Taroborah Coal Project

Appendix 25 –
Preliminary Hazard Analysis

Integrated Risk Management Plan




Taroborah Coal Project

Preliminary Hazard Analysis

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aarc AustralAsian Resource Consultants

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Author:	Michelle O'Rourke
Project Manager:	Paul Jackson
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LIST OF ABBREVIATIONS

AARC	-	AustralAsian Resource Consultants Pty Ltd
AFC	-	Armoured Face Conveyor
CPP	-	Coal Preparation Plant
EIS	-	Environmental Impact Statement
hr	-	Hour
LHD	-	Load Haul Dumps
Mt	-	Million Tonnes
Mtpa	-	Million Tonnes Per Annum
PHA	-	Preliminary Hazard Analysis
ROM	-	Run of Mine
Shenhuo	-	Shenhuo International Group Pty Ltd
TOR	-	Terms of Reference

EXECUTIVE SUMMARY

A Preliminary Hazard Analysis was conducted for the Project to identify the technical and natural hazards associated with the construction, operation and decommissioning phases of the Project.

The Project together with the associated infrastructure, hazardous materials and equipment necessary for the operation of the mine were considered during the Preliminary Hazard Analysis to determine the cumulative risk levels to surrounding land uses.

A qualitative risk analysis approach was applied to the study in accordance with Risk Management Standard 4360:2004 (Standards Australia / Standards New Zealand 2004) and HB203:2006 Environmental Risk Management Principals and Processes (Standards Australia / Standards New Zealand 2006).

Risk was determined by establishing the likelihood and consequence of each hazard. The risk was then compared against pre-established criteria and risk treatments to lessen the likelihood, negative consequences or both associated with the risk.

During the assessment 88 hazards were identified and following the application of control strategies 2 hazards remained with a high risk level, 29 hazards remained with a medium risk level and 57 hazards remained with a low risk.

The subsequent reduction in the risk levels of major hazards following the implementation of control strategies is considered appropriate with respect to the underlying nature of the Project.

1.0 INTRODUCTION

AustralAsian Resource Consultants Pty Ltd (AARC) was commissioned by Shenhuo International Group Pty Ltd (Shenhuo) to conduct a Preliminary Hazard Analysis (PHA) of the proposed Taroborah Coal Project (the Project) for inclusion in the Project's Environmental Impact Statement (EIS).

1.1 SCOPE

The PHA aims to identify all relevant major hazards both technical and natural and indicate the cumulative risk levels to surrounding land uses.

In accordance with the Terms of Reference (TOR) for the Project, the PHA will address:

- The possible frequency of potential hazards, accidents, spillages and abnormal events occurring;
- Life of any identified hazards;
- A list of all hazardous substances to be used, stored, processed, produced or transported and their rate of usage;
- Description of processes, type of the machinery and equipment used;
- Potential wildlife hazards such as snakes and disease vectors; and
- Public liability of the State for private infrastructure and visitors on public land.

1.2 DEFINITIONS

Several terms commonly used during hazard analyses have been defined by the *Risk Management Standard 4360:2004* (Standards Australia / Standards New Zealand 2004) and are provided below.

- ***Hazard*** *is a source of potential harm;*
- ***Event*** *is the occurrence of a particular set of circumstances;*
- ***Frequency*** *is a measure of the number of occurrences per unit of time;*
- ***Likelihood*** *is used as a general description of probability or frequency;*
- ***Consequence*** *is the outcome or impact of an event;*
- ***Risk*** *is the chance of something happening that will have an impact on objectives;*
- ***Control*** *is an existing process, policy, device or action that acts to minimise negative risk; and*
- ***Residual Risk*** *is the risk remaining after implementation of risk treatment.*

2.0 PROJECT DESCRIPTION

The Project will combine open-cut and underground mining operations to produce up to 5.75 Million tonnes per annum (Mtpa) of run of mine (ROM) coal and 5.73 Mtpa of product coal for export. The mine life is estimated at approximately 22 years, including a combined 18-month construction period. The proven and probable coal resource has been estimated at 202 Million tonnes (Mt).

2.1 MINING METHODS

Prior to open-cut mining, local vegetation will be cleared and the associated topsoil will be excavated and stockpiled for subsequent use in rehabilitation.

Overburden, interburden and ROM coal will be extracted from the open-cut pit via hydraulic excavators and rear dump trucks.

Some of the overburden and interburden within the open-cut pit area will require light blasting, whilst other material will require a concerted programme of blasting. Free dug and blasted material will be removed by hydraulic excavators and initially transferred via rear dump trucks to out-of-pit spoil dumps. However, once the open-cut pit is large enough, in-pit dumping will be utilised.

Longwall coal mining involves the development of a long, underground wall along the coal seam. As the coal is being mined from this coal face, the roof and overlying rock of the longwall is allowed to collapse into the void behind. A safe working space is maintained along this wall for the miners to operate the coal mining machinery via the use of hydraulic roof supports. As the mining face advances the immediate roof above the coal is allowed to collapse behind the line of roof supports forming the collapsed “goaf” material.

Since spontaneous combustion represents a significant risk for underground mining, fire barrier pillars will be left between every fourth longwall panel. In addition, mine fans will be located out of pit on the surface and connected to the main headings by a vertical shaft in order to avoid potential combustion issues which arise as a result of air leakage from around the fan portal.

2.1.1 Mining Equipment

2.1.1.1 Open-Cut Mining

Open-cut spoil extraction will be conducted via 550 t hydraulic excavators loading 190 t rear dump trucks. Once overburden has been removed, open-cut coal mining will be undertaken with the assistance of 160 t hydraulic excavators and 90 t rear-dump trucks.

The Project’s open-cut mining fleet has been based upon open-cut operational requirements, annual production targets (up to 2.78 Mtpa of ROM coal) and equipment productivities. The indicative mining fleet requirement, for each year of open-cut operations, is presented in Table 1 below.

Table 1 Open-Cut Operations - Indicative Mining Fleet

Equipment Description	Capacity	Maximum Operating Hours Machine / Year
Waste Mining		
Hitachi EX5500	550t, 28m^3	5,745
Coal Mining		
Komatsu PC1600	160t, 10m^3	3,186
Caterpillar 988	46t, 7m^3	5,745
Waste Haulage		
Caterpillar 789	190t	5,184
Caterpillar 777 Water Truck	78 t	4,289
Coal Haulage		
Caterpillar 777	90t	4,289
Support Plant		
Large Track Dozer	634kw	4,289
Rubber Tyred Dozer	235kw	1,814
Small Track Dozer	228kw	4,289
Large Grader	205kw	4,289

2.1.1.2 Underground Mining

Underground longwall mining operations will require the use of two continuous miners for panel development and one 300 m wide longwall system for panel extraction (primary production). The continuous miners will run in conjunction with cable shuttle cars, which haul the mined coal from the working face to the feeder / breaker at the panel conveyor boot-end. A total of 4 cable shuttle cars of 14 t capacity each are projected to be required to service the two continuous miner sections.

The longwall system will consist of a shearer for mining the coal, an armoured face conveyor (AFC) for transporting the coal off the face, 150 hydraulic roof supports behind the face, a beamed stage loader for sizing the coal from the AFC and transferring onto the panel belt conveyor, and a pump station to supply high pressure solcenic (water based hydraulic fluid) to the roof supports.

In addition to the production fleet, a number of rubber tyred vehicles will be required to support operations, including worker transports, service vehicles, load haul dumps (LHD) (a vehicle used in underground mining) and a grader.

A summary of the indicative underground mining fleet is presented in Table 2 below.

Table 2 Underground Operations – Indicative Mining Fleet

Function & Equipment	Capacity	Maximum Operating Hours Machine / Year
Coal Mining		
Continuous Miner	10 t / min	1300
Cable Shuttle Cars	12 t	950
Feeder / Breakers	165 t / hour (hr)	1300
Longwall System	3000 t / hr	2800
Support Equipment		
Small LHD	10 t	4,200
Large LHD	55 t	4,200
Man Transport	12 persons	3,500
Service Vehicle	4 persons	3,500
Grader	85 kW	2,800

2.2 CHEMICALS

A number of chemicals will be used on site in order to assist with the coal beneficiation process some of which are listed as Dangerous Goods under the *Australian Dangerous Goods Code 7th Edition* (National Transport Commission 2011).

Chemicals will be warehoused in dry storage conditions on the Project site. The estimated annual consumption of chemicals stored is presented in Table 3 below.

Table 3 Estimated Annual Consumption of Chemicals

Chemical	Total Annual Consumption
Flocculent	25,000 kg (OC) – 15,000 kg (UG)
Coagulant	10,000 kg (OC) – 5,000 kg (UG)
Magnetite	315,000 kg (OC) – 165,000 kg (UG)
Detonators, primers, boosters, cord	11,250 kg (OC only)
ANFO: Explosives, Blasting, Type B: Or agent, Blasting Type B	4,050,000 kg (OC only)
C1 Combustible liquids – Diesel	15,750,000 L (OC) – 4,500,000 L (UG)
C2 Combustible liquids – Petroleum distillates, Petroleum & N.O.S Products, N.O.S	160,000 L (OC) – 50,000 L (UG)
Solcenic	27,000 L (UG only)
Other Chemicals	
Natural Gas – methane, compressed natural gas	
Acetylene (Acetylene, Dissolved)	
Paint related Materials	
Oxygen (compressed)	

* OC – Open-cut / UG - Underground

3.0 HAZARD AND RISK ANALYSIS

The PHA was undertaken by members of AARC, using a group brainstorming approach with technical information and Project design details provided by Shenhuo.

The hazard assessment involved consultation with the Department of Community Safety, Queensland Fire and Rescue Service, Queensland Police Service and Queensland Ambulance Service in addition to the Department of Transport and Main Roads (DTMR), members of the Central Highlands Regional Council (CHRC) and the Department of Environment and Heritage Protection to gain an understanding of the scope of the impacts that may affect associated stakeholders.

This PHA used qualitative analysis to obtain a general indication of the level of risk associated with each phase of the Project (construction, operation and decommissioning) and to reveal the major risk issues.

In the essence of qualitative analysis, words were used to describe the magnitude of potential consequences and the likelihood that those consequences will occur. Risk was analysed by combining consequences and their likelihood, taking into account existing controls.

The way in which consequences and likelihood have been expressed and the ways in which they are combined to provide a level of risk is described in Section 3.1.

3.1 METHODOLOGY

The qualitative risk analysis performed in association with the Project was undertaken in accordance with *Risk Management Standard 4360:2004* (Standards Australia / Standards New Zealand 2004) and *HB203:2006 Environmental Risk Management Principals and Processes* (Standards Australia / Standards New Zealand 2006).

The qualitative risk analysis framework adopted during the PHA is provided in Table 4 (qualitative measures of consequence), Table 5 (qualitative measures of likelihood) and Table 6 (qualitative risk analysis matrix).

These scales have been adapted to suit the circumstances and descriptions applied to each event associated with the Project.

Once the level of risk was determined, risks were then compared against pre-established criteria and risk treatments to lessen the likelihood, negative consequences or both associated with the risk.

Table 4 Qualitative Measure of Consequence

Level	Descriptor	Environmental Impacts	Legal	Public / Media Attention	Financial Impact
1	Catastrophic	Significant extensive detrimental long term impacts on the environment, community or public health. Catastrophic and / or extensive chronic discharge or persistent hazardous pollutant. Damage to an extensive portion of aquatic ecosystem. Long term impact on water resource.	Licence to operate likely to be revoked or not granted.	Probable public or media outcry with national / international coverage. Significant green NGO campaign.	>$million
2	Major	Off-site release contained with outside assistance. Short to medium term detrimental environmental impact off-site or long term environmental damage on-site.	May involve significant litigation and fines. Specific focus from regulator.	May attract attention of local and state media and local community groups.	$500,000 - $1 million
3	Moderate	Onsite release contained with outside assistance. Significant discharge of pollutant, a possible source of community annoyance. Non persistent, but possible widespread damage to land. Damage that can be remediated without long term loss or very localised long persistent damage.	Probably serious breach of regulation. Possible prosecution and/or fine. Significant difficulties or delays experienced in gaining future approvals.	May attract attention from local media, heightened concern by local community.	$50,000 – $500,000
4	Minor	On site release immediately contained without outside assistance. Ongoing or repeat exceedances of odour, dust or noise / vibration limits.	Minor on the spot fines or formal written correspondence from regulator.	Local community attention or repeated complaints.	$5,000 – $50,000
5	Insignificant	Negligible environmental impact. Minor transient release of pollutant including odour, dust and noise / vibration.	No serious breach of regulation. Minor licence non-compliances.	Local landholder verbal discussion / complaint.	Less than $5,000

Source: Modified from *Environmental Risk Management – Principles and Process. HB 203:2006* (Standards Australia/Standards New Zealand, 2006).

Table 5 Qualitative Measures of Likelihood

Level	Descriptor	Example	Frequency
A	Almost certain	Is expected to occur in most circumstances	> Once per year
B	Likely	Will probably occur in most circumstances	Once per year
C	Possible	Could occur	Once every 5 years
D	Unlikely	Could occur but not expected	May happen within Project life
E	Rare	Occurs in only exceptional circumstances	Not likely to happen within Project life

Source: Modified from *Environmental Risk Management – Principles and Process. HB 203:2006* (Standards Australia/Standards New Zealand, 2006).

Table 6 Qualitative Risk Analysis Matrix

Likelihood	Consequences				
	1 Catastrophic	2 Major	3 Moderate	4 Minor	5 Insignificant
A - Almost certain	E	E	E	H	H
B - Likely	E	E	H	H	M
C - Possible	E	E	H	M	L
D - Unlikely	E	H	M	L	L
E - Rare	H	H	M	L	L

Source: Modified from *Environmental Risk Management – Principles and Process. HB 203:2006* (Standards Australia/Standards New Zealand, 2006).

Legend:

E = Extreme risk; immediate action required.

H = High risk; senior management attention needed.

M = Moderate risk; management responsibility must be specified.

L = Low risk; manage by routine procedures.

The raw data pertaining to the PHA are provided in Appendix A. The following sections provide a summary of the hazards and subsequent risk levels associated with the Project, during the construction, operation and decommissioning phases.

3.2 HAZARDS

During the PHA, 88 technical and / or natural hazards were identified which could pose a risk to the environment, people, property or surrounding land uses.

The following sections outline the hazards associated with the Project during the construction, operation and decommissioning phases of the Project.

3.2.1 Construction Hazards

Construction of the Project will involve the transport of equipment, materials and machinery, clearing of vegetation and the construction of infrastructure on site. Associated with these activities are the following hazards:

- Transport, storage, handling and use of chemicals and dangerous goods;
- Operation of both light and heavy vehicles;
- Water storages;
- Exposure to sources of heat, pressure, electricity; and
- Contact with potentially harmful wildlife (e.g. snakes).

3.2.2 Operational Hazards

In addition to those hazards identified during the construction phase of the Project, activities occurring during the operations or production phase of the Project are primarily associated with coal mining. Rehabilitation will also begin progressively throughout the operations stage, as areas become available. The major hazards associated with operational activities include the following:

- Interaction with mine structures such as the mined pit, regulated dams, Coal Preparation Plant (CPP), ROM stockpiles, spoil dumps, conveyor and truck loading etc.
- Use of and potential contact with explosives; and
- Operation and interaction of light and heavy vehicles, machinery and equipment.

3.2.3 Decommissioning Hazards

Further rehabilitation activities will occur during the decommissioning phase of the Project and similar hazards will exist throughout this phase such as the interaction with machinery and equipment and contact with potentially harmful wildlife. Additional hazards unique to the decommissioning phase of the Project will include the dismantling and removal of infrastructure from the site.

3.3 RISK ASSESSMENT

Initially, the likelihood and associated consequence value (refer to Section 3.1) was determined for each hazard associated with the Project to qualify the level of risk associated with each event.

Prior to the application of control strategies 19 hazards were assigned an extreme risk rating, 52 hazards were assigned a high risk rating, 10 hazards were assigned a medium risk rating and seven were assigned the low risk rating.

Following the application of control strategies all extreme risks were eliminated and many other risk categories were reduced. The remaining residual risk categories associated with the hazards identified on the Project include 2 high risks, 29 medium risks and 57 low risks.

Table 7 below indicates the hazards assessed during the PHA which were assigned a high risk rating in addition to the associated control measure applied to reduce the initial level of risk associated with each hazard.

Table 7 Hazards Associated with a Residual High Risk Level

Hazard	Potential Impact	Control Measure
Vehicle collision with person or vehicle	Personal injury	Site procedures
Crushing from dismantling and removal of infrastructure	Death or injury	Operational procedures, training, emergency response, first aid

Table 8 below indicates the hazards assessed during the PHA which were assigned a medium risk rating in addition to the associated control measure applied to reduce the initial level of risk associated with each hazard.

Table 8 Hazards Associated with a Residual Medium Risk Level

Hazard	Potential Impact	Control Measure
Land clearing	Loss of flora and fauna	Detailed flora/fauna studies in design/planning phase, progressive rehabilitation and biodiversity offsets
Fumes from blasting	Odour nuisance	Correctly designed shots, quality blasting products and blasting clearance zones
Coal and waste loading affecting pit stability	Wall failure	Geotechnical studies undertaken, engineered pit design, exclusion zones, ROPS on vehicles
Leachate drainage from spoil dumps	Land contamination	Progressive rehabilitation, dirty water containment, surface water/groundwater monitoring programme
	Surface water contamination discharge off site	Progressive rehabilitation, dirty water containment, surface water monitoring programme

Hazard	Potential Impact	Control Measure
	Groundwater contamination	Progressive rehabilitation, dirty water containment, /groundwater monitoring programme
Spoil dump slop stability	Dump failure	Engineered spoil dump design
Noise emission from ROM stockpile	Noise nuisance	Noise attenuation on equipment and adequate compensation of affected sensitive receivers
Dust emission from ROM stockpile	Dust nuisance	Dust suppression spraying, adequate compensation of affected sensitive receivers
Surface water runoff / erosion from ROM stockpile	Land contamination	Site dirty water containment system, final rehabilitation
In-pit rejects storage	Groundwater contamination	Groundwater studies, monitoring piezometers, low permeability, selective placement of spoil
	Surface water contamination	Rejects capped below surface level, Cover and progressive rehabilitation, dirty water containment, surface water/groundwater monitoring programme, engineered design
Regulated dam overflow	Surface water contamination	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer, progressive rehabilitation. Dirty water containment on-site
Regulated dam pipeline rupture	Land contamination	Pipelines protected from vehicles, daily inspections, regular pipeline maintenance, engineering design
	Surface water contamination	Pipelines protected from vehicles, daily inspections, regular pipeline maintenance, engineering design
	Groundwater contamination	Pipelines protected from vehicles, daily inspections, regular pipeline maintenance, interception trench and pump back system
Regulated dam wall failure	Land contamination	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer, engineered spillway
	Surface water contamination	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer, engineered spillway
	Groundwater contamination	Engineered Dam design,

Hazard	Potential Impact	Control Measure
		operational procedures in place, regular inspections, annual engineering inspection by registered engineer, engineered spillway
Failure of rehabilitation	Erosion	Monitoring of rehabilitation, assess failure mechanisms, rework rehabilitation based on amended strategy, rehabilitation design including sediment control structures
Bushfires	Loss of habitat, loss of fauna species	Fire breaks around lease boundaries, maintained annually. Fire extinguishers in all vehicles, adequate water supplies and training for firefighting. Site water trucks with firefighting capabilities, slashing and cleaning around ignition sources
Surface water runoff/erosion from flooding	Surface water contamination	Site dirty water containment
	Land contamination	Site dirty water containment, final rehabilitation, contaminated land assessment and remedial action such as removal of soil
Dam overflow from flooding	Land contamination	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer, progressive rehabilitation
	Surface water contamination	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer, progressive rehabilitation. Dirty water containment on-site
Destructive winds from cyclones	Infrastructure collapse	Engineered infrastructure design, regular inspections by registered engineer, emergency procedures
Disease from harmful wildlife	illness	Staff induction, safety awareness, emergency response, first aid, immediate medical attention
Bite from harmful wildlife	Illness, injury, possible death	Staff induction, safety awareness, emergency response, first aid, immediate medical attention, anti-venom

3.4 CONCLUSION

Managing risks involves identifying hazards proactively rather than reactively, effective communication and efficient implementation of control strategies.

The PHA identified 88 hazards. Following the implementation of control strategies the following risk levels were associated with the identified hazards associated with the Project:

- 0 Extreme;
- 2 High;
- 29 Medium; and
- 57 Low.

Although risk is inherent in all aspects of the Project, with appropriate systematic management of hazards, risks can be reduced to an appropriate standard.

The subsequent reduction in the risk levels of major hazards following the implementation of control strategies during the PHA is considered appropriate with respect to the underlying nature of the Project.

4.0 REFERENCES

National Transport Commission 2011 Australian Code for the Transport of Dangerous Goods by Road and Rail, Seventh Edition, Incorporating Corrigendum 1. Commonwealth of Australia. Melbourne Victoria.

Standards Australia / Standards New Zealand 2006, *Handbook 203:2006 3rd edition, Environmental risk management – Principles and Process.*

Standards Australia / Standards New Zealand 2004, *Australian/New Zealand Standard Risk Management*, AS/NZS 4360:2004.

Appendix A Preliminary Hazard Analysis

Source of Risk			No Control Strategies In Place				Control Strategies In Place			
Environmental Aspect / Hazard	**Incident / Event**	**Potential Impact**	**Consequence**	**Likelihood**	**Risk Rating**	**Management Strategy**	**Consequence**	**Likelihood**	**Risk Rating**	**Additional Mitigation Strategies Required**
Closure of local roads surrounding the Project and upgrade of a T intersection at the Capricorn Highway to access the mine	Noise emission	Noise nuisance	4	C	M	Community consultation / works only undertaken during daylight	4	D	L	
	Dust emission	Dust nuisance	4	C	M	Works only undertaken in daylight hours. Dust suppression	4	D	L	
	Changes to road network	Nuisance to local residents	4	A	H	Provide alternate access	4	D	L	
Clearing/Topsoil Stripping	Noise emission	Noise nuisance	4	A	H	Only undertaken in daylight hours, adequate compensation of affected properties	5	E	L	
	Dust emission	Dust nuisance	4	A	H	Haul road watering, speed limiting, adequate compensation of affected properties	5	E	L	
	Land clearing	Loss of flora and fauna	3	A	E	Detailed flora/fauna studies in design/planning phase, progressive rehabilitation and biodiversity offsets	3	D	M	
	Land clearing	Soil Erosion	4	B	H	land clearing immediately ahead of mining activities, installation of sediment control measures, contour banks	4	D	L	
Blast	Noise emission	Noise nuisance	3	A	E	Community consultation on blast times, noise-minimising blast designs, warning alarm for blasts, control and only during day shift, adequate compensation of affected sensitive recievers	4	D	L	
	Dust emission	Dust nuisance	3	B	H	Community consultation, blast design, adequate compensation of affected sensitive recievers	4	D	L	
	Vibration	Vibration nuisance	3	B	H	Community consultation on blast times, vibration minimising blast designs, warning alarm for blasts, control and only during day shift, adequate compensation of affected sensitive recievers	4	D	L	
	Fume	Odour nuisance	3	B	H	Correctly designed shots, quality blasting products and blasting clearance zones	3	E	M	
	Airblast Overpressure	Overpressure nuisance	3	A	E	Community consultation on blast times, noise-minimising blast designs, warning alarm for blasts, control and only during day shift, adequate compensation of affected sensitive recievers	4	D	L	
	Noise emission	Noise nuisance	3	A	E	Noise attenuation on equipment and adequate compensation of affected sensitive recievers	4	D	L	
	Dust emission	Dust nuisance	3	B	H	Dust suppression spraying, adequate compensation of affected sensitive recievers	4	D	L	

Coal/waste Loading	Spills of fuel	Land contamination	4	A	H	Bunding compliant with AS1940, Spill procedure in place, removal of contamination material, automatic shut off of fuel system in the event of spill	5	C	L	
	Pit stability	Wall failure	2	C	E	Geotechnical studies undertaken, engineered pit design, exclusion zones, ROPS on vehicles	3	D	M	
Road Transport/Haul ROM and Waste	Noise emission	Noise nuisance	3	A	E	Noise attenuation on equipment and adequate compensation of affected sensitive recievers	4	D	L	
	Dust emission	Dust nuisance	3	A	E	Dust suppression spraying, land purchase of affected properties	4	D	L	
	Spills of fuel	Land contamination	4	A	H	Bunding compliant with AS1940, Spill procedure in place, removal of contamination material, automatic shut off of fuel system in the event of spill	5	C	L	
Conveyor	Noise emission	Noise nuisance	4	D	L	Regular maintenance, community consultation	5	E	L	
	Dust emission	Dust nuisance	4	D	L	Dust suppression systems, wet feed plant.	5	E	L	
	Spills of coal	Land contamination	5	B	M	Dirty water containment systems, removal of contaminated land at industrial places at end of mine life	5	E	L	
Rail Transport/Haul Coal	Noise emission	Noise nuisance	4	B	H	Impacts within 60 m of train line. No sensitive receptors located within this proximity within the Project site	5	C	L	
	Dust emission	Dust nuisance	5	C	L	Water sprays to limit dust emissions fom wagons	5	D	L	
	Spills of coal	Land contamination	5	B	M	Computer controlled loading, water sprays, sediment containment systems at load out	5	D	L	
Spoil Dumps	Dust emission	Dust nuisance	3	A	E	Dust suppression spraying, progressive rehabilitation, adequate compensation of affected sensitive recievers	4	D	L	
	Leachate Drainage	Land contamination	3	C	H	Progressive rehabilitation, dirty water containment, surface water/groundwater monitoring programme	3	D	M	
		Surface water contamination discharge off site	3	C	H	Progressive rehabilitation, dirty water containment, surface water monitoring programme	3	D	M	
		Groundwater contamination	3	C	H	Progressive rehabilitation, dirty water containment, /groundwater monitoring programme	3	D	M	
	Slope stability/mass failure		3	C	H	Engineered spoil dump design	3	E	M	
	Spontaneous Combustion	Burning Stockpile	3	C	H	Maintain short retention time, coal stockpile compaction, emergency response crew on site	4	D	L	

ROM stockpile	Noise emission	Noise nuisance	4	B	H	Noise attenuation on equipment and adequate compensation of affected sensitive receivers	3	D	M	
	Dust emission	Dust nuisance	4	B	H	Dust suppression spraying, adequate compensation of affected sensitive receivers	3	D	M	
	Surface Water Runoff - erosion	surface water contamination	4	B	H	Site dirty water containment	4	D	L	
		Land contamination	3	C	H	Site dirty water containment system, final rehabilitation	3	D	M	
Crushing	Noise emission	Noise nuisance	3	B	H	Partially enclosed, adequate compensation of affected sensitive recievers	4	D	L	
	Dust emission	Dust nuisance	4	C	M	Partially enclosed, low dust make, sprays on ROM hopper and wet secondary and tertiary	4	D	L	
In-Pit Rejects Disposal Facility	In Pit Rejects Storage	Groundwater contamination	2	C	E	Groundwater studies, monitoring piezometers, low permeability, selective placement of spoil	3	D	M	
		Land contamination	3	C	H	Rehabilitation including engineered cap, rehabilitation monitoring, contamination land assessment and remediation	4	D	L	
		Surface water contamination	3	C	H	Rejects capped below surface level, Cover and progressive rehabilitation, dirty water containment, surface water/groundwater monitoring programme, engineered design	3	D	M	
	Dust emission	Dust nuisance	3	C	H	Progressive rehabilitation to bury rejects once cells are filled	4	D	L	
	Leaching	Groundwater contamination	2	C	E	Engineered dam design, groundwater monitoring programme	4	D	L	
		Land contamination	4	D	L	Rehabilitation including engineered cap, rehabilitation monitoring	4	D	L	
		Surface water contamination discharge off site	3	C	H	Cover and progressive rehabilitation, dirty water containment, surface water monitoring programme, all surface water contained onsite and reused	4	D	L	
	Dam Overflow	Land contamination	3	C	H	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer, progressive rehabilitation	3	E	M	
		Surface water contamination	2	C	E	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer, progressive rehabilitation. Dirty water containment on-site	3	D	M	
		Groundwater contamination	3	C	H	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer	4	D	L	

Regulated Dams	Dam pipeline rupture	Land contamination	3	B	H	Pipelines protected from vehicles, daily inspections, regular pipeline maintenance, engineering design	3	D	M	
		Surface water contamination	3	B	H	Pipelines protected from vehicles, daily inspections, regular pipeline maintenance, engineering design	3	D	M	
		Groundwater contamination	3	C	H	Pipelines protected from vehicles, daily inspections, regular pipeline maintenance, interception trench and pumpback system	3	D	M	
	Wall failure	Land contamination	3	C	H	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer, engineered spillway	3	E	M	
		Surface water contamination	2	C	E	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer, engineered spillway	3	E	M	
		Groundwater contamination	3	C	H	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer, engineered spillway	3	E	M	
	Erosion of embankments / spillway	Sedimentation of waterways	4	B	H	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer, engineered spillway, dirty water containment	4	D	L	
Bulk Storage of Diesel, Chemicals	Spills - whole tank ruptured	Land contamination	3	C	H	Bund all chemical/hydrocarbon storages to AS 1940.	4	E	L	
		Surface water contamination	3	C	H	Bund all chemical/hydrocarbon storages to AS 1940.	4	E	L	
		Groundwater contamination	3	C	H	Bund all chemical/hydrocarbon storages to AS 1940.	4	E	L	
	Minor spills during refuelling - 50 - 100 litres	Land contamination	4	A	E	Procedures, training and spills clean-up kits.	5	C	L	
Sewage Disposal - sewage treatment plant	Discharge/overflow	Land contamination	4	C	M	Daily checks of plant. Weekly monitoring and trained operators. Suitable spray irrigation system employed	4	D	L	
		Surface water contamination	4	C	M	Daily checks of plant. Weekly monitoring and trained operators. Suitable spray irrigation system employed	4	D	L	

		Groundwater contamination	4	D	L	Daily checks of plant. Weekly monitoring and trained operators. Suitable spray irrigation system employed	4	E	L	
Workshops/wash down pads	Spills	Land contamination	3	C	H	Concrete pads at the workshop, grease oil trap separators on wash down pads and at workshop, spill procedure in place, emergency response procedures, bunding of oil storages at the workshop, contaminated materials storage areas	4	D	L	
		Surface water contamination	3	B	H	Concrete pads at the workshop, grease oil trap separators on wash down pads and at workshop, spill procedure in place, emergency response procedures, bunding of oil storages at the workshop, dirty water containment	4	D	L	
		Groundwater contamination	3	C	H	Concrete pads at the workshop, grease oil trap separators on wash down pads and at workshop, spill procedure in place, emergency response procedures, bunding of oil storages at the workshop.	4	D	L	
	Hydrocarbon sediment discharged through surface water runoff	Land contamination	3	B	H	Concrete pads at the workshop, grease oil trap separators on wash down pads and at workshop, spill procedure in place, emergency response procedures, bunding of oil storages at the workshop, contaminated materials storage areas, dirty water containment	4	D	L	
		Surface water contamination	3	B	H	Concrete pads at the workshop, grease oil trap separators on wash down pads and at workshop, spill procedure in place, emergency response procedures, bunding of oil storages at the workshop, dirty water containment	4	D	L	
		Groundwater contamination	4	C	L	Concrete pads at the workshop, grease oil trap separators on wash down pads and at workshop, spill procedure in place, emergency response procedures, bunding of oil storages at the workshop.	4	D	L	
		Erosion	3	A	E	Monitoring of rehabilitation, assess failure mechanisms, rework rehabilitation based on amended strategy, rehabilitation design including sediment control structures	4	C	M	

Rehabilitation	Failure of rehabilitation	Dust emission	4	B	H	Monitoring of rehabilitation, assess failure mechanisms, rework rehabilitation based on amended strategy, rehabilitation design including sediment control structures	4	D	L	
		Visual impact	4	C	M	Monitoring of rehabilitation, assess failure mechanisms, rework rehabilitation based on amended strategy	4	D	L	
Ignition sources (workshop, process plant, clearing activities)	Bushfires	Loss of habitat, loss of fauna species	3	A	E	Fire breaks around lease boundaries, maintained annually. Fire extinguishers in all vehicles, adequate water supplies and training for fire fighting. Site water trucks with fire fighting capabilities, slashing and cleaning around ignition sources	3	D	M	
Underground Mining - Longwall	Land subsidence	Residual Tension cracks	3	B	H	Tension cracks will be less than 5 m deep and a maximum width of 0.2 to 0.3 m in the worst case scenario. Surface cracks will be rehabilitated using remedial earthworks and the use of sealants if necessary.	4	D	L	
		Residual Ponding	3	B	H	Subsidence-induced ponding will be mitigated by the completion of minor remedial drainage earthworks to re-establish free drainage. Minor remedial drainage works shall ensure that subsidence does not result in hydrological changes	4	D	L	
		Loss of habitat, loss of fauna species	3	D	M	Review of biodiversity offsets following impact mitigation measures such as revegetation, remedial drainage works and remedial earthworks to rehabilitate tension cracks	4	D	L	
Operation of light and heavy vehicles, machinery and equipment	Vehicle collision with person or vehicle	Personal injury	2	C	E	Site procedures	2	D	H	
	Hydrocarbon leak from vehicle, machinery or equipment	Land contamination	4	B	H	Spill procedure in place, emergency response procedures,vehicle maintenance, equipment maintenance and machinery maintenance. log books, auditing.	5	C	L	
		Surface water contamination	4	B	H	Spill procedure in place, emergency response procedures,vehicle maintenance, equipment maintenance and machinery maintenance. log books, auditing.	5	C	L	

		Groundwater contamination	4	D	L	Spill procedure in place, emergency response procedures,vehicle maintenance, equipment maintenance and machinery maintenance. log books, auditing.	5	E	L	
Flooding	Surface Water Runoff - erosion	surface water contamination	3	C	H	Site dirty water containment	3	E	M	
		Land contamination	3	C	H	Site dirty water containment, final rehabilitation, contaminated land assessment and remedial action such as removal of soil	3	E	M	
	Dam Overflow	Land contamination	3	C	H	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer, progressive rehabilitation	3	E	M	
		Surface water contamination	3	B	H	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer, progressive rehabilitation. Dirty water conatinment on-site	3	E	M	
		Groundwater contamination	3	D	M	Engineered Dam design, operational procedures in place, regular inspections, annual engineering inspection by registered engineer. Interception trench and pumpback system	4	D	L	
Drought		Insufficient water for operations	2	D	H	Design of the water management to accommodate worst case drought scenario, emergency water supply through additional groundwater aquistion	4	D	L	
Cyclones	destructive winds (and heavy rainfall with flooding - see above)	Infrastructure collapse	1	E	H	Engineered infrastructure design, regular inspections by registered engineer, emergency procedures	3	E	M	
Dismantling and removal of infrastructure on decommissioning	Crushing	Death or injury	1	C	E	Operational procedures, training, emergency response, first aid	1	E	H	
Harmful wildlife	Disease	Illness	2	C	E	Staff induction, safety awareness, emergency response, first aid, immediate medical attention	3	E	M	
	Bite	Illness, injury, possible death	1	C	E	Staff induction, safety awareness, emergency response, first aid, immediate medical attention, anti-venom	3	E	M	




Taroborah Coal Project

Integrated Risk Management Plan

Prepared for:

Shenhuo International Group Pty Ltd

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Project Manager: Paul Jackson
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LIST OF ABBREVIATIONS

CPP	-	Coal Preparation plant
CHRC	-	Central Highlands Regional Council
ERP	-	Emergency Response Plan
HAZOP	-	Hazard Operability
HIPAPS	-	Hazardous Industry Planning Advisory Papers
IRMP	-	Integrated Risk Management Plan
km	-	Kilometre
MDL	-	Mineral development License
MIA	-	mine Infrastructure Area
Mt	-	Million tonnes
Mtpa	-	Million tonnes per annum

P&ID	-	Process and Instrumentation Diagram
QR	-	Queensland Rail
ROM	-	Run of Mine
ToR	-	Terms of Reference
WHS Act	-	Work Health and Safety Act 2011
WHS Regulation	-	Work Health and Safety Regulation 2011

1.0 INTRODUCTION

This Integrated Risk Management Plan (IRMP) has been developed in accordance with the Terms of Reference (ToR) for the Taroborah Coal Project (the Project).

The IRMP provides a holistic approach to hazard assessment and risk management for incorporation into the safety and health management systems on the Project site.

1.1 SCOPE

The purpose of the IRMP is to provide a standard to facilitate assessment of the associated risks with each phase of the Project including construction, operation and decommissioning.

The IRMP is intended as a guide to enable the Project to effectively plan and schedule risk management procedures for incorporation into the Project's safety management system. It should be used to complement appropriate guidelines to assist in risk identification and analysis.

The IRMP will describe the following processes to assist in integrated risk management at the Project site:

- Qualitative risk assessment methodology based on *AS/NZS Risk Management Standard 4360:2004* and *HB203:2006 Environmental Risk Management Principals and Processes;*

- An operational hazard analysis, fire safety assessment and emergency response plans which are to be developed during the design phase of the Project;

- A construction safety assessment which will be carried out to ensure safety during construction and commissioning; and

- Regular independent hazard audits to verify the integrity of the safety systems and that plant is being operated in accordance with design requirements.

2.0 PROJECT DETAILS

2.1 PROJECT LOCATION

The Project is located in the Bowen Basin in Queensland, approximately 22 kilometres (km) west of Emerald (refer to Figure 1) and is located entirely within the Central Highlands Regional Council (CHRC) local authority area.

Access to the Project site will be via the Capricorn Highway, which laterally dissects the Project tenement, Mineral Development License (MDL) 467, together with the Queensland Rail (QR) Central West system.

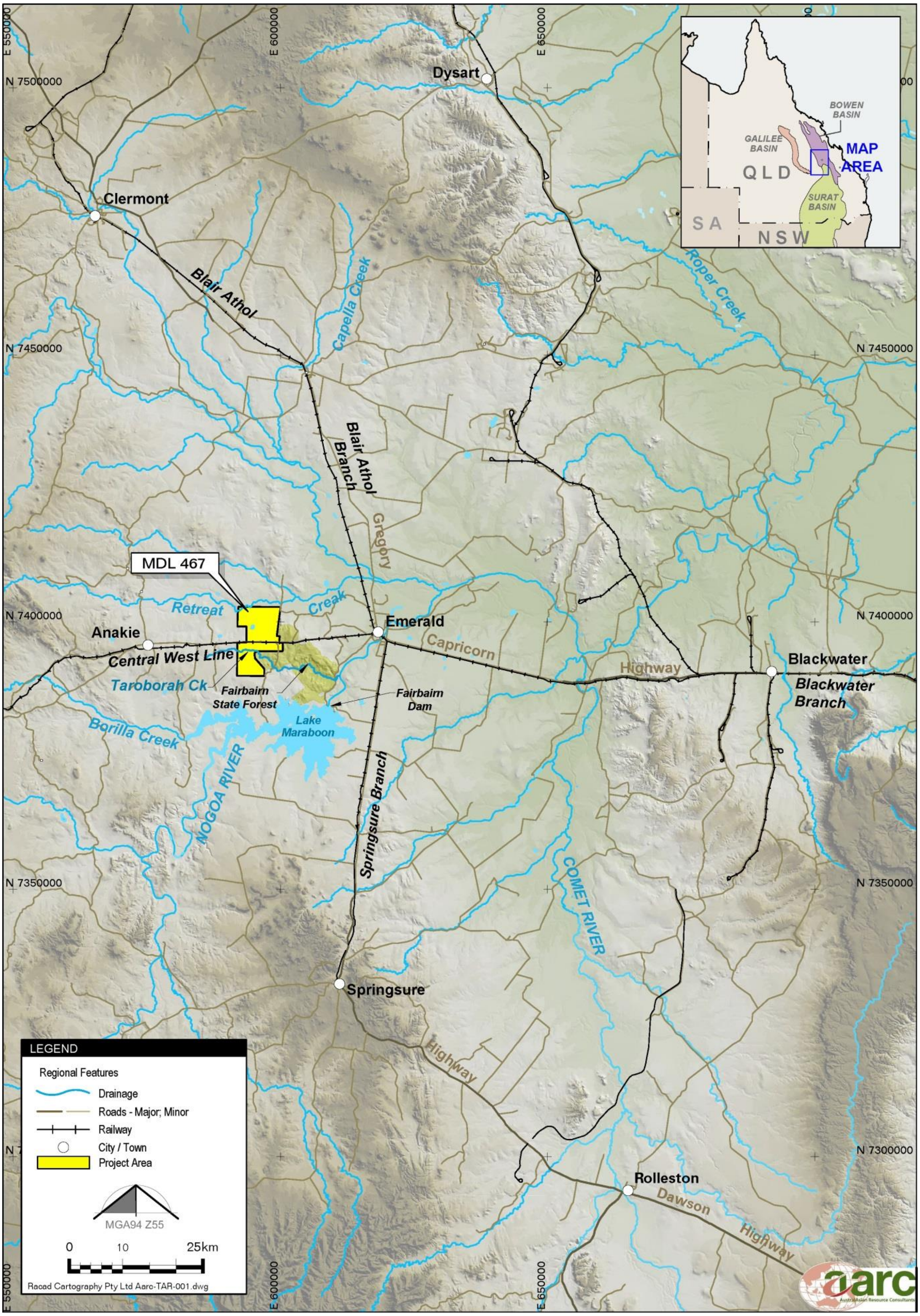


Figure 1 Local Project Location

2.2 PROJECT DESCRIPTION

The Project will combine open-cut and underground mining operations that are expected to produce up to 5.75 Million tonnes per annum (Mtpa) of run of mine (ROM) coal and 5.73 Mtpa of product coal for export. The mine life is estimated at approximately 21 years, including an initial 12 month construction period. The proven and probable coal resource in the open-cut and underground areas of this deposit has been estimated at 202 Million tonnes (Mt).

Open-cut mining will involve excavator and truck operations whereby overburden and interburden will be removed by hydraulic excavators, transferred to trucks and hauled initially to out-of-pit spoil dumps adjacent to the open-cut pit. Once mining of the pit progresses, in-pit dumping of spoil will be employed.

Underground operations will be conducted via longwall mining. The transport of underground ROM coal to the Coal Preparation Plant (CPP) will be via conveyors to the open-cut highwall. Three entries to the underground mine are planned, providing access for staff, materials, equipment, belt conveyors and ventilation.

Coal processing will involve ROM crushing, screening and washing in order to separate product coal from waste materials. Rejects produced by the CPP will be managed via a co-disposal system whereby fine rejects will be partially dewatered and coarse rejects will be dried prior to being stored in a rejects bin and then hauled and disposed of in spoil dumps.

The key features and major infrastructure associated with the Project include:

- The development of a mine for the extraction and export of thermal coal, utilising both underground and open-cut methods;
- Coal Preparation Plant;
- Workshops for maintenance of equipment, heavy vehicles and machinery;
- Offices for mine site management and employees;
- Train load-out facility and rail loop to transport export quality coal;
- Spoil dumps;
- Haul roads and site access corridors;
- Water storage and drainage features; and
- Power and telecommunications infrastructure.

Figure 2 illustrates the proposed Mine Infrastructure Area (MIA) layout.

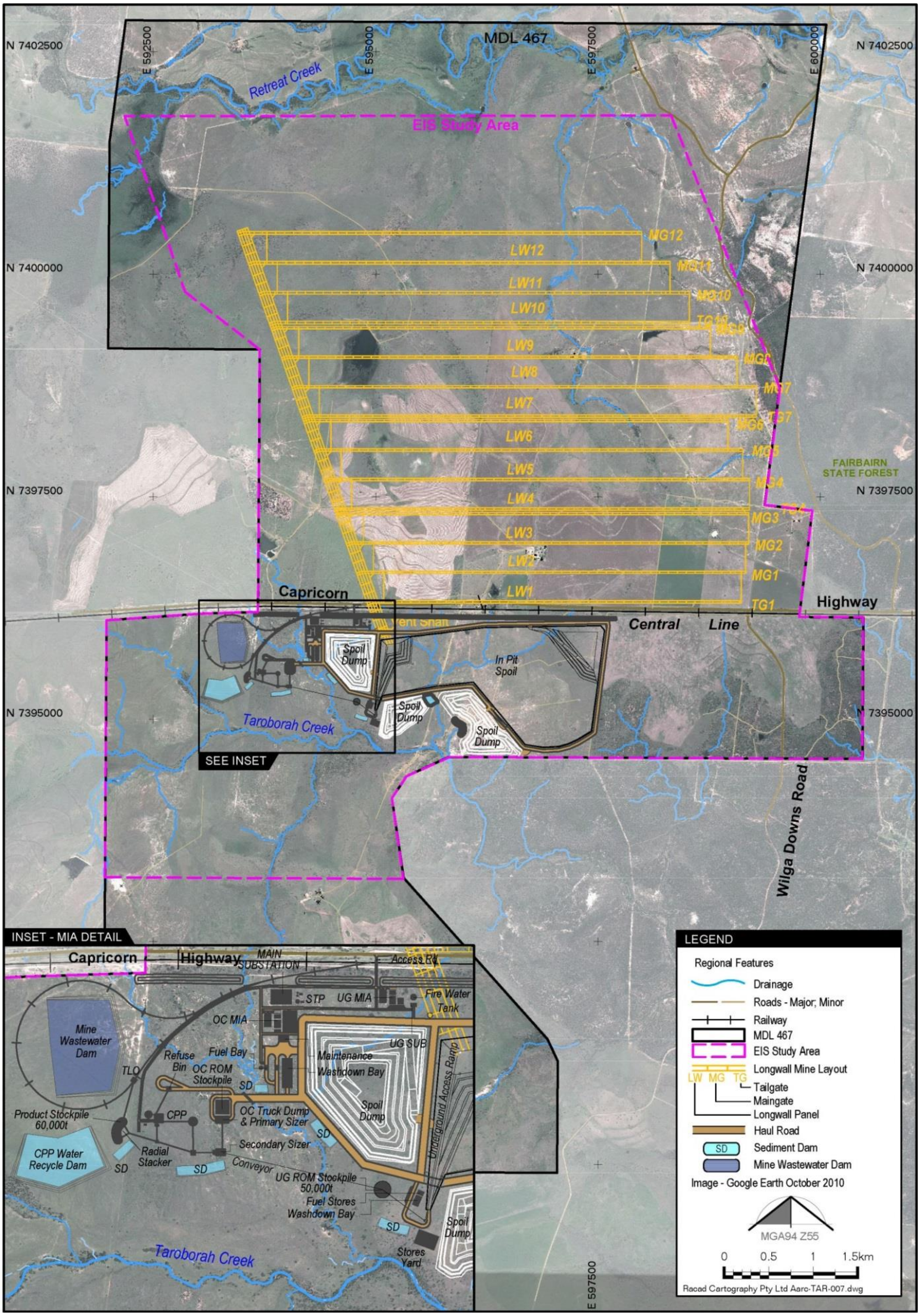


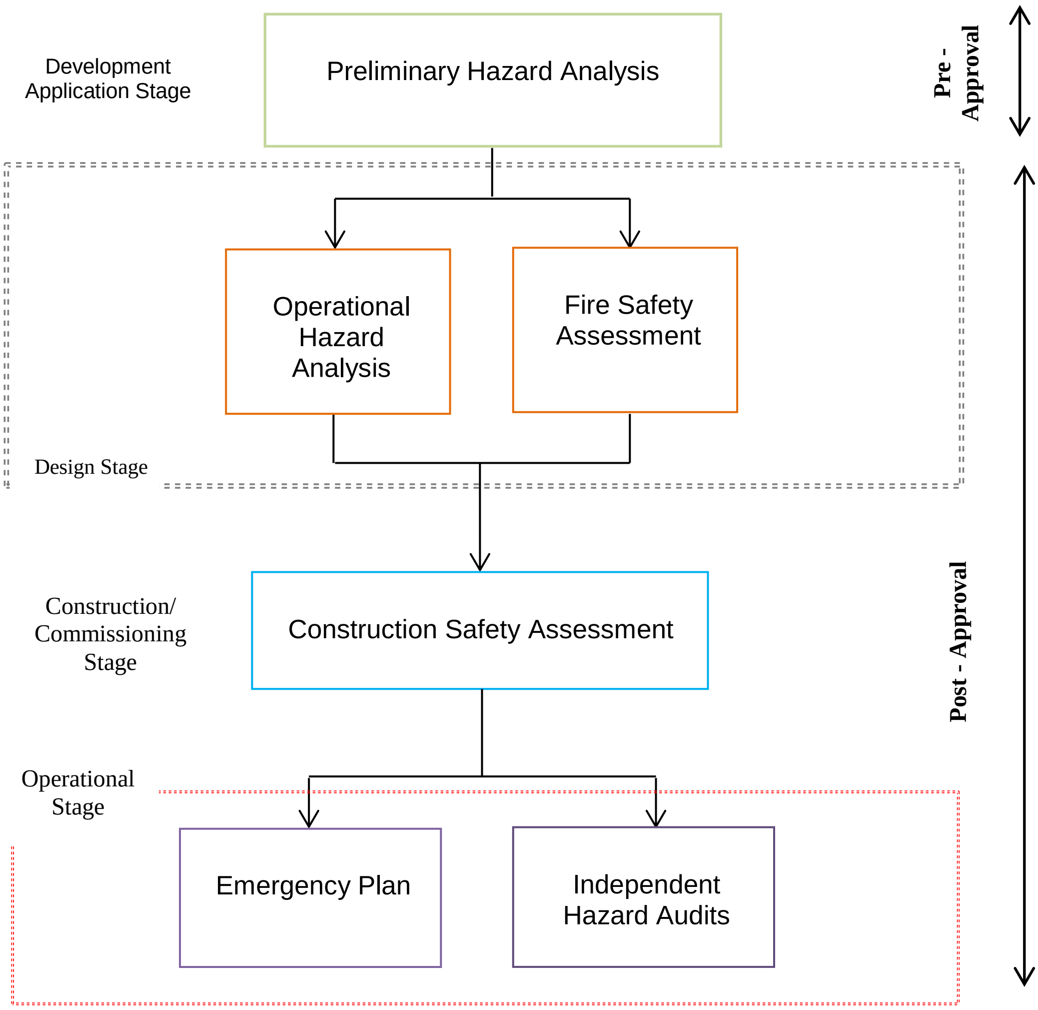
Figure 2 Mine Infrastructure Layout

3.0 INTEGRATED RISK MANAGEMENT

Integrated risk management is a process designed to ensure safety assurance of potentially hazardous projects and takes into account both technical and the broader safety implications of potentially hazardous operations.

Integrated risk management on the Project site shall be guided by a number of *Hazardous Industry Advisory Papers* (HIPAPS), published by the NSW Government Department of Planning in addition to other guidelines consistent with best practice industry standards.

Figure 3 illustrates the process of integrated risk management adopted on the Project site.



Source: Modified from NSW Department of Planning Hazardous Industry Planning Guidelines (2011)

Figure 3 Integrated Risk Assessment Process

Throughout this document, various risk analysis areas shall be outlined, many of which will require a team of trained staff to identify and evaluate existing controls in order to determine consequences and likelihood and hence the level of risk.

Initially, qualitative analysis is often used to obtain a general indication of the level of risk and to reveal the major risk issues associated with a specific task, piece of plant or scenario and should be informed by factual information and data where available. Later, however, it may be necessary to undertake more specific or quantitative analysis on the major risk issues identified (Standards Australia/Standards New Zealand 2004).

Qualitative analysis may be used:

- As an initial screening activity to identify risks that require more detailed analysis;
- Where this kind of analysis is appropriate for decisions; or
- Where the numerical data or resources are inadequate for a quantitative analysis.

In essence, qualitative analysis uses words to describe the magnitude of potential consequences and the likelihood that those consequences will occur. These scales can be adapted or adjusted to suit the circumstances, and different descriptions may be used for different risks.

Risk is analysed by combining consequences and their likelihood. In most circumstances existing controls are taken into account.

The way in which consequences and likelihood are expressed and the ways in which they are combined to provide a level of risk will vary according to the type of risk and the purpose for which the risk assessment output is to be used.

Once the level of risk has been determined, risks may be compared against pre-established criteria and risk treatments may be initiated to lessen the likelihood and / or negative consequences associated with the risk.

Qualitative risk analysis performed in association with the Project should be undertaken in accordance with *Risk Management Standard 4360:2004* (Standards Australia / Standards New Zealand 2004) and *HB203:2006 Environmental Risk Management Principals and Processes* (Standards Australia / Standards New Zealand 2006).

An example of the qualitative risk analysis framework that should be adopted during qualitative risk assessment is provided in Table 1 (qualitative measures of consequence), Table 2 (qualitative measures of likelihood) and Table 3 (qualitative risk analysis matrix). This information has been procured from *Environmental Risk Management – Principles and Process. HB 203:2006* (Standards Australia/Standards New Zealand, 2006).

Table 1 Qualitative Measures of Consequence

Level	Descriptor	Example of Impact
1	Catastrophic	Death, toxic release off-site with detrimental effect, huge financial loss
2	Major	Extensive injuries, loss of production capability, off-site release contained with outside assistance and little detrimental impact, major financial loss
3	Moderate	Medical treatment required, on-site release contained with outside assistance, high financial loss
4	Minor	First aid treatment, on-site release immediately contained, medium financial loss
5	Insignificant	No injuries, low financial loss, negligible environmental impact

Example only - the measures used should reflect the needs and nature of the organisation and activities being studied

Table 2 Qualitative Measures of Likelihood

Level	Descriptor	Description
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Could occur
D	Unlikely	Could occur but not expected
E	Rare	Occurs only in exceptional circumstances

Example only - the measures used should reflect the needs and nature of the organisation and activities being studied

Table 3 Qualitative Risk Analysis Matrix

Likelihood	Consequences				
	1 Catastrophic	2 Major	3 Moderate	4 Minor	5 Insignificant
A - Almost certain	E	E	E	H	H
B - Likely	E	E	H	H	M
C - Possible	E	E	H	M	L
D - Unlikely	E	H	M	L	L
E - Rare	H	H	M	L	L

Source: Modified from *Environmental Risk Management – Principles and Process. HB 203:2006* (Standards Australia/Standards New Zealand, 2006).

Legend:

E = Extreme risk; immediate action required.

H = High risk; senior management attention needed.

M = Moderate risk; management responsibility must be specified.

L = Low risk; manage by routine procedures.

The number of categories should reflect the needs of the study, and the ability to distinguish between categories reliably.

4.0 OPERATIONAL HAZARD ANALYSIS

An operational hazard analysis will be undertaken to identify potential hazards and operational problems in terms of plant design and human error. The technique is applied during final design of the process and plant items or when plant alterations or extensions are to be made throughout the various phases of the Project.

The operational hazard analysis will be facilitated in accordance with *Hazardous Industry Planning Advisory Paper No 8. Hazard and Operability (HAZOP) Guidelines* (NSW Department of Planning 2011a).

4.1 METHODOLOGY

The Operational Hazard Analysis uses a group brainstorming approach to systematically question every part of a process or operation to discover qualitatively how deviations from normal operation can occur and whether further design measures are required to protect the workforce from hazards.

The analysis should be led by a team utilising a diverse range of skills relevant to the facility, including the designer and the operator. A full description of the process including a Process and Instrumentation Diagram (P&ID) or equivalent should be used to systematically question every component of the infrastructure to discover how departures from operational design can occur and can give rise to hazards.

The questioning is sequentially focused around a number of guide words which are derived from general hazards. The guide words ensure that the questions posed to test the integrity of each part of the design will explore every conceivable way in which operation could deviate from the design intention.

Only those departures from normal operation that have the potential to cause harm need to be recorded for remedial action.

4.2 THE TEAM

The group carrying out the operational hazard analysis will typically consist of a team of approximately five to eight including engineers, management and staff who possess a range of relevant skills in operating plant and equipment (NSW Department of Planning 2011a).

A chairperson should be assigned to guide the analysis. The chairperson should be experienced in hazard and operational analysis techniques and be familiar with the description of the process being analysed (NSW Department of Planning 2011a).

4.3 PROCEDURE

The following procedure (represented by Figure 4) has been developed by the NSW Department of Planning (2011a) and will assist in guiding the operational hazard analysis:

a) The process designer briefly outlines the broad purpose of the section of design under study and displays the P&ID (or equivalent);

b) Any general questions about the scope and intent of the design are discussed;

c) The first relevant part of the plant is selected for study and is highlighted on the P&ID;

d) The engineer explains in detail the components purpose, design features, operating conditions, fittings, instrumentation and protective systems, etc., and details of the other components immediately adjacent;

e) Any general questions about the relevant part are then discussed;

f) The detailed 'line by line' study commences at this point. The chairperson takes the group through the guide words chosen as relevant. Each guide word or prompt identifies a deviation from normal operating conditions. This is used to prompt discussion of the possible causes and effects of the deviation. If, in the opinion of the team, the combination of the consequences and the likelihood (refer to Section 3.0 for qualitative risk assessment) of occurrence are sufficient to warrant action, then the combination is regarded as a 'problem' and recorded. If the existing safeguards are deemed to be sufficient then no further action is required. The person responsible for defining the corrective action is also nominated;

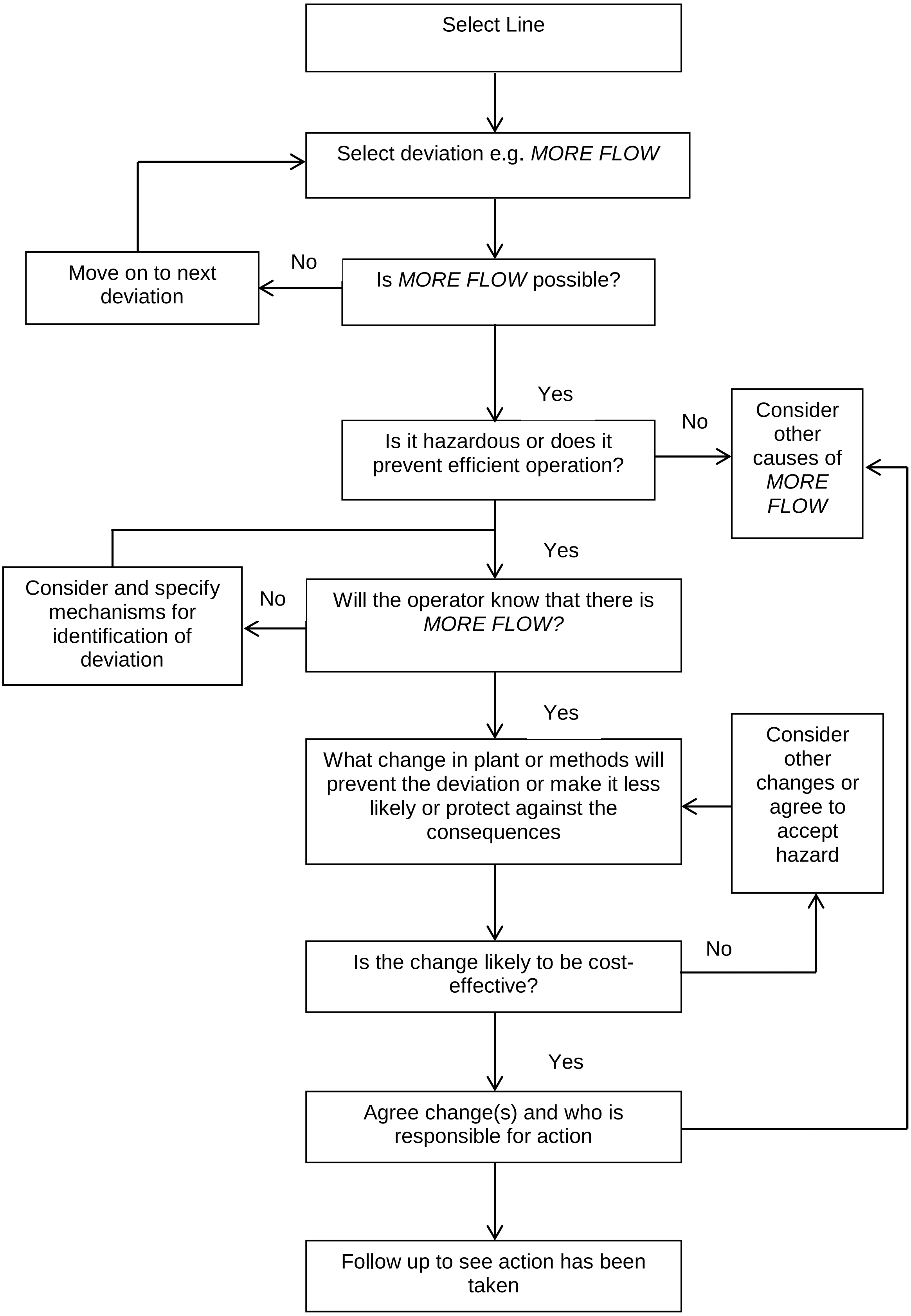
g) Do not let the study be impeded by trying to find the actual solution. The main aim of the analysis is to find problems rather than the actual solution. The study should proceed, deferring consideration of the unsolved problems to a later date;

h) When the guide word requires no more consideration, the chairperson refers the team to the next guide word;

i) Discussion of each guide word is confined to the section marked, the component at each end and any equipment in between. Any changes agreed during the analysis are recorded, and where appropriate, marked on the P&ID or layout;

j) Once all guide words have been exhausted for a particular component, the line should be highlighted to show completion; and

k) Once all the lines in a plant sub-section have been addressed, additional guide words may be used for an overview of the P&ID as a whole.



Source: NSW Department of Planning (2011a)

Figure 4 Operational Hazard Analysis Procedure Diagram

4.4 ANALYSIS REPORT

A report should be generated to demonstrate the adequacy of the operational hazard analysis carried out and to assist in future analyses of operational plant and equipment.

The report should outline the scope of the analysis and provide sufficient background information of the plant to allow the reader to understand the consequence of the findings and recommendations (NSW Department of Planning 2011a).

The report may broadly outline the hazardous scenarios considered during the study and should include specific findings, recommendations and an action plan covering all identified issues that represent a significant hazard (NSW Department of Planning 2011a).

5.0 FIRE SAFETY

A fire safety assessment should be undertaken in accordance with *Hazard Industry Planning Advisory Paper No. 2, Fire Safety Study Guidelines* (NSW Department of Planning 2011b) and should be conducted as early as possible in the detailed design stage of the Project, with modifications incorporated into the design as necessary.

The objective of the fire safety assessment is to ensure that the proposed fire prevention, detection, protection and fighting measures are appropriate for the specific fire hazard and adequate to meet the extent of potential fires for the Project.

5.1 FIRE SAFETY ASSESSMENT

The fire safety assessment should be seen as complementary to the other hazard related studies undertaken for the Project and should be specifically designed to address the needs of the Project.

The assessment of fire safety should include the following elements (NSW Department of Planning 2011b):

- Identification of fire hazards and their consequences;
- Fire prevention strategies;
- Analysis of the requirements for fire detection and protection and measures to be implemented;
- Water supply and demand for fire fighting and water containment; and
- First aid requirements for fire safety.

5.2 IDENTIFICATION OF FIRE HAZARDS

Initially, a study team will be required to identify all possible hazardous materials, processes and incidents associated with flammables and combustibles. The possible causes of these incidents should also be identified. The Preliminary Hazard Analysis and Operational Hazard Analysis should be used for guidance in the hazard identification process.

The analysis should address the type of the materials and quantities involved and the variety of hazardous events and ignition sources etc. The exposure of the site to external fire hazards should also be assessed.

An example of the fire hazard identification technique is provided in Table 4 below (NSW Department of Planning 2011b).

Table 4 Example Fire Hazard Identification Diagram

Facility / Event	Cause / Comment	Consequence	Prevention
Petroleum bund fire	• Tank corrosion • Pipe rupture	• Leakage of contents into bund, if ignited may result in bund fire	• Tanks cleaned, inspected • Adequate foam stocks on site • Alarms

Source: Modified from *Hazard Industry Planning Advisory Paper No. 2, Fire Safety Study Guidelines* (NSW Department of Planning 2011b)

5.3 CONSEQUENCE ANALYSIS

Following hazard assessment, the consequences of incidents should be estimated. These estimates will largely be drawn from previous hazard analyses conducted as part of the Preliminary and Operational Hazard Analysis but should also relate to specific time related exposures (toxic concentrations, heat flux etc.) (NSW Department of Planning 2011b).

The consequence analysis should address both the direct impacts of incidents and the potential for propagation and secondary incidents.

5.4 FIRE PREVENTION STRATEGIES

The greatest component of fire safety is prevention. Suitable design and layout of the plant and operating procedures are vital to fire prevention.

The assessment should move from the hazard identification and consequence analysis to identifying mitigation measures which minimise the likelihood of fires and / or reduce their severity (NSW Department of Planning 2011b).

Examples of matters which should be considered as part of fire prevention include (NSW Department of Planning 2011b):

- Building design (compliance with regulations);
- Minimisation of hazardous materials in storage or in process;
- Removal of ignition sources;
- Bund design, construction and capacity;
- Water storage for fire fighting etc.;
- Appropriate storage of tyres and separation of flammable materials; and
- Training.

Site upkeep including removal of wastes, regular maintenance of facilities and equipment in addition to clearing drains can be particularly important fire prevention practices that should be addressed on site.

Safe work practices, including conformance with best practice standards and the provision of material safety data sheets and company policies also have an important bearing on fire safety and should be addressed clearly during fire safety planning (NSW Department of Planning 2011b).

5.5 DETECTION AND PROTECTION MEASURES

Following assessment of fire prevention strategies, the analysis should assess fire detection and protection requirements. This should include detection of pre-conditions for fire, such as flammable atmospheric gases, and physical protection measures such as purging with inert gases of vapour spaces (NSW Department of Planning 2011b).

Issues to consider include (NSW Department of Planning 2011b):

- Prevention of fire pre-conditions;
- Detection of fire pre-conditions;
- Explosion suppression;
- Early warning systems to detect combustion, smoke and flames;
- The installation of automatic sprinkler systems, foam systems, hydrant systems and hose reel systems for fire suppression;
- The location of fire fighting equipment for intervention i.e. located in proximity to the area likely to be affected;
- Water supply systems to prevent propagation; and
- Isolation of fuel supply.

5.6 FIRE FIGHTING WATER DEMAND AND SUPPLY

Water requirements during a fire event should be based on the worst case fire scenario(s) and the anticipated foam/cooling water requirements. The calculation should consider the duration and intensity of potential fires in addition to prevention measures including plant design and nominated protection systems.

Water demand will also be influenced by choice of fire fighting media, fire rated construction, segregation (bunds) and facility layout and the analysis needs to include the effect of potentially competing demands for reticulated and static water supply (NSW Department of Planning 2011b).

Analysis of water supply will be mainly concerned with details of fire water pumps including the number of pumps and their configuration; power supply; pump details including capacity and type etc. In addition, the adequacy and availability of town water supply should be assessed, based on written advice from the local water authority. Analysis of water supply must be assessed against the calculated water demand (NSW Department of Planning 2011b).

5.7 FIRE PROTECTION AND EQUIPMENT

The provision for first aid fire protection equipment and operational arrangements must be considered in addition to fixed fire protection systems (NSW Department of Planning 2011b).

Relevant matters to be covered would include (NSW Department of Planning 2011b):

- Portable fire extinguishers - size, type, medium, number, location, testing and maintenance;
- Hose reels - number, location, type, testing and maintenance;
- Warning signs;
- Site fire crews - training, responsibilities and drills;
- Training of operators / staff - emergency action/shut down procedures; and
- Road vehicles measures – extinguishers and vehicle maintenance.

Emergency planning should consider the interaction of fire protection equipment employed on the Project site.

5.8 FIRE SAFETY REPORT

The results of the fire safety analysis should be documented initially through a Fire Safety Report and subsequently expressed through all safety related management systems via:

- Site inductions;
- Plan of Operations; and
- Emergency Response and Contingency Plans etc.

The Fire Safety Report should include the following components (NSW Department of Planning 2011b):

- A clear summary of findings and recommendations;
- A description of the plant including layout, location and processes;
- Identification of flammable materials;
- A summary of fire scenarios and their subsequent consequence;
- A description of the fire prevention and mitigation strategies employed on the Project site; and
- Details of how the fire safety system interacts to cope with the identified fire hazard scenarios.

The report should provide sufficient information on each element so that the adequacy of fire detection, prevention and mitigation can be made (NSW Department of Planning 2011b).

6.0 CONSTRUCTION SAFETY

The purpose of outlining construction safety is to facilitate a systematic approach to the identification and management of construction and commissioning hazards.

The construction phase of the Project is a critical time in ensuring the operational safety of infrastructure and is likely to present hazards which can result in significant levels of risk to surrounding land uses.

The following sections outline a systematic approach to the management of construction safety on the Project site in accordance with *Hazardous Industry Planning Advisory Paper No. 7 Construction Safety* (NSW Department of Planning 2011c) and Australian/New Zealand Standard 4360:2004 - *Risk Management*.

6.1 CONSTRUCTION SAFETY ASSESSMENT

A construction safety assessment should be carried out after Project design has been completed. The construction safety assessment will focus on construction-related hazards with the potential to affect site operations, which may in turn lead to off-site impacts, rather than on occupational health and safety issues, which are dealt with outside the integrated risk planning system.

It is the aim of the construction safety assessment to identify all hazards which are specific to construction and commissioning activities associated with the Project. The assessment should also identify the safeguards that will be put in place to ensure those hazards are controlled.

The construction safety assessment may be applied to new development and modifications and additions to existing development in addition to the decommissioning of a facility at the end of its operating life.

6.2 IDENTIFICATION OF HAZARDS

The aim of the assessment is to identify all hazards which are related to construction and commissioning activities. These may or may not have been considered as part of the Preliminary Hazard Analysis.

Hazard identification should be carried out via a brainstorming approach between technically competent people who are directly involved with the Project. Participants should first be familiarised with other safety studies, relevant operational safeguards and safety assurance arrangements to avoid omission of any critical aspects relating to the nature and history of the development (NSW Department of Planning 2011c).

The following areas should be given particular attention in the hazard identification process (NSW Department of Planning 2011c):

- Contamination;
- Hazardous materials;
- Excavation hazards;
- Interaction with continuing operations;

- Drainage arrangements;
- Extreme natural events; and
- Sequencing of commissioning activities.

In addition, all other relevant studies that have been conducted as part of the integrated risk analysis process such as the Operational Hazard Analysis, fire safety assessment and the Preliminary Hazard Analysis should be reviewed and relevant identified hazards should be incorporated into the assessment where appropriate.

6.3 CONSTRUCTION SAFETY ANALYSIS

Following hazard identification, each incident should be analysed with the aim of either eliminating the hazard or ensuring that safety precautions are in place so that the associated risks are at an acceptable level.

The first stage in this analysis should be an estimate of the consequences of the identified incidents, including the possibility of escalation. This provides a mechanism by which the identified incidents can be tentatively ranked. Those incidents considered having only minor consequences do not need to be considered in detail, however, understanding and judgement is required to identify exactly which incidents warrant further analysis.

As a guide, detailed consideration should be given to incidents (NSW Department of Planning 2011c):

- With the potential for fatalities - both onsite and offsite personnel should be considered;
- With the potential for injury at or beyond the site boundary;
- Which could result in the evolution or release of toxic gases; and
- Which could result in significant releases of flammable gases.

When an understanding is gained of the magnitude of the identified hazards, methods of dealing with them must then be developed. Ideally, the hazards should be designed out. This may be achieved through using alternative materials, equipment or techniques, or through altering the programs (NSW Department of Planning 2011c).

Where elimination of the hazard is not practicable, an assessment should be made of the adequacy of safeguards. This will involve considering the acceptability of the associated risks.

Detailed quantification of risk would not normally be necessary. In most cases it should be possible to make a qualitative judgement as to the acceptability of the risks provided participants have a solid understanding of the likelihood and consequences of the incident and are familiar with the concepts of risk analysis (refer to 3.0 for qualitative risk assessment).

Regardless of methodology adopted, where risks are considered unacceptable additional protection measures should be employed. Risks should always be minimised, regardless of assessed level, through the implementation of risk reduction techniques.

In addition, plant should not be commissioned without first commissioning and testing alarm systems (NSW Department of Planning 2011c).

6.4 CONSTRUCTION PERIOD OPERATIONAL SAFEGUARDS

Operational safeguards minimise potential risks through the establishment of precautionary measures which should form the basis of any safety management system.

As a guide, the following safety related documentation and operational safeguards should be considered for construction and commissioning activities associated with the Project (NSW Department of Planning 2011c):

- Work and entry permit systems;
- Hot work procedures;
- Isolation and tagging procedures;
- Procedures for control of onsite work by contractors;
- Access arrangements for external personnel and vehicles;
- Emergency procedures;
- Availability of materials safety data sheets for hazardous materials;
- Operating procedures for construction / commissioning activities;
- Operating procedures for adjacent plant;
- Fire safety and fire fighting arrangements;
- Incident / injury reporting systems; and
- Training / qualifications requirements.

In particular emergency procedures should be outlined within the emergency plan developed for the Project which should address all of the potential incidents identified during the construction safety (NSW Department of Planning 2011c).

Each safeguard must be clearly assigned to a responsible member of the workforce.

6.5 SAFETY ASSURANCE

To ensure that all plant associated with Project is properly built and commissioned; a systematic safety assurance system should be developed as a final check on the appropriateness of design and specification for various components of the plant.

The following key elements of the safety assurance system should be integrated into the Project's Safety Management System (NSW Department of Planning 2011c):

- Documentation - All procedures, authorisations and inspection/ certification reports must be well documented, kept in a secure location, and traceable;

- Materials of construction - Specification of construction materials should generally be undertaken as part of the design process. Systems should be in place to ensure that the materials utilised are those specified;

- Fabrication - Ensure that fabricators are equipped with adequate specifications; that qualified trades people are used; that fabrication techniques, materials, and testing and certification requirements are appropriate; and that the quality of the delivered product can be assured;

- Installation – Correct installation and dimensions, compliance with codes and standards, equipment integrity, ensure no inappropriate modifications;

- Safety review – Pre-startup safety review to ensure that all elements of the safety system are in place prior to commissioning, including hardware and software and emergency response equipment; and

- Training / Qualifications - Address the training requirements for the plant's proper construction and operation and specify the degree of expertise required.

7.0 INDEPENDENT HAZARD AUDITS

Hazard audits involve a systematic analysis of operations and safety systems. Hazard audits aim to identify any inadequacies in the measures which are in place to mitigate hazardous incidents (NSW Department of Planning 2011d).

Independent hazard audits provide assurance that the plant and operations are safe and operated at a high level of competence. In addition, hazard audits provide an opportunity to review operational procedures and safety systems to allow incorporation of further improvements where appropriate (NSW Department of Planning 2011d).

Audits are equally applicable to existing developments where they may trigger other studies such as a hazard analysis or identify the need for revision of previous studies.

7.1 HAZARD AUDIT OBJECTIVES

The aim of a hazard audit as outlined in *Hazardous Industry Advisory Paper No. 5, Hazard Audit Guidelines* (NSW Department of Planning 2011d) is to evaluate the nature and scale of hazards and the systems — both hardware and software — that are used to control these hazards.

The outcome of the audit will facilitate hazard and risk reduction measures for plant and equipment.

It is the expectation that the audit will identify previously unrecognised hazards and early recognition of below standard performance in areas such as management controls and the maintenance and testing of equipment (NSW Department of Planning 2011d).

The focus of the hazard audit will be on changes that have occurred since the completion of previous studies and audits, where these have been undertaken.

7.2 HAZARD AUDIT METHODOLOGY

Familiarisation of the Project site by the auditor should be facilitated by a site visit. During this visit the auditor will likely conduct an independent review of documentation systems established at the Project site to identify the extent to which systems and procedures exist to protect the integrity of the environment (NSW Department of Planning 2011d).

During independent hazard audits the following information will likely be required by the independent auditor for their review (NSW Department of Planning 2011d):

- For the first hazard audit - the Operational Hazard Analysis and those thereafter;
- Fire safety assessments and emergency plans and procedures;
- Monitoring records for the operation's critical safety parameters, inspection, testing and maintenance records, and analyses of hazardous incidents, accidents and near misses;
- Maintenance programs and procedures, safeguards and hazard control systems, fire safety and emergency planning and an evaluation of the quality of documentation covering these programs and procedures;
- Plant and process descriptions, preferably in documented form, along with detailed process flow diagrams;

- Complete information on all materials and chemicals being stored and processed on site, including intermediate and waste products;
- Actual operating conditions should be compared to design conditions of process equipment, storage vessels, materials transfer equipment and the quantities of hazardous materials stored, processed and transferred; and
- The adequacy of the number of operators and contractors employed on site and their training should be made.

During the audit previous hazard analyses conducted at the site will be used as a reference against which operations are evaluated, in order for the auditor to determine what changes have been implement and their effectiveness.

7.3 HAZARD AUDIT REPORTING REQUIREMENTS

Hazardous Industry Advisory Paper No. 5, Hazard Audit Guidelines (NSW Department of Planning 2011d) outlines the preferred structure of the Hazard Audit Report, so as to clearly highlight the audit findings and recommendations to management and to public authorities (where relevant).

Accordingly, the report does not need to include every detail of the audit; however the report should include (NSW Department of Planning 2011d):

- Clearly identify the purpose and scope of the audit;
- Demonstrate that the audit team is independent, appropriately qualified and experienced;
- Describe the facility, its operations and hazards in sufficient detail to provide a context for the findings and recommendations;
- Describe the audit methodology, covering both physical systems and management systems; and
- Follow up the implementation of any previous study recommendations.

It is the responsibility of management to develop an action plan specifically addressing each of the audit's findings and recommendations.

8.0 EMERGENCY RESPONSE

The workplace health and safety of personnel working at mine sites in Queensland is governed by the *Mining and Quarrying Safety and Health Act 1999* and the *Mining and Quarrying Safety and Health Regulation 2001.* These require the safety and health management systems at mines to manage risk effectively and ensure the risk of injury or illness to any person resulting from operations is at an acceptable level.

8.1 EMERGENCY RESPONSE PLAN

An Emergency Response Plan (ERP) is required to be developed under section 35 of the *Mining and Quarrying Safety and Health Regulation 2001*. Section 35 of the Regulation states that the ERP must be developed with regard to the risk management process carried out under Section 32 of the regulation as follows:

- *Prepare the mine for managing and controlling the hazards causing the emergencies;*
- *Detect emergencies;*
- *Respond appropriately to the emergencies;*
- *Coordinate control of emergencies;*
- *Give notice, information and warnings about emergencies;*
- *The immediate availability of trained rescue persons or emergency services;*
- *Locating, and accounting for persons;*
- *Controlling or re-establishing control of the hazard causing the emergency;*
- *Isolating the area of the incident, including, for example, by cutting off the supply of energy to the area of the incident;*
- *Emergency egress and evacuation, including refuges;*
- *First aid and persons trained in giving first aid;*
- *Liaising with, and using, local or state emergency services; and*
- *Backup services and facilities for the emergency.*

The *Draft Code of Practice – Emergency Response at Australian Mines* (Safe Work Australia 2011a) is an approved code of practice under Section 274 of the *Work Health and Safety Act 2011* (the WHS Act) and provides guidance on the development of the ERP.

During the development and implementation of the ERP, the site must consult with relevant persons undertaking work at the mine and local emergency services, in accordance with the *Work Health and Safety Regulation 2011* (WHS Regulation), having regard to their advice for incorporation in the ERP.

When consulting with the local emergency services, the following should be discussed (Safe Work Australia 2011a):

- What resources the local services can contribute to responding to emergencies at the mine;
- What resources the mine might need to ensure that the equipment used by the local emergency services is able to function effectively; and
- How long it will take the emergency services to respond to any emergency at the mine.

Further guidance on consultation, cooperation and coordination can be found in the *Code of Practice: Work Health and Safety Consultation, Co-operation and Co-ordination* (Safe Work Australia 2011b).

Schedule 16 of the WHS Regulation requires the following information to be included in the ERP:

- Site and hazard details;
- Command structure and site personnel;
- Notifications;
- Resources and equipment; and
- Procedures.

In addition, Schedule 16 of the *Model Work Health and Safety Regulations* (Safe Work Australia 2011c) also outlines the sspecific detail required to satisfy legislative requirements.

8.2 AUDITING

The safety management system established on the Project will need provision for the auditing of the ERP to ensure the plan is operating effectively and to ensure new information, standards and procedures are incorporated into the plan where required. In addition, the performance of the ERP should be assessed against performance standards, after each emergency or trial of the ERP (Safe Work Australia 2011a).

In accordance with the *Draft Code of Practice – Emergency Response at Australian Mines* (Safe Work Australia 2011a) mine site management should:

- Test the plan a number of times each year using mock emergencies;
- Periodically audit and review the plan;
- Conduct investigations after any emergency events;
- Regularly inspect, check and ensure that all emergency equipment is working including:
  - lifelines and other equipment;
  - breathing equipment caches and changeover stations;
  - refuge stations and other places of safety;

- fire fighting equipment;
- first aid equipment; and
- any other critical equipment contained in the plan.

- Provide regular mine rescue training for emergency response workers at the mine; and
- Recruit, train and retain sufficient emergency response workers to implement the plan.

It is essential an auditing system is established to ensure implementation of the ERP and that appropriate procedures for all identified incidents have been incorporated and procedures are developed to ensure that safeguard requirements are communicated to all relevant sections of the workforce.

9.0 REFERENCES

NSW Department of Planning 2011a, Hazardous Industry Planning Advisory Paper No. 8 HAZOP Guidelines. Sydney NSW Australia.

NSW Department of Planning 2011b, *Hazardous Industry Planning Advisory Paper No. 2 Fire Safety Study Guidelines.* Sydney NSW Australia.

NSW Department of Planning 2011c, *Hazardous Industry Planning Advisory Paper No. 7 Construction Safety*. Sydney NSW Australia.

NSW Department of Planning 2011d, *Hazardous Industry Planning Advisory Paper No. 5 Hazard Audit Guidelines*. Sydney NSW Australia.

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Standards Australia / Standards New Zealand 2006, *Handbook 203:2006 3rd edition, Environmental risk management – Principles and Process.*

Standards Australia / Standards New Zealand 2004, *Australian/New Zealand Standard Risk Management*, AS/NZS 4360:2004.