafluoride.
Scope 1 emissions	Direct emissions occur from sources that are owned or controlled by the Project (in this case, the proponent, North Mining Limited) (e.g. fuel use). Scope 1 emissions are emissions over which the Project has a high level of control.
Scope 2 emissions	Emissions from the generation of purchased electricity consumed by the Project. Scope 2 emissions can be measured easily and can be significantly influenced through energy efficiency measures.
Scope 3 emissions	Indirect emissions are emissions that are a consequence of the activities of the Project, but occur at sources owned or controlled by another reporting entity (e.g. outsourced services). Scope 3 emissions are only estimates and may have a relatively high level of uncertainty, unreliability and variability.

2.4 Impact Assessment Methodology

Scope 1 and 2 emissions were calculated based on the methodologies and emission factors contained in the NGA Factors 2012 (DCCEE 2012a).

Scope 3 emissions associated with product transport were calculated based on emission factors contained in the National GHG Inventory: Analysis of Recent Trends and GHG Indicators (AGO 2007). Other Scope 3 emissions were calculated using methodologies and emission factors contained in the NGA Factors 2012 (DCCEE 2012a).

All methodologies and calculations have been made assuming that all operations will occur as described in **Section 1.1**.

2.5 Data Sources

The calculations in this report are based on activity data projections developed by NPM, during the mine planning process. Umwelt has not undertaken physical testing and/or auditing to verify the accuracy of the data provided by NPM.

Table 2.2 contains the source of activity data.

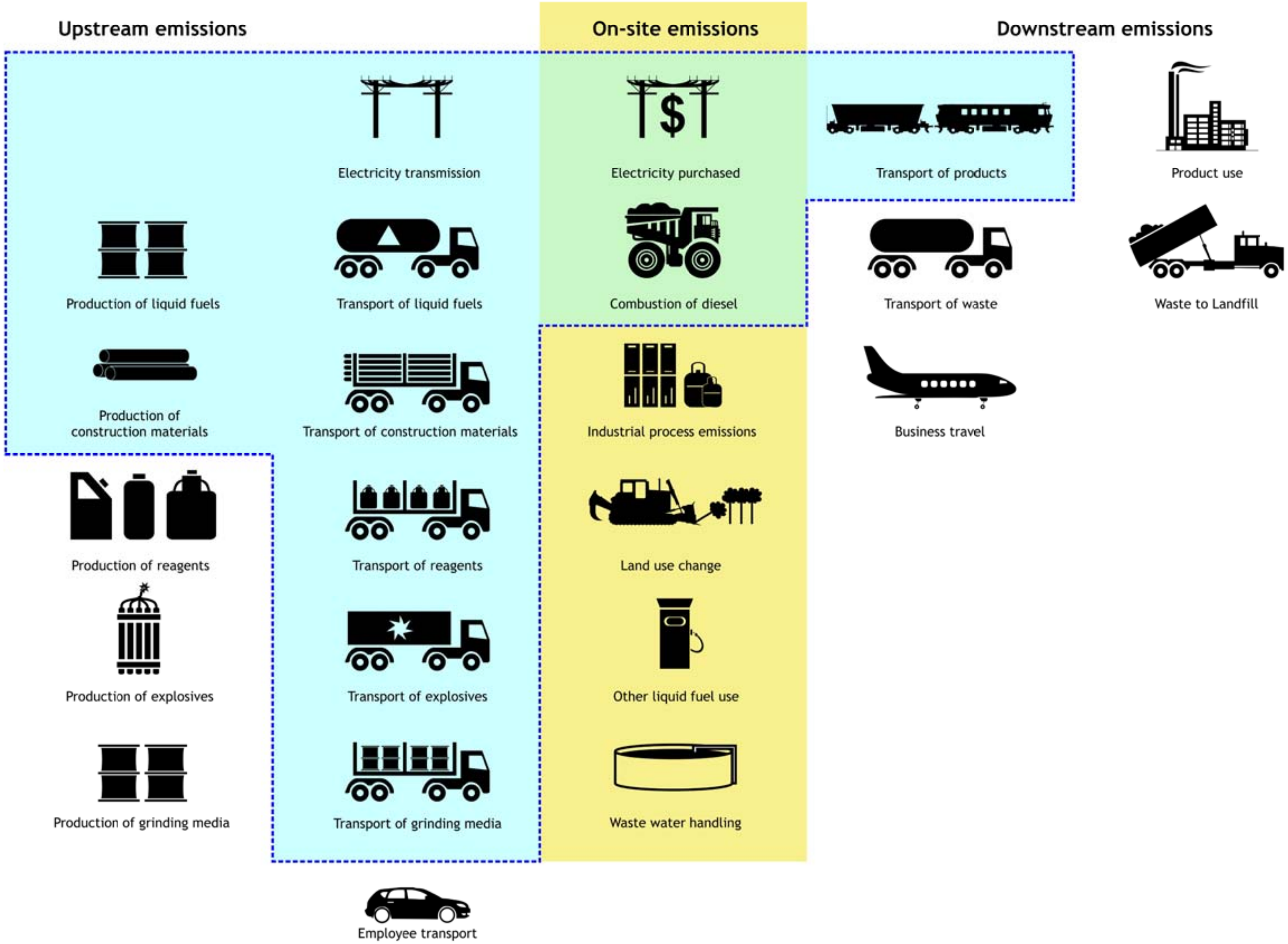
Table 2.2 – Source of Activity Data Used for the Assessment

Activity Data	Source
On-site fuel consumption	NPM – forecast diesel consumption
Electricity consumption	NPM – forecast electricity consumption
Construction materials	Umwelt estimates based on project data
Product transport	Umwelt estimates based on project data
Industrial processes – SF6	NPM – historical NGERS data
Waste water handling	NPM – historical NGERS data
Closure and Rehabilitation data	Umwelt estimates

A detailed description of activity data and calculations are provided in **Appendices A**, **B**, **C** and **D**.

2.6 Assessment Boundary

The GHGEA assessment boundary was developed to include all significant Scope 1, 2 and 3 emissions. **Figure 2.1** demonstrates how the assessment boundary interacts with the potential emission sources under NPMs operational control and other emission sources associated with the Project.



Legend

Assessment Boundary

Scope 1 and 2 Emissions

FIGURE 2.1

Greenhouse Gas Assessment Boundary

3.0 Impact Assessment Results

GHG and energy use estimates have been calculated for the construction, operation and closure stages of the Project.

3.1 Construction Stage

Many construction activities are likely to occur over the first five to eight years of the Project. The GHGEA only considers the major construction activities which have been identified in **Section 1.1**, and would not normally occur as part of on-going mine operations.

GHG estimates have been prepared for the construction of the following projects:

- developing a new site access road from McClintocks Lane;
- developing an access control and visitors car park at the intersection of the proposed site access and McClintocks Lane;
- upgrading/sealing of McClintocks Lane between the NPM access road and Bogan Road; and
- upgrading the intersection of McClintocks Lane and Bogan Road.

TSF 3 will be constructed from open cut waste and occur as part of open cut mining operations. The GHG emissions associated with the construction of TSF3 will be included in operational emissions as stationary diesel use.

The following assumptions were made for the construction stage calculations:

- the new access road is 2.2 kilometres;
- the McClintocks Lane upgrade is 3.3 kilometres; and
- the car park is suitable for 24 high use bays and one widened bay, with a surface area of approximately 600 m^2.

3.1.1 Greenhouse Gas Emissions

The Project's construction related GHG emissions are summarised in **Table 3.1**. Approximately 8500 t CO_2-e Scope 3 emissions are forecast to be associated with the construction activities related to the Project. Scope 3 emissions will be generated by third parties combusting energy and generating industrial emissions while producing and transporting construction materials. Scope 3 emissions will also be generated by contractors consuming energy during on-site construction.

The breakdown of construction related emissions in **Table 3.1** demonstrates that approximately 51 per cent of forecast construction related emissions are attributable to the consumption of construction materials. The consumption of energy during construction contributes 39 per cent of construction emissions, while 10 per cent of construction emissions are attributable to the transport of construction materials (see **Table 3.1**).

3.1.2 Energy Use

The construction activities related to the Project are forecast to require approximately 62,000 Gigajoules (GJ) of energy.

3.2 Operation Stage

The following inputs were used for the operation stage calculations:

- all copper concentrate is exported;
- rail distance from Goonumbla rail siding to Port Kembla is 550 kilometres;
- the average shipping distance from Port Kembla to Japan, China and India is 10,530 kilometres;
- 25,740 tonnes of materials such as grinding media, cement and reagents are delivered to NPM annually;
- materials are delivered an average of 350 kilometres by road. It has been assumed that some materials will be sourced locally, with the majority of materials sourced from Sydney; and
- diesel is delivered 390 kilometres by road from Sydney.

3.2.1 Life of Mine Greenhouse Gas Emissions

The Project's life of mine (LOM) GHG emissions are summarised in **Table 3.1**. The Project is forecast to be associated with approximately 4,324,000 t CO_2-e of GHG emissions over 19 years of operation.

The Project is forecast to generate approximately 174,000 t CO_2-e Scope 1 emissions from combusting diesel during its operation phase. Annual average Scope 1 emissions are forecast at approximately 9200 t CO_2-e per annum.

The Project is forecast to be associated with approximately 3,210,000 t CO_2-e Scope 2 emissions from consuming electricity during its operation phase. Annual average Scope 2 emissions are forecast at approximately 169,000 t CO_2-e per annum.

The Project is forecast to be associated with approximately 940,000 t CO_2-e Scope 3 emissions during its operation phase. Scope 3 emissions will be generated by third parties providing product transport and energy. Annual average Scope 3 emissions are forecast at approximately 49,500 t CO_2-e per annum.

Figure 3.1 demonstrates that the Project's GHG inventory is dominated by Scope 2 emissions. Approximately 96 per cent of the Project's GHG emissions occur upstream and downstream of the Project. NPM are in direct control of approximately 4 per cent of the GHGs associated with the Project.

Scope 2 and 3 emissions have been included in the GHGEA to demonstrate the potential upstream and downstream impacts of the Project. All Scope 2 and 3 emissions identified in the GHGEA are attributable to, and may be reported by, other sectors.

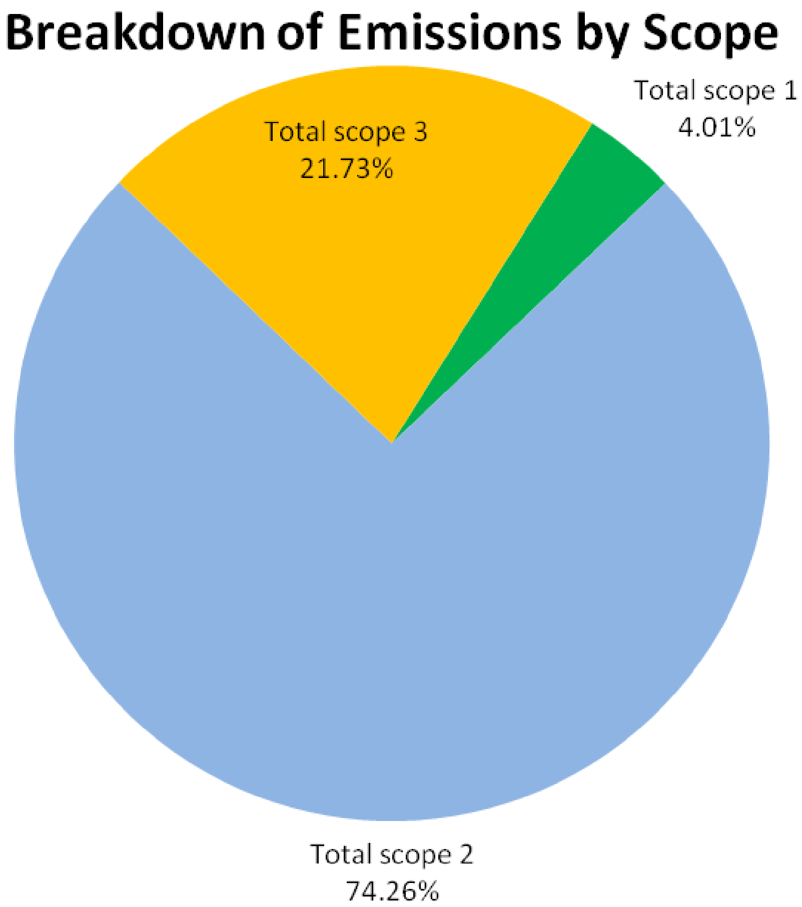


FIGURE 3.1

Breakdown of Emissions by Scope

3.2.2 Maximum Annual Greenhouse Gas Emissions

The Project will maintain the approved maximum ore processing rate of 8.5 Mtpa. **Table 3.2** summarises the Project's annual GHG emissions at an annual ore processing rate of 8.5 Mtpa. The maximum GHG emissions associated with the Project are forecast to be approximately 330,000 t CO_2-e per annum.

The Project is forecast to generate approximately 13,300 t CO_2-e Scope 1 emissions per annum at its maximum extraction rate.

The Project is forecast to be associated with approximately 245,000 t CO_2-e Scope 2 emissions per annum at its maximum extraction rate.

The Project is forecast to be associated with approximately 71,600 t CO_2-e Scope 3 emissions per annum at its maximum extraction rate.

3.2.3 Energy Use

The Project's on-site energy requirements are forecast at approximately 15,630,000 GJ over 19 years of operation. Annual average energy consumption is forecast at 823,000 GJ per annum. The average energy intensity of the copper concentrate produced is expected to be approximately 8.43 GJ/product tonne.

3.3 Closure and Rehabilitation Stage

The Project's closure and rehabilitation stage will include decommissioning infrastructure, soil remediation, shaping the final land form and rehabilitating areas. All activities are likely to generate GHG emissions through the combustion of diesel, however, shaping the final land form will be the most greenhouse intensive activity during the closure and rehabilitation stage. Some of the civil construction required for the final land form will occur over the LOM, therefore a proportion of the GHG emissions associated with shaping the final land form is included in operating emissions. The GHG assessment of the closure and rehabilitation stage has focussed on the civil works required to cap the tailings emplacement areas, as this activity will be the most significant source of GHG emissions.

The following assumptions were made for the closure and rehabilitation stage calculations:

- approximately 615 hectares of tailings facilities will be capped; and
- all tailings facilities will be capped with 1 to 2 metres of site sourced waste rock/topsoil.

3.3.1 Greenhouse Gas Emissions

The Project's total closure and rehabilitation emissions are summarised in **Table 3.1**.

The Project is forecast to generate approximately 13,800 t CO_2-e Scope 1 emissions from diesel combustion during the closure phase. The closure phase is also expected to be associated with approximately 1050 t CO_2-e Scope 3 emissions. Scope 3 emissions will be generated by third parties providing energy.

3.3.2 Energy Use

The Project is forecast to consume approximately 197,900 GJ during the closure phase.

Table 3.1 – Greenhouse Gas Emission Summary for the Proposed Project (See Appendices A – D for further details)

Stage	Scope	Source	Source Totals ($t\ CO_2$-e)	Scope Totals ($t\ CO_2$-e)
Construction	Scope 3 (Indirect)	Materials	4,274	8,409
		Energy Use	3,311	
		Transport of Materials	824	
Total Greenhouse Gas Emissions for Construction				**8,409**
LOM	Scope 1 (Direct)	Diesel use[1]	173,408	173,408
	Scope 2 (Indirect)	Electricity	3,209,879	3,209,879
	Scope 3 (Indirect)	Transport of Diesel and Materials	17,998	939,160
		Associated with energy extraction and distribution	669,790	
		Product transport	251,372	
Total Greenhouse Gas Emissions for LOM Operations				**4,322,447**
Closure And Rehabilitation	Scope 1 (Direct)	Stationary diesel use	13,752	13,752
	Scope 2 (Indirect)	Electricity	0	0
	Scope 3 (Indirect)	Associated with energy extraction and distribution	1,049	1,049
Total Greenhouse Gas Emissions for Closure and Rehabilitation				**14,801**

[1] Includes diesel used in explosives and all on-site equipment.

Table 3.2 – Maximum Annual Greenhouse Gas Emission Summary for the Proposed Project (See Appendix A for further detail)

Stage	Scope	Source	Source Totals ($t\ CO_2$-e)	Scope Totals ($t\ CO_2$-e)
Operations	Scope 1 (Direct)	Diesel use[2]	13,204	13,204
	Scope 2 (Indirect)	Electricity	244,436	244,436
	Scope 3 (Indirect)	Transport of Materials	1,371	71,518
		Associated with energy extraction and distribution	51,005	
		Product transport	19,142	
Total Annual Operation				**329,158**

[2] Includes diesel used in explosives and all on-site equipment.

3.4 Data Exclusions

The activities and emission sources listed in **Table 3.3** have been excluded from the GHGEA as they were inconsistent with the GHG Protocol's principles of relevance and accuracy.

Petrol use was excluded from the GHG assessment as it is not forecast to be a major source of energy or GHG emissions. GHG emissions from petrol use are unlikely to be considered relevant by internal or external stakeholders.

Waste water handling and industrial processes (SF6s) were excluded from the GHG assessment as they are not forecast to be a major source of GHG emissions. Based on NPM's annual National Greenhouse and Energy Reporting System (NGERS) reporting, industrial processes and waste water handling will only generate a very small proportion of the Project's emissions. GHG emissions from industrial processes and waste water handling are unlikely to be considered relevant by internal or external stakeholders.

The GHG implications of land use change were excluded from the assessment. The Project is expected to remove approximately 37 hectares of native woodland and 25 hectares of plantation timber. Clearing 62 hectares of vegetation may release up to 10,200[3] t CO_2-e. The Project is also expected to reduce cropping land uses, which may reduce GHG emissions associated with cultivation and nitrogen application. The net GHG impact of land use change could not be assessed with any degree of certainty, and could not be represented as accurate.

Waste transferred to local landfill was excluded from the GHG assessment as waste is not forecast to be a major source of GHG emissions. GHG emissions from landfill emissions are unlikely to be considered relevant by internal or external stakeholders.

Employee travel and business travel were excluded from the GHG assessment as they are not forecast to be a major source of GHG emissions. GHG emissions from employee travel and business travel are unlikely to be considered relevant by internal or external stakeholders.

Copper concentrate use has been excluded from the GHG assessment due to uncertainties associated with the accuracy of calculating GHG emissions. The consumption of copper concentrate is likely to generate significant scope 3 emissions, however, a recognised methodology for estimating emissions was not available for the assessment.

[3] Based on a 30 year, medium density, environmental planting.

Table 3.3 – Data Exclusions

Emissions Source	Scope	Description	Reason for Exclusion
Combustion of fuel for energy	Scope 1	• Small qualities of fuels such as petrol.	Emission levels are likely to lack relevance to stakeholders.
Industrial processes	Scope 1	• Sulphur hexafluoride (high voltage switch gear). • Hydrofluorcarbon (commercial and industrial refrigeration).	Emission levels are likely to lack relevance to stakeholders.
Waste water handling (industrial)	Scope 1	• Waste water management.	Emission levels are likely to lack relevance to stakeholders.
Land use, Land use change and Forestry	Scope 1	• Clearing vegetation. • Mine site re-vegetation.	Emissions considered to be offset by sequestration from rehabilitation plantings.
Solid waste	Scope 3	• Solid waste to landfill.	Emission levels are likely to lack relevance to stakeholders.
Business travel	Scope 3	• Employees travelling for business purposes.	Emission levels are likely to lack relevance to stakeholders.
Employee travel	Scope 3	• Employees travelling between their place of residence and the Northparkes site.	Emission levels are likely to lack relevance to stakeholders.
Product use	Scope 3	• Consumers processing copper concentrate into copper and copper products.	The lack of data quality is likely to impact accuracy.

4.0 Impact Assessment Summary

The GHG emissions generated by the Project have the potential to impact the physical environment and the GHG reduction objectives of national and international governing bodies. The following section makes the distinction between environment impacts and impacts on policy objectives.

4.1 Environmental Impact

The Project's GHG emissions will have a disperse impact as they are highly mobile and are generated up and down the supply chain. GHG emissions primarily alter the atmospheric concentration of carbon dioxide and methane. The secondary impacts of GHG emissions include; global warming, ocean acidification and carbon fertilisation of flora. The tertiary impacts of GHG emissions (i.e. climate change) may have many ramifications for the natural and built environment.

The Project's direct emissions are forecast to be approximately 9200 t CO_2–e per annum.

Approximately 40 to 50 per cent of the Project's carbon dioxide emissions are expected to impact the atmosphere and become a 'GHG' (i.e. causing radiative forcing). The remaining 50 to 60 per cent of the project's CO_2 emissions are expected to be absorbed by the ocean and cycled through land biota (Knorr 2009, Raupach *et al*. 2008). The airborne fraction (i.e. the proportion of CO_2 that remains in the atmosphere) of the carbon dioxide emitted from the Project is likely to remain in the atmosphere for a long period. The 2007 Intergovernmental Panel on Climate Change (IPCC) policy makers summary report states that 'about half' of a CO_2 pulse to the atmosphere is removed over a timescale of 30 years; a further 30 per cent is removed within a few centuries; and the remaining 20 per cent will stay in the atmosphere for many thousands of years' (Archer *et al*. 2009).

To put the Project's emissions into perspective, global GHG emissions are forecast to be 46,000,000,000 t CO_2-e by 2020 (Sheehan *et al*. 2008). During operation, the Project will contribute approximately 0.000020 per cent to the global emissions per annum (based on its projected scope 1 emissions). The scope 2 and 3 emissions associated with the Project should not be considered in a global context, as global projections only represent scope 1 emissions (i.e. the sum of all individual emission sources).

4.2 Impact on Climate Change

The IPCC define climate change as a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties, and persists for an extended period, typically decades or longer (IPCC 2007).

Climate change is caused by changes in the energy balance of the climate system. The energy balance of the climate system is driven by atmospheric concentrations of GHGs and aerosols, land cover and solar radiation (IPCC 2007). There is strong evidence to suggest that observations of global warming are directly correlated to increased concentrations of atmospheric GHGs (IPCC 2007).

It would be misleading to assess the climate change impacts of the Project by simply applying a radiative forcing coefficient to the GHGs generated by the Project. Carbon emitted to the atmosphere is exchanged between carbon reservoirs such as oceans and ecosystems over a wide range of timescales. It is erroneous to assume that the GHGs generated by the Project will materially shift the atmospheric concentration of GHGs in a linear way (IPCC 2007).

The extent to which global emissions and atmospheric concentrations of GHGs have a demonstrable impact on climate change will be largely driven by the global response to reducing total global emissions that includes all major emission sources and sinks.

4.3 Impact on National Policy Objectives

The Federal Government has committed to reduce Australia's GHGs emissions to 25 per cent below 2000 levels by 2020 if the world agrees to an ambitious global deal to stabilise levels of GHGs in the atmosphere at 450 parts per million CO_2 -e or lower (DCCEE 2012b).

If the world is unable to reach agreement on a 450 parts per million target, Australia will still reduce its emissions by between 5 and 15 per cent below 2000 levels by 2020 (DCCEE 2012b).

If Australia is able to meet the 5 per cent reduction target by 2020, the nation will be generating approximately 525 Mt CO_2-e per annum (National Greenhouse Gas Inventory 2010).

The Project is forecast to generate approximately 16,500[4] t CO_2-e Scope 1 emissions per annum by 2020. The Project's annual Scope 1 emissions are forecast to represent approximately 0.003 per cent of Australia's national emissions by 2020. The Project's Scope 2 and 3 emissions should not be considered against national objectives, as Scope 2 and 3 emissions (which occur in Australia) will be reported by other sectors of the Australian economy.

The Project is unlikely to limit the Federal Government achieving its national GHGs objectives.

4.4 Impact on International Objectives

At present there is no comprehensive global agreement on GHGs reduction targets that includes commitments from all major emitters such as China, India and the United States of America.

The Seventeenth Conference of the Parties (COP17) climate change negotiations in Durban, however, provides some direction for international GHG objectives. Countries agreed in Durban to begin work on a new climate change agreement that will cover all countries. The intention is to develop an agreement, including emission reduction commitments, by 2015 to come into effect from 2020. Countries also agreed that there would be a second commitment period of the Kyoto Protocol from 1 January 2013 (DCCEE 2012a).

[4] Note that this value is based on forecast activity data for 2020 and not annual average data.

Under the Cancun Agreements, Australia has committed to reducing its 2020 national GHG inventory by 5 per cent (based on the 2000 inventory) (DCCEE 2012c).

Australia's international objectives align with its national objectives. As discussed in **Section 4.4**, the Project is unlikely to prevent the Federal Government achieving its national/international 5 per cent GHG reduction target.

5.0 Assessment of Greenhouse Gas Mitigation Measures

The Project's GHG mitigation measures are driven by the Rio Tinto Climate Change Policy. Rio Tinto also has an obligation to adhere to the *Energy Efficiency Opportunities Act 2006*, which requires NPM to participate in the Energy Efficiency Opportunities (EEO) Program.

5.1 Rio Tinto Climate Change Policy

The NPM climate change policy aligns with the Rio Tinto climate change policy. Rio Tinto's Climate Change Position (2013) states:

We have set quantified emissions intensity reduction goals.

We are working to reduce our emissions intensity by reducing where practicable:

- the energy intensity of our operations;
- the emissions intensity of our energy use, including through the use of renewable energy;
- the intensity of emissions arising from the chemical processes used at our operations; and
- emissions from other sources, including from land holdings.

We are seeking a substantial decarbonisation of the business by 2050. Research, development and deployment of new technologies and better practices will be crucial to achieve this, although we recognise that constraints imposed from process chemistry and technology costs may remain.

We are adapting to climate change by making our businesses and projects resilient to a changing climate and having plans to adapt to the impacts before they arise, especially in the design of new projects with long lifetimes.

We recognise the value of action on climate change. We factor into our planning and decision making, including our choice of investments, the costs and associated risks of emissions and business disruption, as well as the costs and benefits of mitigation and adaptation, and the opportunities created for our business by the move to a low carbon economy. We include carbon prices in our investment decision-making.

We work with others, engaging with:

- our customers and suppliers to reduce supply chain emissions, and make best use of our products to build a low carbon economy;
- our host communities by listening to and working with them on energy, emissions and climate issues that are important to them;
- governments and other stakeholders to advocate constructively for policies that are environmentally effective, economically efficient and equitable; and
- investors and the broader community by reporting publicly our emissions and performance, and integrating our climate related activities into our broader sustainable development programme.

We engage in policy debates, seeking policies that:

- avoid damage to the competitiveness of trade exposed industries and displacement of emissions with no reduction in the global total;
- make use of market mechanisms, both within and across jurisdictions, to promote innovation and cost effective outcomes;
- use revenue raised from any carbon pricing to facilitate the transition to a low carbon economy, including through the development of new technology; and
- are broadly based and predictable.

5.2 Current Greenhouse Gas Management Measures

NPM is controlled by Rio Tinto. Controlling corporations that use more than 0.5 petajoules (PJ) of energy per year must participate in the EEO Program. Rio Tinto triggers the energy use thresholds of the EEO Program and it is therefore required to undertake energy efficiency assessments and report the progress of energy efficiency projects. NPM currently complete energy efficiency assessments, undertake energy efficiency planning and assist Rio Tinto to report on the progress of nominated energy efficiency projections. NPM will continue to participate in the EEO Program and undertake the following activities to improve energy use efficiency:

- develop an energy efficiency opportunities project and communication plan;
- evaluate energy use for the Project;
- identify and investigate potential energy efficiency opportunities; and
- implement, track, communicate and report on energy efficiency opportunities (DEUS 2005).

NPM is planning to implement a range of EEO projects. The following list provides three examples of current mitigation measures:

- installing two new pressure filters to improve the capacity of filtration section and reduce concentrate recovery losses;
- redesigning bogger bucket capacity to increase ore carrying capacity, to enable the number of boggers to be reduced; and
- upgrading processing screen capacity to increase energy efficiency and mill throughput.

5.3 Assessment of Potential Management Measures

Figure 5.1 demonstrates that the vast majority of the Project's GHG emissions will be generated by electricity consumption during the concentration process.

The following sections assess the Project's planned GHG mitigation measures against best practice GHG management.

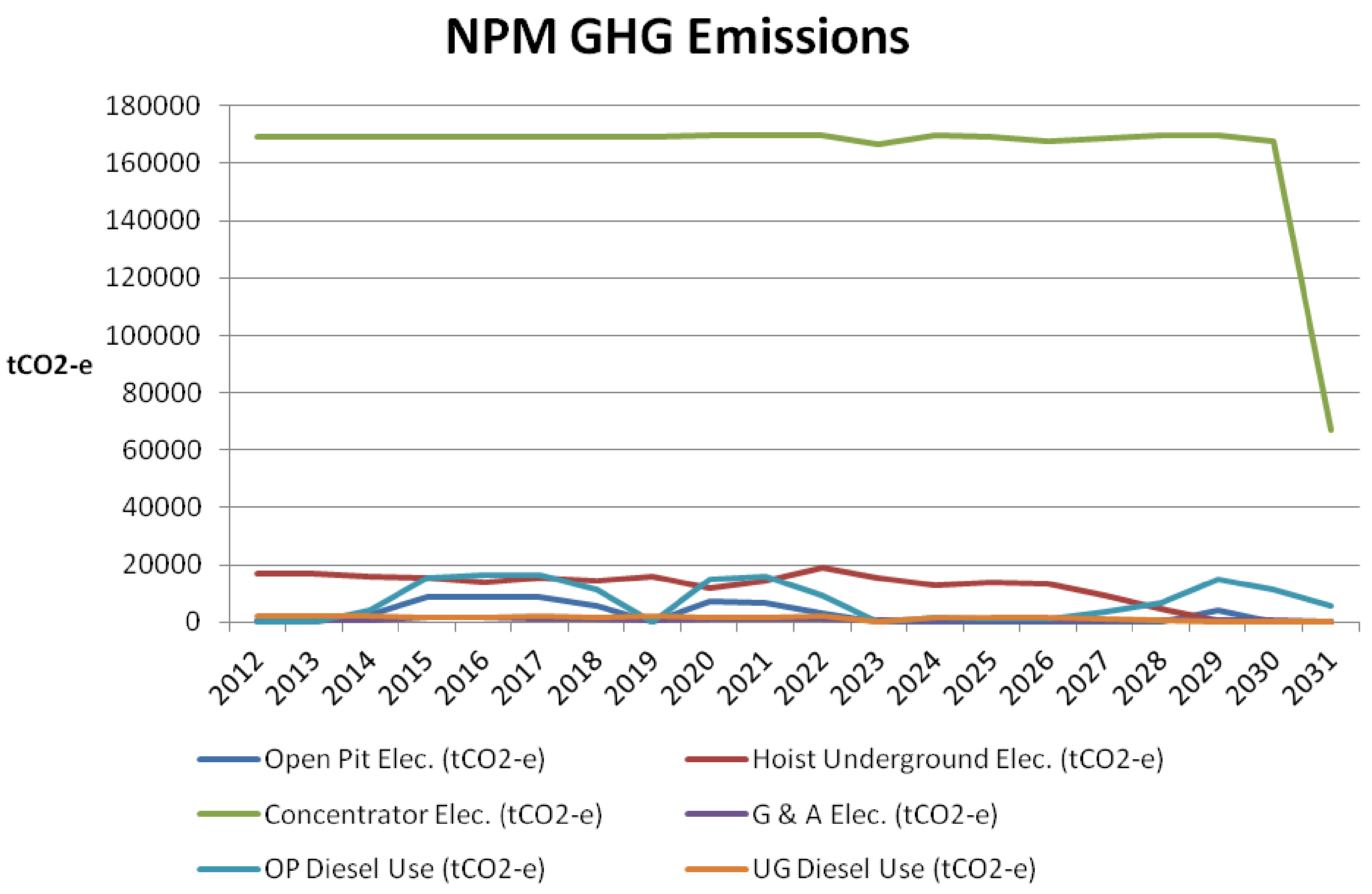


FIGURE 5.1

Forecast Greenhouse Gas Emissions by Operation

5.3.1 Options for the Concentrator

Electricity consumption at the Concentrator is forecast to generate approximately 87 per cent of the Project's combined Scope 1 and 2 emissions. **Table 5.1** includes the GHG mitigation measures assessed for the Concentrator.

Table 5.1 – Options Assessed for the Concentrator

Energy Use During Processing		
Potential Mitigation Measure	**Planned for Project**	**Reason for Inclusion/Exclusion**
1. High efficiency motors	Yes	High efficiency motors are used for all replacements and upgrades. Cost efficiencies do not warrant premium efficiency motors.
2. Optimising ore throughput	Yes	Optimising ore throughput is a key performance indicator for NPM. NPM have introduced a second crusher to optimise the performance of the SAG mill.
3. Optimising grind size	Yes	Grind size is constantly monitored and adjusted to optimise copper recovery.
4. Utilising Variable Speed Drives (VSD's)	Yes	VSDs are installed on all motor replacements and upgrades. NPM have determined that it is not cost effective to retrofit VSDs to older equipment.
5. Utilising Gearless Mill Drives	No	Gearless drives are very expensive and generally only fitted to large mills over 36 feet. The NPM mill is only 28 feet and considered too small for a gearless mill drive.
6. Optimising motor size to load	Yes	The concentrator plant is operating at maximum capacity. All motors are running at close to maximum load capacity.
7. Mechanical efficiency of driven equipment	Yes	NPM have retrofitted all belt driven pumps with matched v-belt sets to reduce slippage losses.
8. Removing flow restrictions	Yes	The widespread use of VSD has reduced the need to mechanically restrict flow.
9. Renewable energy	No	NPM does not consider on-site renewable energy would provide a reasonable economic return. Some solar is used on the administration buildings.

5.3.2 Options for Underground Ore Transfer

Electricity consumption associated with transferring underground ore from block caves to the concentrator is forecast to generate approximately 6 per cent of the Project's combined Scope 1 and 2 emissions. **Table 5.2** includes the GHG mitigation measures assessed for the operations involved in the transfer of underground ore.

Table 5.2 – Options Assessed for Underground Ore Transfer

Energy Use During Processing		
Potential Mitigation Measure	**Planned for Project**	**Reason for Inclusion/Exclusion**
10. Hoist - Friction winder system	Yes	Allows significant energy savings by utilising counter weights and tail ropes.
11. Hoist - Regenerative braking	No	The current operations have significant power quality issues. NPM have considered regenerative braking, but they believe the technology would cause too many power quality issues.
12. Conveyors – high efficiency motors	Yes	High efficiency motors are used for all replacements and upgrades.
13. Conveyors – Variable Speed Drives	Yes	VSDs are installed for all motor replacements and upgrades. NPM have determined that it is not cost effective to retrofit VSDs to older equipment.
14. Conveyors – low rolling resistance pulley covers	Yes	NPM has installed new conveyor belts that use a pulley cover compound that reduces rolling resistance and energy use.
15. Renewable energy	No	NPM does not consider on-site renewable energy would provide a reasonable economic return.

5.3.3 Options for Haul Trucks

Table 5.3 includes the GHG mitigation measures assessed for open pit haul trucks.

Table 5.3 – Options Assessed for Haul Trucks

Energy Use During Extraction		
Potential Mitigation Measure	**Planned for Project**	**Reason for Inclusion/Exclusion**
16. Limiting the length of material haulage routes	Yes	NPM plan to make haul roads as short as practically possible. NPM also plan to use a direct dump strategy for overburden. E31 and E31N waste rock will be transported directly to the location of TSF 3 wall construction. This direct dumping will reduce double handling and total haulage distances.
17. Optimising ramp gradients	Yes	Ramp grades are designed to maximise safely and optimise fuel use efficiency.
18. Utilising fuel efficient haul trucks	No	NPM does not control haul truck selection. The use of the most fuel efficiency haul trucks can not be guaranteed.
19. Maximising payload	Yes	Trucks will be operated at maximum payload.
20. Increasing haul truck payload	No	Pit sizes are generally small and are not suited to large and ultra-class haul trucks.
21. Improving rolling resistance of haul roads	No	Open pit haul roads will be used intermittently and maintained while in use. NPM does not consider sealing haul roads would provide a reasonable economic return.
22. Replacing trucks with conveyors	No	The proposed campaign style open pit mining is not suited to transferring ore by conveyor. NPM does not consider conveyors would provide a reasonable economic return.
23. Replacing diesel with biodiesel	No	NPM has considered biodiesel, but it has decided not to use biodiesel to avoid potential engine warranty issues.

5.3.4 Options for Open Pit Mining Operations

Table 5.4 includes the GHG mitigation measures assessed for open pit mining operations.

Table 5.4 – Options Assessed for Open Pit Mining Operations

Energy Use During Extraction		
Potential Mitigation Measure	**Planned for Project**	**Reason for Inclusion/Exclusion**
24. Scheduling activities so that equipment and vehicle operation is optimised	Yes	The mine planning process has scheduled activities to optimise the productivity and efficiency of equipment.
25. Using fuel additives	Yes	NPM have evaluated diesel additives and plan to use them during on-going operations.
26. Utilising efficient equipment	No	NPM does not control equipment selection. The use of the most fuel efficient equipment cannot be guaranteed.
27. Blasting strategies to improve extraction efficiency	Yes	Optimising blasting strategies is an important aspect of the NPM operation. NPM vary the power factor of each blast to optimise both digging and crushing performance.
28. Maximising resource recovery efficiency	Yes	Resource recovery will be optimised within the constraints of the Project.
29. Working machines to their upper design performance	Yes	Machines will be worked to their upper design performance. Optimising machine performance is a key performance indicator for operators.
30. Electric drills	No	NPM has considered using electric drills, however, it does not consider electric drills would be practical or cost effective. NPM's evaluation of electric drills found that it would not be cost effective to reticulate electricity to the open pit areas. NPM also believes that electric drilling lacks the required flexibility to work successfully in relatively small campaign open cut pits as proposed at NPM.
31. Preventing unnecessary water ingress	Yes	NPM plan to bund all open pit areas.
32. Replacing diesel with biodiesel	No	NPM has considered biodiesel, but it has decided not to use biodiesel to avoid potential engine warranty issues.

NPM are planning to implement all reasonable and feasible GHG mitigation actions across their core operations. NPM have a strong commercial incentive to optimise the energy efficiency of the copper concentration process, and NPM's continued efforts to improve energy efficiency will mitigate GHG emissions. The underground operations will also continue to use block caving techniques, as it is the most efficiency way to extract resources at the NPM site. The continued use of block caving techniques should minimise the GHG emission intensity of the underground operations.

NPM are not planning to implement a number of open pit mitigations options, due to the size and nature of the open pit operations. The open pit areas will be relatively small and operated to optimise the efficiency of the tailings dam construction. NPM plan to outsource the operation of open pit areas, which may limit mitigation options that involve investment in fuel efficient technology.

5.4 Future Energy Efficiency Management Measures

NPM will generate and evaluate many energy efficiency measures during a normal annual planning cycle. It is not reasonable or feasible to implement all management measures identified though the annual planning process, therefore measures will be prioritised to ensure the implementation of the most cost effective measures.

6.0 Conclusion

The Project is expected to be associated with the generation of approximately 4,324,000 t CO_2-e of GHG. Scope 1 and 2 emissions are expected to average approximately 178,000 t CO_2-e per annum, which is a relatively large reportable value within the Australian National Greenhouse and Energy Reporting System.

The copper concentration process is forecast to be responsible for approximately 87 per cent of the Project's combined Scope 1 and 2 emissions. The concentration process is energy intensive and it is forecast to require an average of approximately 666,500 GJ of electricity per annum.

While the Project is forecast to generate significant GHG emissions over its 19 year operation, approximately 96 per cent of GHG emissions will be produced beyond the direct control of NPM. Power stations generating electricity are the Project's predominant source of GHG emissions, so the Project's emissions will be heavily influenced by the electricity demands of the concentration process and the GHG intensity of electricity generation in NSW.

The Project's contribution to national GHG emissions (i.e. its scope 1 emissions), will average approximately 9,200 t CO_2-e per annum. Australia's national GHG emissions are approximately 564,000,000 t CO_2-e per annum (National Greenhouse Gas Inventory 2011). The Project may contribute approximately 0.0017 per cent to annual national emissions. The Project is unlikely to impact national GHG policy objectives due to its relatively small contribution to national emissions.

NPM are planning to implement all reasonable and feasible GHG mitigation actions across their core operations. NPM have a strong commercial incentive to optimise the energy efficiency of the copper concentration process, and NPM's continued efforts to improve energy efficiency will mitigate GHG emissions. The underground operations will also continue to use block caving techniques, as it is the most efficiency way to extract resources at the Project site. The continued use of block caving techniques should minimise the GHG emission intensity of the underground operations.

7.0 References

Archer, D., Elby, M., Brovkin, V., Ridgwell, A., Cao, L., Mikolajewicz, U., Caldeira, K., Matsumoto, K., Munhoven, G, Montoenegro, A and Tokos, K. (2009). Atmospheric lifetime of fossil fuel carbon dioxide. *Annual Review of earth and Planetary Sciences 2009.* 37:117-34.

Australian Greenhouse Office (2007). National Greenhouse Gas Inventory: Analysis of Recent Trends and Greenhouse Gas Indicators.

Department of Climate Change and Energy Efficiency (2012a). National Greenhouse Accounts (NGA) Factors 2012, Department of Climate Change, Canberra.

Department of Climate Change and Energy Efficiency (2012b). International climate change negotiations, Durban 2011.

Department of Climate Change and Energy Efficiency (2012c). Fact Sheet: Australia's emission reduction targets. Commonwealth of Australia, Canberra.

Department of Energy, Utilities and Sustainability (2005). Guidelines for Energy Savings Action Plans.

Department of Resources, Energy and Tourism (2013). Analysis of diesel use for mine haul and transport operations.

Knorr, W. (2009). Is the airborne fraction of anthropogenic CO_2 emissions increasing? *Geophysical Research Letters* VOL. 36, 2009.

National Greenhouse Gas Inventory (2011). National Greenhouse gas Inventory. http://ageis.climatechange.gov.au/

Raupach, M., Canadell, J and Le Qu´er´e, C. (2008). Anthropogenic and biophysical contributions to increasing atmospheric CO_2 growth rate and airborne fraction. *Biogeosciences Discuss.,* 5, 2867–2896, 2008.

Sheehan, P., Jones, R., Jolley, A. Preston, B.L., Durack, P.J., Islam, S.M.N. and Whetton, P.H. (2008). Climate change and the new world economy: Implications for the nature and policy responses. Global Environmental Change 18: 380 – 396.

WRI/WBCSD (2004). The Greenhouse Gas Protocol: The GHG Protocol for Modified RDC Accounting. World Resources Institute and the World Business Council for Sustainable Development, Switzerland.

APPENDIX A

Project's Construction Emission Calculations

Appendix A – Project's Construction Emission Calculations

The GHG emissions for the construction phase of the Project are based on the following assumptions. The assumptions made for the construction related emissions are based on typical values for similar projects. The following assumptions have been used for calculation purposes only, and are not meant to describe the exact specifications of the Project.

The assumptions are:

- all roads will be constructed to a width of 10 metres;
- all roads will require a 230 millimetre lean concrete sub-base;
- all roads will require 75 millimetres of Asphalt AC20;
- all roads will require 50 millimetres of Asphalt AC14;
- all roads will require two 7 millimetre applications of bitumen;
- the vertical alignment of all roads will be optimised to balance cut and fill volumes;
- topsoils and other materials excavated for road construction will be utilised on-site;
- the bitumen content of asphalt averages 5 per cent;
- construction materials such as asphalt, cement and steel will be transported an average distance of 350 kilometres;
- materials will be transported via road on trucks with a payload of 33 T;
- diesel consumption for trucks transporting materials will average 54.6 L/100 kilometres;
- diesel use for road construction will average 240 kL/kilometre of road construction. This is a conservative assumption based on halving the diesel use estimates the RTA used for major Pacific Highway upgrades (four lanes, divided road) (RTA 2008).

Table 1 - Construction Materials

Activity Data			Emission Factors[5]	GHG Emissions
Material Type	**Usage**	**Unit**	**t CO_2-e/tonne**	**t CO_2-e**
Lean concrete sub-base	30,691	t	0.076	2,333
Asphalt (AC20)	9,174	t	0.071	651
Asphalt (AC14)	6,116	t	0.071	434
Bitumen	1,712	t	0.5	856
Total GHG emissions (t CO_2-e)				**4,274**

Table 2 - Energy Use During Construction

Activity Data				Emission Factors		
				Scope 1	**Scope 3**	**Full Life Cycle**
Purchased energy	**Usage**	**Units**	**GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**
Diesel	1,320	kL	50,952	69.5	5.3	74.8
						t CO_2-e
Total GHG emissions (t CO_2-e)						**3,311**

Table 3 - Transport of Materials

Activity Data				Emission Factors		
				Scope 1	**Scope 3**	**Full Life Cycle**
Purchased energy	**Usage**	**Units**	**GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**
Diesel	283.83	kL	10,956	69.9	5.3	75.2
						t CO_2-e
Total GHG emissions (t CO_2-e)						**824**

[5] Emission factors sources from the University of Bath, Inventory of Carbon and Energy (ICE) v2.0, 2011.

APPENDIX B

Project's Operating Emission Calculations

Appendix B – Project's Operating Emission Calculations

Table 1 – Life of Mine Stationary Diesel Use

Activity Data	**Energy Use**		**Emission Factors**		
			CO_2	**CH_4**	**N_20**
kL	**GJ/kL**	**GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**
64,639	38.6	2,495,065	69.2	0.1	0.2
			t CO_2-e	**t CO_2-e**	**t CO_2-e**
Breakdown of individual GHG emissions (t CO_2-e)			172,659	250	499
Total GHG emissions (t CO_2-e)					**173,408**

Table 2 - Life of Mine Electricity

Activity Data	**Energy Use**	**Emission Factors**		
		CO_2	**CH_4**	**N_20**
kWh	**GJ**	**kg CO_2-e/kWh**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**
3,647,590,000	13,131,324	0.88	N/A	N/A
		t CO_2-e	**t CO_2-e**	**t CO_2-e**
Breakdown of individual GHG emissions (t CO_2-e)		3,209,879	N/A	N/A
Total GHG emissions (t CO_2-e)				**3,209,879**

Table 3 - Life of Mine Extraction, Production and Distribution of Energy Purchased

Activity Data		Emission Factors		
		CO_2	CH_4	N_20
Purchased energy		**kg CO_2-e/Unit**	**kg CO_2-e/Unit**	**kg CO_2-e/Unit**
Diesel (GJ)	2,495,065	5.3	N/A	N/A
Electricity (kWh)	3,647,590,000	0.18	N/A	N/A
		t CO_2-e	**t CO_2-e**	**t CO_2-e**
Breakdown of individual GHG emissions (t CO_2-e)		669,790	N/A	N/A
Total GHG emissions (t CO_2-e)				**669,790**

Table 4 - Life of Mine Product Transport

Activity Data				Emission Factors		
				CO_2	CH_4	N_20
Transport mode	**Product (t)**	**Distance (km)**	**Tonne km (tkm)**	**kg CO_2-e/tkm**	**kg CO_2-e/tkm**	**kg CO_2-e/tkm**
Rail	1,853,120	550	1,019,216,000	0.0054	N/A	N/A
Ship	1,853,120	10,530	19,513,353,600	0.0126	N/A	N/A
				t CO_2-e	**t CO_2-e**	**t CO_2-e**
Breakdown of individual GHG emissions (t CO_2-e)				251,372	N/A	N/A
Total GHG emissions (t CO_2-e)						**251,372**

Table 5 - Transport of Materials

Activity Data							Emission Factors
							Scope 3 - Full Life Cycle
Materials	**Usage**	**Deliveries (No.)**	**Total Distance (Km)**	**Diesel use (l/Km)**	**Diesel use (kL)**	**Diesel use (GJ)**	**kg CO_2-e/GJ**
Diesel (kL)	64,639	1,959	1,527,831	0.546	834	32,200	75.2
Grinding Media/Reagents (Tonne)	463,320	14,040	9,828,000	0.546	5,366	207,131	75.2
							t CO_2-e
Total GHG emissions (t CO_2-e)							**17,998**

APPENDIX C

Project’s Maximum Annual Operating
Emission Calculations

Appendix C – Project's Maximum Annual Operating Emission Calculations

Annual maximum emissions have been calculated based on processing 8.5 Mtpa.

Table 1 – Life of Mine Stationary Diesel Use

Activity Data	**Energy Use**		**Emission Factors**		
			CO_2	**CH_4**	**N_20**
kL	**GJ/kL**	**GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**
4,922	38.6	189,989	69.2	0.1	0.2
			t CO_2-e	**t CO_2-e**	**t CO_2-e**
Breakdown of individual GHG emissions (t CO_2-e)			13,147	19	38
Total GHG emissions (t CO_2-e)					**13,204**

Table 2 - Life of Mine Electricity

Activity Data	**Energy Use**	**Emission Factors**		
		CO_2	**CH_4**	**N_20**
kWh	**GJ**	**kg CO_2-e/kWh**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**
277,768,455	999,966	0.88	N/A	N/A
		t CO_2-e	**t CO_2-e**	**t CO_2-e**
Breakdown of individual GHG emissions (t CO_2-e)		244,436	N/A	N/A
Total GHG emissions (t CO_2-e)				**244,436**

Table 3 - Life of Mine Extraction, Production and Distribution of Energy Purchased

Activity Data		Emission Factors		
		CO_2	CH_4	N_20
Purchased energy		**kg CO_2-e/Unit**	**kg CO_2-e/Unit**	**kg CO_2-e/Unit**
Diesel (GJ)	189,989	5.3	N/A	N/A
Electricity (kWh)	277,768,455	0.18	N/A	N/A
		t CO_2-e	**t CO_2-e**	**t CO_2-e**
Breakdown of individual GHG emissions (t CO_2-e)		51,005	N/A	N/A
Total GHG emissions (t CO_2-e)				**51,005**

Table 4 - Life of Mine Product Transport

Activity Data				Emission Factors		
				CO_2	CH_4	N_20
Transport mode	**Product (t)**	**Distance (km)**	**Tonne km (tkm)**	**kg CO_2-e/tkm**	**kg CO_2-e/tkm**	**kg CO_2-e/tkm**
Rail	141,117	550	77,614,350	0.0054	N/A	N/A
Ship	141,117	10,530	1,485,962,010	0.0126	N/A	N/A
				t CO_2-e	**t CO_2-e**	**t CO_2-e**
Breakdown of individual GHG emissions (t CO_2-e)				19,142	N/A	N/A
Total GHG emissions (t CO_2-e)						**19,142**

Table 5 - Life of Mine Transport of Materials

Activity Data							Emission Factors
							Scope 3 - Full Life Cycle
Materials	**Usage**	**Deliveries (No.)**	**Total Distance (Km)**	**Diesel use (l/Km)**	**Diesel use (kL)**	**Diesel use (GJ)**	**kg CO_2-e/GJ**
Diesel (kL)	4,922	149	116,338	0.546	64	2,452	75.2
Grinding Media / Reagents (Tonne)	35,282	1,069	748,406	0.546	409	15,773	75.2
							t CO_2-e
Total GHG emissions (t CO_2-e)							**1,371**

APPENDIX D

Project's Decommissioning and
Closure Calculations

Appendix D – Project's Decommissioning and Closure Calculations

Diesel consumption data has been calculated based on the following assumptions:

- capping the tailings emplacement areas will require 9,225,000 m^3 of sand, gravel and rock;
- the bulk density of capping material is 1650 kg/m3; and
- the capping process with require 0.013 GJ/tonne placed (combination of track and shovel, moving material 1 kilometre) (Department of Resources, Energy and Tourism 2013).

Table 1 - Stationary Diesel Use

Activity Data	Energy Use		Emission Factors		
			CO_2	CH_4	N_20
kL	**GJ/kL**	**GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**
5,126	38.6	197,876	69.2	0.1	0.2
			t CO_2-e	**t CO_2-e**	**t CO_2-e**
Breakdown of individual GHG emissions (t CO_2-e)			13,693	20	40
Total GHG emissions (t CO_2-e)					**13,752**

Table 2 - Extraction, Production and Distribution of Energy Purchased

Activity Data		Emission Factors		
		CO_2	CH_4	N_20
Purchased energy	**GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**	**kg CO_2-e/GJ**
Diesel	197,876	5.3	N/A	N/A
Electricity	0	47.0	N/A	N/A
		t CO_2-e	**t CO_2-e**	**t CO_2-e**
Breakdown of individual GHG emissions (t CO_2-e)			N/A	N/A
Total GHG emissions (t CO_2-e)				**1,049**

Newcastle

75 York Street
Teralba NSW 2284

Ph. 02 4950 5322

www.umwelt.com.au