OLYMPIC DAM EXPANSION

DRAFT ENVIRONMENTAL IMPACT STATEMENT 2009

APPENDIX C
RISK ASSESSMENT

bhpbilliton
resourcing the future

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APPENDIX C

RISK ASSESSMENT

ArupRiskConsulting

BHP Billiton

Olympic Dam Development Study

Risk Assessment

FINAL REPORT

ARUP

ArupRiskConsulting

BHP Billiton

Olympic Dam Development Study

Risk Assessment

November 2008

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This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

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Abbreviations and Units

Term	Definition
AADT	Average Annual Daily Traffic
ABS	Australian Bureau of Statistics
ADG	Australian Dangerous Goods
ALARP	As Low As Reasonably Practical
AMD	Acid Mine Drainage
ARD	Acid Rock Drainage
AS/NZS	Australian Standard / New Zeeland Standard
EMP	Emergency Management Procedure
EMS	Environmental Management Systems
EWRM	Enterprise-Wide Risk Management
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
FS	Feasibility Study
FIFO	Fly-in, Fly-out
GAB	Great Artesian Basin
GHG	Greenhouse Gas
HAZOP	Hazard and Operability Study
HDPE	High Density Polyethylene
HSEC	Health, Safety, Environment and Community
ISO	International Standards Organisation
ML	Mega Litres
MLA	Mining Lease Application
MPs	Management Programs
Mtpa	Mega (million) tonnes per annum
MSDS	Material Safety Data Sheet
mSv	milli Sieverts, abbreviation for unit of radiation
OH&S	Occupational, Health and Safety
OD	Olympic Dam
ODC	Olympic Dam Corporation
PFS	Pre Feasibility Study
PPE	Personal Protection Equipment
ppm	parts per million
RA	Risk Assessment
RD	Roxby Downs
SA	South Australia
SML	Standard Mine Lease
TTTC	Take Time Take Charge
tpa	Tonnes per annum
UOC	Uranium Oxide Concentrate

WMC	Western Mining Corporation

Glossary

Term	Definition
Additive Effects	The additive effect refers to the summation of risk levels from different risk events that have a similar impact on the same receptor. A particular impact may result from several different independent risk events and the total risk faced by the receptor is the sum of all these individual risk events.
Cumulative Effects	This refers to the increase in risk levels due to other proposed projects or future projects, where these projects may also have an impact on the same receptors.
Receptor	The body or object on which a risk event has an impact. The risk assessment in this document has considered seven different receptors.
Risk	A chance of something happening that will have an impact on a receptor. Risk is measured as the combination of the consequence of an event and its likelihood.
Risk Treatment	Process of selection and implementation of measures that may include reducing, avoiding, modifying, sharing or retaining risk.
Synergistic Effects	This is where the effect of two risk events with different consequences is greater than the sum of the effects of each individual risk event.

Prefixes for Units

Quantity	Symbol	Level
Tera	T	10^{12}
Giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3} (1000)
hecto	h	10^{2} (100)
deca	da	10^{1} (10)
deci	d	10^{-1} (0.1)
centi	c	10^{-2} (0.01)
milli	m	10^{-3} (0.001)
micro	µ	10^{-6}
nano	n	10^{-9}

1 Introduction

1.1 Report Structure

The risk assessment for the Olympic Dam Expansion (ODX) Draft Environmental Impact Statement (EIS) is summarised in this report and detailed in Arup 2008.

This report describes the process undertaken and provides a summary of the results from the various individual risk assessments for each of the identified separable components of the expansion project.

Arup 2008 contains specific details of the risk assessment process, details of various calculations and the detailed risk registers.

1.2 Overview

A Draft Environmental Impact Statement (EIS) for the proposed expansion of the Olympic Dam operation at Roxby Downs in South Australia was requested by The Australian Minister for the Environment and Heritage, the South Australian Minister for Mineral Resources Development and the Northern Territory Minister for Natural Resources, Environment and Heritage.

This risk assessment is a part of the EIS process and is designed to identify the potential hazards that affect human health, the socio-cultural environment, the natural environment, as a result of the proposed expansion.

Risk assessment is a structured process designed to evaluate both the likelihood and consequence of adverse impacts that may occur as a result of exposure to one or more hazards. The level of risk is the product of the probability of that event occurring and the subsequent consequence, should that event occur.

A qualitative approach has been used to determine and analyse the risks posed by this project, referencing specific quantitative data to support various decisions.

Impacts that result from normal operations are assessed in the main body of the Draft EIS. The risk assessment will only consider unplanned conditions and variations/deviations to the normal operating conditions.

Potential incidents that may occur have been identified through a hazard analysis process that systematically analysed and considered the hazards, threats and/or potential release trails, noting the mechanisms which could trigger the release of the hazard with subsequent impacts on human safety and the environment.

Where appropriate, the risk assessment process considered existing and planned control and mitigation measures, including occupational health and safety management practices, company policies and operating procedures, were considered during the risk assessment process and their effectiveness was factored in the assessment of the risk levels.

1.3 An Evolving Process

During the period July to October 2006 eleven risk workshops were convened for the proposed Olympic Dam expansion.

Following the eleven risk workshops, the Risk Assessment report was written and Revision 10 of this report was issued in February 2007 as a Final Draft. Following the issue of the Revision 10 report, as part of the review and development process for the whole project, BHP Billiton advised of some minor changes to the original project scope.

These changes required that six additional risk workshops be held (taking the total number of workshops held to seventeen). Further to this, the context or scope of some of the eleven original workshops was changed. This required a review of the risk registers to ensure the project scope as described in Chapter 5 (Description of the proposed expansion) of the

Draft EIS was appropriately assessed and in some instances the reconvening of the workshop to more thoroughly assess the risk for the revised scope additional risk workshops were reconvened to address scope changes an as such in excess of 22 risk workshops have been undertaken at the time of writing of this report.

Where there were revisions to the risk register, these have been discussed in the relevant parts of Chapter 7 of this report.

2 Scope of Work

The risk assessment has been undertaken in a manner that is focused on providing a thorough and comprehensive assessment of the risk profile of the proposed expansion to present to:

- regulatory authorities,
- BHP Billiton,
- the community and the workforce.

The risk assessment has addressed the pertinent issues detailed in the government EIS Guidelines (see Draft EIS Appendix A).

2.1 The Project

The current operation at Olympic Dam has conditional approval to produce 350,000 tonne per annum (tpa) of copper plus associated products. The Roxby Downs Indenture Ratification Act, ratified by the South Australian Parliament in 1982 and amended in 1996, represents the legal framework for the overall mine operation.

The proposed expansion of the mine anticipates a production rate of up to 750,000 tpa of copper plus associated products (this includes the export of 1.6 Mtpa of copper concentrate containing uranium via the Port of Darwin). The proposed expansion requires an EIS in accordance with Australian, South Australian and Northern Territory requirements.

This risk assessment considers the whole of the activities in relation to the proposed expansion, not just the difference or changes between the current level of activity and the final proposed level of activity.

2.2 EIS Guidelines Requirements

The broad requirements of the EIS risk assessment as per the three governments, can be seen in table 1.

EIS GUIDELINES REQUIREMENTS
• Determine the risks posed to the workforce, potentially affected communities, surrounding land users and the natural environment • Assess the hazards including radiation, process materials, tailings storage, road and rail transport, fire, blasting and security threats • Evaluate all phases of the project including construction, operations, decommission and post-closure management.

Table 1: Broad EIS risk Assessment Guidelines

This risk assessment has also incorporated the following:

- Assessed and reported all identified risk events, not just those with more significant consequences
- Assessed the adequacy and coverage of current BHP Billiton emergency management plans, policies and operating procedures and incorporated the effectiveness of these into the assessment of the risk levels

- Addressed cumulative risk levels, particularly as it might apply in a qualitative risk assessment. The risk assessment has also considered any synergistic and additive effects with regard to the individual risk items in the risk registers and across the whole of the risk registers. These are discussed in the relevant sections below.

2.3 Project Definition

During each of the risk workshops the segment of the project being analysed was defined by, amongst other things, various parameters which described the location / boundaries, size, timeframe, throughput or capacity of the activities in that segment. These parameters are listed in Chapter 7.

However, the project is in the BHP Billiton Selection Phase and the data used at the workshops may not have been fully defined or finalised or has since changed. At the time of defining these parameters for use in the workshops, values were chosen that represented the known value, the most conservative case (worst case, normally means largest credible value for parameter) or a value that represented the most optimistic value that could credibly be chosen by BHP Billiton.

As such, the risk levels identified in the workshops reflect the most conservative case (worst case) scenarios. However, it is important to note, because of the logarithmic nature of a qualitative risk assessment, a final selection of a parameter value by BHP Billiton for the project that is less than that used in the workshop does not necessarily mean the actual risk levels are lower than those noted in the risk registers. But more importantly, the use of conservative values for the parameters means the risk levels also are conservative.

In summary, because of the approach taken during the workshops, there is a level of confidence that the actual risk will not exceed the assessed and reported risk because of size or capacity issues. Also, the robustness of the process was strengthened by reviewing the project parameters for each project component and documenting the implications of such change in relevant sections of Chapter 7.

3 Olympic Dam Operations

3.1 Existing Operations

3.1.1 Summary of Current Operations

The existing operation located at Olympic Dam, includes:

- An underground mine
- Processing plant
- Tailing storage cells and evaporation ponds
- Extraction and use of water from the Great Artesian Basin (GAB)
- Operation of a fly-in/fly-out camp
- Transport of materials to site and products from site by road
- Accommodation facilities at Roxby Downs township
- Electricity provided through the National Electricity Market (i.e. the grid).

3.1.2 Existing Outputs

The current approximate levels of production and approximate size of the operation, include:

- Copper production of 235,000 tpa
- Uranium oxide production of 4,500 tpa
- Gold, 100,000 ounces per year
- Silver, 800,000 ounces per year
- 1,700 staff plus 2,450 contractors employed on site
- Roxby Downs township houses over 4,000 persons
- Average use of 35 ML/day of artesian water
- Use of 125 MW (maximum demand) of electricity

3.2 Proposed Expansion

3.2.1 Summary of Proposed Operation

The main changes envisaged in relation to the proposed expansion of the Olympic Dam operation include:

- Open pit mine (potential approximate size of 3.5 km x 4.1 km and up to 1,100 m deep)
- New and expanded processing plant
- Production (based on 60 Mtpa of mined mineralised rock) of approximately:
    - 515,000 tpa copper
    - 14,500 tpa uranium oxide concentrate
    - 700,000 ounces of gold
    - 2,100,000 ounces of silver
- Construction of desalination plant in northern Spencer Gulf plus pipeline to Olympic Dam (capacity for Olympic Dam of approximately 200 ML/day)
- Construction of rail line from Pimba to Olympic Dam
- Expansion of Roxby Downs township to approximately 10,000 people

- Construction of new/relocated air strip
- Construction of new temporary accommodation camp (fly-in/fly-out) with a capacity of up to 8,000 beds
- Construction of new power line from Port Augusta and/or construction of a 600 MW combined cycle gas fired power station at Olympic Dam and associated gas supply pipeline from Moomba
- Construction of an unloading facility (northern Spencer Gulf) and private access corridor to move preassembled modules
- Construction of sulphur unloading facility at Port Adelaide (Outer Harbor)
- Construction of a ship-loading facility at Port of Darwin and transportation of copper concentrate from Olympic Dam to Darwin via the existing rail line.

It should be noted that these values were not necessarily finalised at the time of the workshop and as such, the values used in the workshop may differ. However, care has been taken to ensure the workshops always assessed the risk based on vales not less than those finally selected by BHP Billiton.

3.2.2 Risk Assessment Structure

The risk assessment has considered all activities associated with the proposed expanded mining operation. Furthermore, because some of the design, location and capacity (sizing) decisions have not been finalised, various options for specific activities were also assessed.

To enable the activities associated with the whole of the project to be sensibly assessed they were initially broken into seventeen segments. Each segment was considered in a workshop with the risks being separately reported. These segments are:

- Transport (Operation Phase)
- Water Supply
- Construction of Hiltaba Village (i.e. construction workforce accommodation facility)
- Construction Phase
- Rehabilitation (Post Closure Phase)
- Roxby Downs Township
- Process Plant – Smelting
- Process Plant – Concentration, Tailings and Refining
- Process Plant – Hydrometallurgy
- Energy
- Mining.

As part of the project review and rationalisation process, six additional segments were added, being:

- Landing Facility
- Access Corridor (from Landing Facility to Port Augusta)
- Combined Cycle Gas Turbine Power Station
- Gas Pipeline
- Sulphur unloading and handling at Port Adelaide

- Copper concentrate export facilities including loading at Olympic Dam transportation to Darwin, shiploading and shipping.

The critical limits for the activity of the expanded mine operation as assessed for the purpose of this risk assessment included:

Mining

- 65 to 80 Mtpa open pit mineral extraction followed by in pit crushing and leading to a yield between 750,000 tpa to 1,000,000 tpa refined copper

Processing

- Single and two stage smelting operation
- Acid plant operation
- Tailing system involving no thickening
- Tailing system with thickening
- Approximately 400,000 tpa of the copper production to be converted to anodes at Olympic Dam and the rest to be exported as copper concentrate

Water Supply

- Desalination plant near Whyalla
- Option for a desalination plant at Port Pirie
- Option for a desalination plant at Port Augusta
- Secondary water supply from GAB involving the extension of Wellfield B
- Secondary water supply from local saline aquifers
- Daily production rate of approximately 200 to 220 ML
- Associated water pipeline from the desalination plant to Olympic Dam

Power Supply

- Supply of electrical power from the power network (existing and additional transmission lines)
- Construction of a new 275kV transmission line from Port Augusta to Olympic Dam
- On-site power generation – Combined Cycle Gas Turbine power station with an approximate capacity of 600 MW and additional power sources including co-generation, solar power (mainly for residential purpose)

Gas Supply

- Three pipeline route options
- Pipeline to deliver natural gas from Moomba to Olympic Dam to supply the power station (approximate annual demand of 40 PJ) and the processing plant (approximate annual demand of 5.5 PJ for furnaces)

Transport

- A new rail line between Pimba and Olympic Dam
- Port activities such as Port Adelaide and Port of Darwin
- Rail transport from Adelaide to Darwin
- Combined use of rail and road
- Intermodal facility at Port Adelaide and Pimba

Accommodation	▪ Separate contractor's camp (Hiltaba Village) ▪ Temporary accommodation associated with the construction phase such as construction of linear infrastructure ▪ Roxby Downs expansion as a conventional town
Access corridor	▪ Dedicated private corridor from the landing facility to the pre-assembly yard, near Port Augusta ▪ Use of existing roads (Stuart Highway) north of Port Augusta for transportation of pre-assembled modules (up to 800 tonnes)
Landing (berthing) facility	▪ Dedicated landing facility for barges and similar located in Northern Spencer Gulf ▪ Capability for drive-off unloading ▪ Mooring facility located in deeper water in Spencer Gulf
Sulphur	▪ Unloading at Port Adelaide ▪ Handling, storage and loading to rail wagons at Port Adelaide
Copper concentrate export facilities	▪ Loading to rail wagons at Olympic Dam ▪ Transportation of copper concentrate to Port of Darwin and temporary storage ▪ Shiploading at Port of Darwin and shipping.

The above limits for this risk assessment were reviewed during each of the risk workshops and, where increased knowledge or updated data affected these limits; this was noted during the workshop and then provided the basis for the determination of the risk levels.

In addition to participation in the workshops BHP Billiton were involved in several other aspects of the whole risk assessment process. These are further discussed in Sections 5.6 and 5.11.

Risks associated with road transport over which BHP Billiton has direct control (haulage of materials, bussing of construction workers, etc) have not been rated in the qualitative risk assessment (risk registers). The impacts from these activities have been analysed using quantitative techniques and are discussed separately in Chapter 9 and detailed in Arup 2008.

4 Review Of BHP Billiton Procedures And Policies

The BHP Billiton Group procedures and policies examined were grouped in the following six categories:

- Environment management policies
- Health, Safety, Environment and Community management standards
- Enterprise-Wide Risk Management policy
- Other BHP Billiton Group documents including:
  - Business guidelines and toolkits
  - BHP Billiton Wide guidelines
  - BHP Billiton Wide procedures
  - BHP Billiton Wide protocols
  - BHP Billiton Wide standards
  - BHP Billiton Wide toolkits

4.1 Environment Management Policies

Review of various documents indicated that the BHP Billiton Group is committed to a development program that meets the present needs without affecting the ability of future generations to meet their needs.

The policies developed by the BHP Billiton Group focus on health, safety, environment and community (HSEC) strategies aiming for Zero Harm to people, host communities, and the environment. The policies are designed to ensure that the BHP Billiton Group does not compromise the safety values and, at the same time, are seeking to address the following issues:

- promote and improve the health and safety of their workforce and the community
- identify, assess and manage the risk to the workforce, the environment and the host community
- uphold ethical business practices that meet applicable legal or other requirements
- understand, promote and uphold fundamental human rights, respecting the traditions of the Indigenous host communities and valuing cultural heritage
- set and achieve active targets to use resources such to reduce and prevent pollution
- enhance biodiversity protection by considering ecological values and land use during the construction, operation and decommission phases of a project
- engage regularly with the communities affected by the operations and take their views and concerns in BHP Billiton' s decision-making
- develop partnerships that promote sustainable development of host communities, enhance economic benefits and contribute to poverty alleviation
- provide regular review of performance and report progress.

4.2 HSEC Management Standard

The Health, Safety, Environment and Community (HSEC) Management Standard is based on a Plan-Do-Check-Act (PDCA) methodology platform that is detailed as follows:

Leadership and Accountability – highlights the fact that directors, managers, employees and contractors must understand and are required to demonstrate leadership and commitment to sustainable development and Zero Harm through effective HSEC.

Legal Requirements, Commitments and Document Control – enlists relevant legal, regulatory and other HSEC requirements that are identified and complied with and set an effective HSEC document control system in place.

Risk and Change Management – identifies health, safety, environment and community hazards and associated risks that are assessed and managed; planned and unplanned changes are identified and managed.

Planning, Goals and Targets – ensures that sustainable development is part of business planning with HSEC goals and targets established to drive continual improvement in performance.

Awareness, Competence and Behaviour – establishes a framework that ensures that employees and contractors are aware of the relevant HSEC requirements, hazards, risks and controls and that they conduct their activities in a responsible manner.

Health and Hygiene – ensures that employees and contractors are assessed for their fitness for work and are protected (along with the public) from health hazards associated with the company's operations.

Communication, Consultation and Participation – sets an effective and transparent communication and consultation with stakeholders associated with BHP Billiton's activities. Stakeholders are encouraged to participate and contribute to sustainable development through HSEC performance improvement activities.

Business Conduct, Human Rights and Community Development – intended to regulate the activities and operations to be conducted in an ethical manner that supports the fundamental human rights and respect traditional rights, values and cultural heritage, as part of the sustainable community development.

Design, Construction and Commissioning – intended to manage the HSEC risks and opportunities as an integral part of the project phases including design, approval, procurement, construction and commissioning.

Operation and Maintenance – designed to ensure that all the plant and equipment is operated, maintained inspected and tested using all systems and procedures that manage HSEC risks.

Suppliers, Contractors and Partners – intended to ensure that the contracting services, purchasing, hire of equipment and materials, and activities with partners are carried out in such way to minimize any adverse HSEC consequences and to enhance community development opportunities (where possible).

Stewardship – intended to ensure that the lifecycle HSEC impacts associated with resources, materials, processes and products are minimized and managed.

Incident Reporting and Investigation – designed to ensure that all HSEC incidents are reported and analysed and that preventive actions are taken

Crisis and Emergency Management – defines a framework for procedures and resources that effectively respond in crisis and emergency situations.

Monitoring, Audit and Review – designed to ensure that the performance of the HSEC standard is monitored, audited and reviewed to identify trends, measure progress, assess conformance and to drive continual improvement.

4.3 Enterprise-Wide Risk Management (EWRM) Policy

4.3.1 EWRM Description

This framework provides the basis for risk management to become an integral part of the process, so allowing risks to be identified and managed in a consistent and holistic manner with the goal of controlling and managing those risks to reduce the chance of the risk event occurring. The Enterprise-Wide Risk Management (EWRM) policy (January 2005) has since been superseded but it was the proprietary risk assessment standard that contributed to the EIS risk assessment. The policy comprised seven standards, including:

- Risk Rating and Ranking – Standard 1
- Risk Assessment – Standard 2
- Post-Event Analysis – Standard 3
- Risk Control Assurance – Standard 4
- Cost Benefit Analysis – Standard 5
- Risk Management Terminology – Standard 6
- Control Framework – Standard 7

The following diagram illustrates the scheme of risk management processes applied by BHP Billiton including the EWRM process.

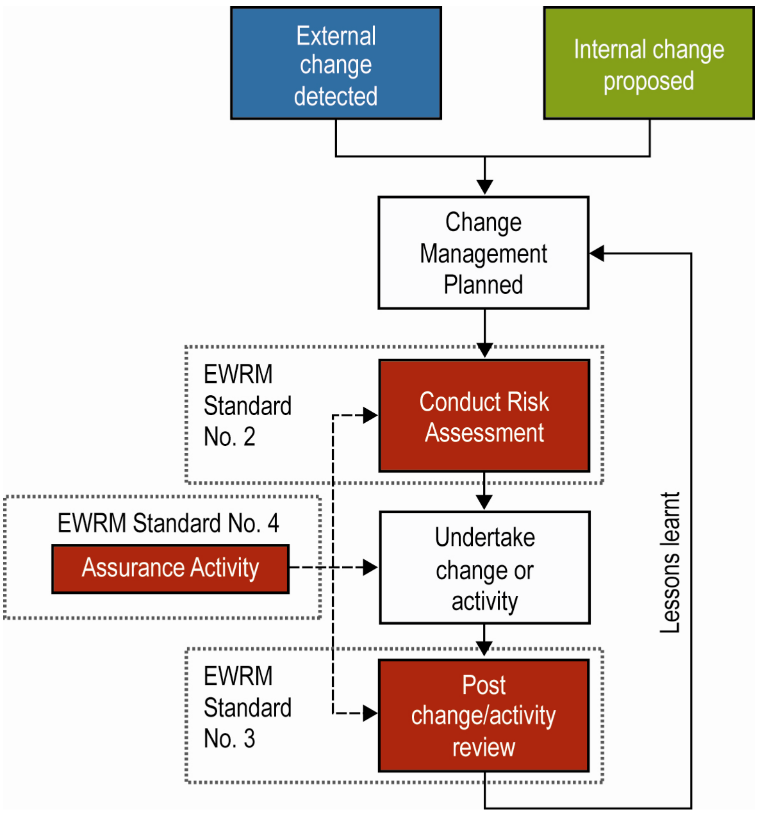

Figure 1: BHP Billiton Group Risk Management Process

4.3.2 Ongoing Risk Management

The EWRM system was a comprehensive process that allowed the BHP Billiton Group to assess the risk posed by all and any of its operations. Furthermore, the EWRM process and its proprietary replacement process aims to address the impacts on the environment, the social/cultural and heritage receptors and the health and safety. The BHP Billiton Group processes are based on AS/NZS 4360:2004, Risk Management.

Furthermore, it is understood that the BHP Billiton Group have a firm policy that all operations including any changes to the existing operations, will be subject to a risk assessment using the EWRM process. As such, there is a reasonable degree of confidence that the ongoing operation at Olympic Dam will be influenced by risk and managed in a manner to control risk and eliminate unacceptable practices.

4.4 Other BHP Billiton Documents

A very large number of standards policies and procedures have been issued by BHP Billiton to provide both general and specific operation guidelines. These documents have been classified as per the following sections.

4.4.1 BHP Billiton Business Guidelines and Toolkits

This category of standards includes the following:

Mine Road Design Manual – the manual is intended to provide design data guidelines and maintenance criteria to assist all levels of mine personnel involved in mine road construction and maintenance. A risk analysis is requested on each change to the mine road system.

Haul Road Dust Suppression Methods – this collection of Mine Operation Network documents is intended to supply information related to the methods and their effectiveness of road dust suppression systems trailed at various locations.

Mine Operation Network – Conveying vs Trucking – this document describes the approach and methods used when deciding whether to use conveyors or trucks to move material from one location to another.

Drilling Guidelines – these draft guidelines are provided to act as a catalyst when designing and conducting drill programs. This guide may be read in conjunction with the notes on geological logging, sampling and analysis and the generic drill contract, all of which are provided via the geology and resource evaluation toolkits.

Diesel Emission Management – this document is based on Australian, USA and Canadian experiences. This specification mentions a variety of methods of operator protection.

Additional Mining Specifications, mentioned below, refer to mine planning and pit design including:

- Life of Mine Planning Toolkit,
- Pit Design Procedures
- Hard Rock – Rule of Thumb
- Skin Analysis in the Selection of Final Pit Limits

4.4.2 BHP Billiton Group Guidelines

This collection of documents refers to operation guidelines and includes the following:

Confined Spaces – developed to provide enhanced understanding of the requirements of good practice pertaining to work in or around confined spaces.

Drinking Water Quality – intended to provide a guidance on the provision of drinking water on BHP Billiton sites and where supplied offsite. One of the important aspects of this document describes the need to undertake a risk assessment of the source water and understanding the hazards present in the source water from the ecology, farming activities, pesticide, animal wastes, run off from soil erosion.

Drug and Alcohol Programs – this guideline applies to all BHP Billiton controlled sites and controlled activities, and to all BHP Billiton employees, contractors and visitors.

Employee Assistance Program – intended to establish an employee assistance program to provide access to confidential, objective and skilled assistance with solving work and non-work related problems.

Energy and Greenhouse – recommended to be used as guideline for the management of energy and greenhouse performance. The document considers a reduction in greenhouse emission by monitoring of current levels of emission, improvement of energy efficiency, the introduction of alternative energy sources and communication of the importance of on emission and energy efficiency.

Equipment Safeguarding – refers to safeguarding of people from moving parts of plant, mobile machines, equipment and power tools.

Ergonomic Analysis – outlines the key factors in establishing a program for conducting ergonomic analysis of tasks using ergonomic principles and for assessing any potential health impacts.

Excavation Activities Involving Surface and/or Ground Penetration – intended to eliminate or minimise the risk of fatalities, injuries and incidents from the inadvertent rupturing of any underground or concealed power cable or other services through the adoption of proven risk management processes. This guideline forms the basis for the development of procedures, permits and detailed work practices required to meet the intent and requirements of the HSEC Management Standards and Fatal Risk Control Protocols.

Explosives – describes the use, storage, handling and initiation of explosives including packaged explosives, emulsion explosives, water gel explosives, bulk explosives, explosive boosters, detonating cords, safety fuses, electric and non-electric detonators, detonating relays, electronic detonators and any other material classed as an explosive in local legislation.

Fatigue Management Program – outlines key factors in establishing a fatigue management program to identify and assess the fatigue-related risks for a working environment, including site and external factors, and to implement a process for controlling the fatigue-related risks and their potential impact on health and wellbeing.

First Aid and Medical Management of Electric Shock – outlines key factors in establishing a fatigue management program to identify and assess the fatigue-related risks for a working environment and to implement a process for controlling the fatigue-related risks and their potential impact on health and well-being.

Guidelines for Community Development – encourages operations to incorporate community development principles into their approach when working with local communities to meet their social and physical infrastructure requirements

Guidelines for Community Relation Plan – intended to assist with planning, monitoring and evaluation of community issues.

Guidelines for Consultation and Participation Process – outlines the intent of BHP Billiton to develop appropriate strategies for open and inclusive communication and participation of stakeholders.

Hazardous Materials Management - intended to provide practical guidance on how to implement each of the requirements of the Hazardous Materials Management Fatal Risk Control Protocol.

Health Exposure Assessment – intended to outline the approach to health exposure assessment as the foundation of preventive and protective occupational health practice.

Hearing Conservation - intended to provide information on the management of noise exposures within BHP Billiton, to ensure that all potential exposures are adequately managed to minimise the potential for noise induced hearing loss in the workforce

High Voltage Isolation and Switching – intended to eliminate or minimise the risk of fatalities, injuries and incidents from the uncontrolled release of high voltage energy, through the adoption of proven risk management processes.

HSEC Risk Management – intended to cover the identification of HSEC-related risks, assessment, documentation and management in a consistent manner.

Incident Cause Analysis Management – intended to provide advice in completing incident investigations for HSEC incidents. It outlines the BHP Billiton investigation process that examines the causes and contributing factors leading to these events.

Isolation – outlines the intent and expectations for each of the requirements within the Isolation Fatal Risk Control Protocol.

Lifting Operations – intended to eliminate or minimise the risk of fatalities and injuries arising from lifting operations.

Light Vehicles – intended to provide guidance and clarity in respect of the requirements of Fatal Risk Control Protocol 1 : Light Vehicles.

Manual Metal Arc Welding – intended to eliminate or minimise the risk of fatalities, injuries and incidents from the inadvertent contact with a manual metal arc welding circuit through the adoption of proven risk management processes.

Molten Material Management – intended to provide guidance and clarity in respect of the requirements of Fatal Risk Control Protocol 6 Molten Material Management, which describes the minimum acceptable requirements for the handling and processing of molten materials or work related.

Occupational Rehabilitation Program – intended to outline key factors in establishing a program for the occupational rehabilitation and return to work of those with injuries and illnesses that are work-related and, where possible, non-work-related.

Oil Spills – this document is recommended to be used as guideline for the management and establishment of appropriate measures and response plans for oil spills.

Permit to Work – intended to eliminate or minimise the risk of fatalities, injuries and incidents arising from the uncontrolled release of energy or hazardous materials.

Personal Protective Equipment Compliance Auditing – intended to define the elements recommended in a personal protective equipment (PPE) compliance system.

Underground Ground Control – aimed to provide guidance, clarity and examples of leading practice with respect to the requirements of the Fatal Risk Control Protocol 4: Underground Ground Control

Underground Mobile Equipment – aimed to provide guidance and clarity in respect of the requirement of Fatal Risk Control Protocol 3: Underground Mobile Equipment.

Waste Emission – recommended to be used for the management of non-hazardous wastes, hazardous wastes and emissions, and that their associated risks.

Working at Heights – intended to provide guidance and clarity in respect of the requirements of Fatal Risk Control Protocol 9: Working at Heights.

4.4.3 BHP Billiton Group Procedures

The following documents are included into the BHP Billiton Group procedures category:

Occupational Exposure Limits – aimed to ensure that occupational exposure limits for personnel based on leading international knowledge and practice and that exposure data are consistently reported.

Reporting Manual – intended to detail BHP Billiton's internal HSEC reporting practices. The BHP Billiton HSEC Management Standards, in particular Standard 13 (Incident Reporting and Investigation) and Standard 15 (Monitoring, Audit and Review) are the basis for this manual.

Aircraft Travel for Teams – aimed to control the potential business impact resulting from multiple personnel travelling on the same aircraft.

4.4.4 BHP Billiton Group Protocols

The BHP Billiton Group protocol category includes:

Fatal Risk Control Protocol – reviews of past fatalities and significant incidents have identified a series of key fatal risks to operators. These risks required the development of sound practices to eliminate fatalities and incidents that could, in slightly different circumstances, cause fatalities.

Audit Protocol – intended to describe the process for conducting an audit against the requirements of the BHP Billiton HSEC Management Standards, and to assist in the preparation and execution of such audits.

4.4.5 BHP Billiton Group Standards

The BHP Billiton Group standards include:

Health, Safety, Environment and Community (HSEC) Management Standards – refer to Section 4.2 above.

Sustainable Development Policy – aimed to underline BHP Billiton's commitment to sustainable development by ensuring the viability of the business and contributing to the lasting benefits of the society through the consideration of the social, environmental, ethnic and economic aspects of their activities.

4.4.6 BHP Billiton Group Toolkits

The BHP Billiton Group toolkits include:

Fatigue Education – intended to outline key factors in establishing a framework for fatigue education to encourage informed choices on health and lifestyle that lead to ongoing fitness for duties.

Gas Awareness – intended to provide checklists to assist individuals manage risk in activities and tasks involving or close to systems containing hazardous gases.

Greenhouse Emission – intended to assist BHP Billiton sites to identify, monitor, calculate and report their greenhouse gas (GHG) emissions based on a common adopted methodology.

Hazard Identification and Qualitative Risk Assessment Approach – intended to identify and describe the steps required for conducting a qualitative HSEC risk assessment in a consistent manner. The document states that the Qualitative Risk Assessment shall be conducted in accordance with the process outlined in the HSEC Guideline : HSEC Risk Management and the following flowchart in the figure below :

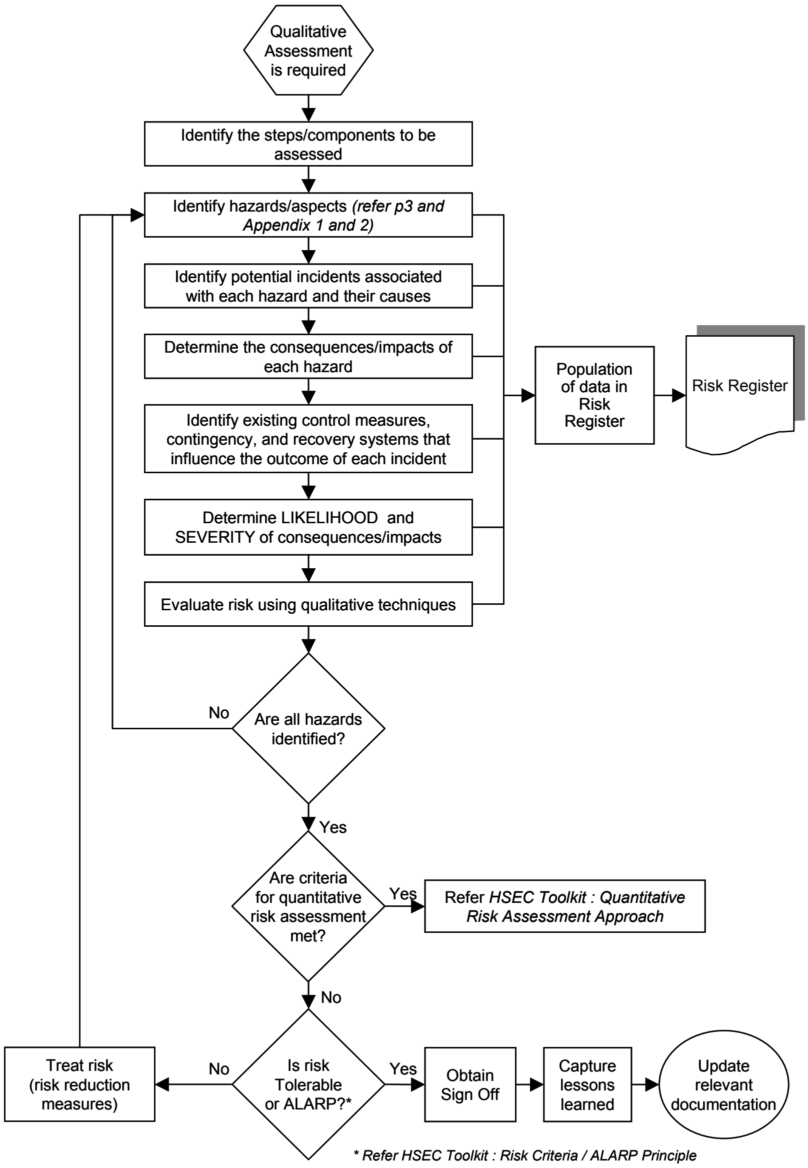

Figure 2: Diagram illustrating the BHP Billiton HSEC Qualitative Risk Assessment approach

Quantitative Risk Assessment – intended to provide a description of the general concepts and steps used when undertaking an HSEC quantitative risk analysis.

Risk Criteria ALARP Principle – this document describes the HSEC criteria for tolerability of risk and the process for demonstrating ALARP (As Low As Reasonably Practicable)

Risk Registers – intended to describe the minimum requirements for developing and maintaining HSEC risk registers. The Toolkit also describes the minimum reporting requirements that shall be applied in order to maintain the awareness of HSEC risks.

Selection Criteria for Level of Detail of Risk Analysis – aimed to provide guidance to allow the determination of the level of detail required for a risk analysis as part of the HSEC risk management process.

Task Analysis – aimed to provide a description of the process used for conducting an HSEC task analysis.

4.5 Olympic Dam Procedures

There are four categories of procedure concerning the BHP Billiton operation at Olympic Dam and they are as follows:

1. Environmental
2. Health
3. HSEC Overarching
4. Safety.

4.5.1 Environmental

The following documents are included in the Olympic Dam environmental procedures:

Environmental Management Manual 2005-2007 - serves the following three purposes:

- To fulfil BHP Billiton Olympic Dam's commitments to comply with the requirements of Clauses 10, 11 and 13 of the Roxby Downs (Indenture Ratification) Act, 1982 (the Indenture),
- To describe how the environmental requirements of the BHP Billiton HSEC Management System apply to, and are incorporated into, Olympic Dam's activities; and
- To serve as a site standard which defines Olympic Dam's minimum commitment to environmental management in accordance with AS/NZS ISO 14001 2004: Environmental Management Systems - Requirements with guidance for use (Standards Australia 2004).

Environmental Management Program 2006-2007 – this collection of documents have a role to identify, assess and manage the risks to employees, contractors, the environment and host communities posed by :

- Emissions
- Water including reduction in aquifer pressure emission
- Land disturbance due to spillage
- Flora and fauna
- Major storage dams
- Environmental management system

Internal and External Environmental Management System (EMS) Audits – performed to verify the effectiveness of the EMS to ensure that it continues to conform with the requirements of AS/NZS ISO14001:2004.

Identification and Prioritisation of Environmental; Aspects and Impacts – aimed to ensure that the identification of environmental aspects and impacts is conducted in a way consistent with the requirements of the Environmental Management System (EMS) and with section 4.3.1 of AS/NZS 14001:2004: Environmental Management Systems – Requirements.

Key Obligations for the Environmental Management Program (EMP) and Monitoring Programs (MPs) - outlines those requirements applying to BHP Billiton Olympic Dam under State Acts and Regulations and applicable licence conditions.

Management Review of the Environmental Management System – intended to describe the process of reviewing the effectiveness of the BHP Billiton Olympic Dam Environmental Management System (EMS).

4.5.2 Health

The following documents are part of the health procedures applied to Olympic Dam:

Health Services System Manual – intended to reinforce BHP Billiton's commitment to preventing all injuries and accidents in the workplace through a pro-active and comprehensive Safety Management System in conjunction with the Injury Management Team.

Injury Manual – intended to provide a framework on how Injury Management will be managed.

Management of Fitness for Work at Olympic Dam – aimed to describe the procedures for dealing with Fitness for Work issues

4.5.3 HSEC Overarching

The policies included in this section are:

Consultation Policy – intended to describe the process of consultation at Olympic Dam Corporation.

Contract Management Manual – intended to define the mandatory environment, health and safety (HSEC) requirements for the selection, induction and day-to-day management of contracts at the Olympic Dam Operations site.

Housekeeping – intended to ensure that housekeeping at Olympic Dam Corporation (ODC) complies with legal requirements and world class standards.

Management of Change Process– intended to address the following issues:

- To define the process and responsibilities associated with the management of change as applied to plant, equipment, processes, services and materials
- To ensure that all changes are implemented in a systematic and traceable manner
- To ensure change does not compromise the risk to safety, personnel health, environment, production and operation of plant.

Management of HSEC Legal and Other Obligations – intended to ensure the identification and management of all HSEC legal and other obligations pertaining to BHP Billiton Olympic Dam and to ensure compliance with the BHP Billiton Sustainable Development Policy and Olympic Dam Sustainable Development Commitment.

Occupational Health & Safety Training – outlines the processes used to identify, coordinate, deliver record and evaluate Occupational Health and Safety Training in accordance with the Occupational Health, Safety and Welfare Act, 1986 and WorkCover Exempt Employer Standards.

OH&S Internal Systems Audits – intended to describe the process used to conduct Occupational Health & Safety (OH&S) internal systems audits of the Olympic Dam Corporation Safety Management System.

Olympic Dam Sustainable Development Commitment - outlines the direction the Company wishes to take on health, safety, environment and community matters and communicates BHP Billiton's goals and principles to all levels of the organisation and the public or other stakeholders.

Risk Management – intended to describe the key processes applied to the identification of hazards and the assessment and management of risks, for all operations at Olympic Dam

Site Occupational Health & Safety Policy –outlines the company's prime objective to develop, sustain and strengthen the culture and processes that ensure the safety and health of all employees, contractors, customers and the communities.

Site Access and Security Standard – outlines the policies and procedures applied to the site access and the security procedures that were/are implemented.

Take Time Take Charge – intended to describe the process and responsibilities of the “Take Time Take Charge” (TTTC) process, where people must stop and think about the hazards and controls required to perform a job safely before they proceed with the task.

4.5.4 Safety

The policies included in this section are:

Manual Handling – intended to describe the processes used to manage manual handling activities to minimise the risk of injury while undertaking any manual handling task

Manual Metal Arc Welding – intended to minimise the risk of electric shocks being received when personnel are carrying out welding tasks

Olympic Dam Clothing Standard – intended to describe the minimum clothing standard required to work at the BHP Billiton Olympic Dam (OD) Site

Safe Use of Portable Electrical Equipment – intended to specify the requirements for safe usage of extension leads and plug in type equipment.

5 Risk Assessment Methodology

5.1 General Information

This risk assessment follows the methodology and process as set out in Australian and New Zealand Standard AS/NZS 4360:2004 Risk Management. The process followed in undertaking this risk assessment for the expansion of the Olympic Dam operation is represented in the figure below:

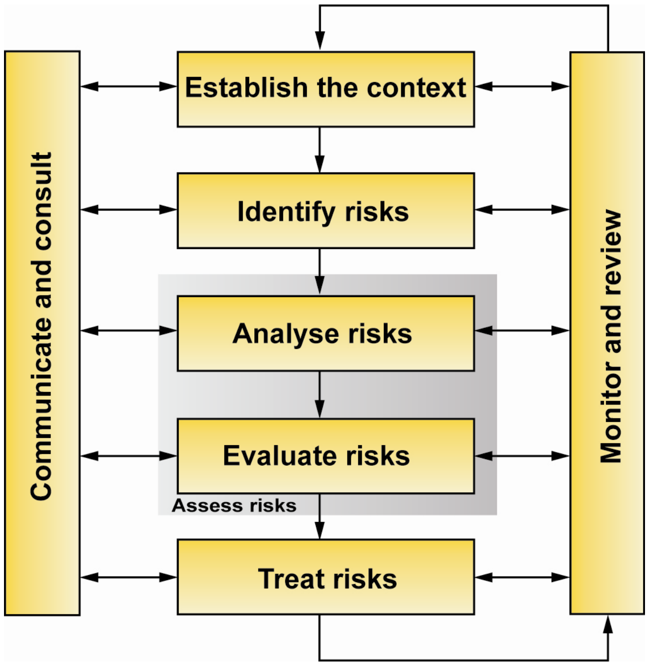

Figure 3: Australian Standard AS/NZS 4360:1999 – Risk Management

5.2 Risk Assessment Process

It was considered appropriate to use a qualitative approach to determine the risk profile posed by the Olympic Dam expansion.

Following extensive discussions with BHP Billiton it was agreed that a specific qualitative process based on the principles of AS/NZS 4360 would be developed for this risk assessment. The BHP Billiton in-house Enterprise-Wide Risk Management (EWRM) system was not used for several reasons, the main three being:

- it is semi-quantitative,
- it is structured to specifically analyse risks to BHP Billiton, and
- it does not lend itself to being used in a manner which enables evaluation against societal or community based acceptability criteria.

As such, specific look-up tables were developed for this risk assessment along with a risk matrix (see Sections 5.7 and 5.8 below) to be used with the risk register, which was structured to capture the risk in a manner that satisfies the EIS Guidelines.

The qualitative process was enhanced by reference to specific quantitative data to assist with the selection of the most appropriate frequency values, where this proved beneficial to the integrity of the overall process.

Further to this, the risk posed by transportation (of both materials and persons) was separately analysed using a wholly quantitative process. This analysis is presented separately in Chapter 9.

5.3 Risk Assessment Stages

The overall steps undertaken in this study are described as follows:

Assessment Criteria	Development of a series of validated risk matrices Develop look-up tables for consequences and frequency
Establish the Context	Segment the whole of the project into logical divisions Clearly describe the boundaries, functions and size (capacity) for each of the segments
Identify the Risks	Systematic identification of potential hazards Identification of key elements of receptors such as environmental entities, communities and cultural/heritage issues
Analyse the Risks	For each hazard identify the fault/failure mechanisms that would allow the release of the hazard Describe the resultant risk event Assess the consequences and probability of the event using look-up tables
Evaluate the Risks	Using the relevant risk matrices assess the level of risk for each event
Treat the Risks	If the risk level is unacceptable apply further control and mitigation measures Assess residual risk after the implementation of additional control measures to ensure that the risk level is tolerable
Communicate and Consult/ Monitor and Review	Being a risk assessment, as part of the EIS process, these two elements of the generally accepted risk management framework are not able to be implemented, with the exception of discussions held with BHP Billiton as part of treating the risk (see Section 5.6 below). **It is expected that as part of the implementation of this project, BHP Billiton will develop a full risk management plan based on the risks identified in the risk registers attached to this report, plus any other risks identified as part of the delivery process, and through this plan, BHP Billiton will continually monitor and review the risks to ensure they are managed in the appropriate manner.**

5.4 Workshop

Risk workshops were used to assess the risk and develop the risk register for each of the seventeen segments of the project.

These seventeen segments of the project are as follows:

1. Transport – Operation Phase (as described in Section 7.1 and Appendix C of Arup 2008)
2. Water Supply(as described in Section 7.2 and Appendix D of the Arup 2008)

3. Camp Hiltaba (Construction Camp) (as described in Section 7.3 and Appendix E Arup 2008)
4. Construction (as described in Section 7.4 and Appendix F of Arup 2008)
5. Decommissioning and Rehabilitation (as described in Section 7.5 and Appendix G of Arup 2008)
6. Township (as described in Section 7.6 and Appendix H of Arup 2008)
7. Smelting (as described Section 7.7 and in Appendix I of Arup 2008)
8. Concentration, Tailings and Refining (as described in Section 7.8 and in Appendix J of Arup 2008)
9. Hydrometallurgy (as described in Section 7.9 and Appendix K of Arup 2008)
10. Energy (as described in Section 7.10 and Appendix L of Arup 2008)
11. Mining (as described in Section 7.11 and Appendix M of Arup 2008)
12. Landing Facility (as described in Section 7.12 and in Appendix O of Arup 2008)
13. Haul corridor (as described in Section 7.13 and in Appendix P of Arup 2008)
14. Combine Cycle Gas Fired Power Generation Station (as described in Section 7.14 and in Appendix Q of Arup 2008)
15. Gas Pipeline (as described in Section 7.15 and in Appendix R of Arup 2008)
16. Sulphur Handling Facility (as described in Section 7.16 and in Appendix S of Arup 2008)
17. Copper Concentrate export facilities (as described in Section 7.17 and Appendix T of Arup 2008)

For each of these workshops a separate panel of participants was selected. The relevant experience and knowledge allowed the workshop participants to develop outcomes that were reasonable, rational and representative.

The attendance register for each workshop is presented in the relevant Appendices of Arup 2008 Report.

In addition to the persons from the team responsible for the design or implementation of that segment of the project, participants included, as appropriate, environmental and radiation specialists and BHP Billiton persons with site experience including processing, mining, site and town management, power generation and transmission, gas pipeline, water infrastructure, logistics and regional/local environment.

All workshops were facilitated by an experienced Arup risk consultant who was independent from the design teams.

Each risk assessment (workshop) followed a rigorous and structured format. This ensured the process not only followed the guidelines in AS/NZS 4360, but was consistent and provided a platform for developing a comprehensive and representative risk register.

The workshop process comprised three prime stages, being:

- Setting the context
- Identifying the hazards
- Analysing the risks.

The focus of the workshops was to identify and qualify the risk events that have an impact on the environment (including fauna, flora, land, air and water), society, health and safety. The decisions taken by the workshop participants were recorded in real time using a data projector that enabled the participants to correct and confirm the interpretation and recording.

Note that at no times during the workshop, were the risk levels displayed. It has been found by experience that knowledge of the output/results can, during the course of the workshop, influence the ongoing decision making and assessment process.

5.4.1 Context (Risk Assessment Boundaries)

Setting the boundaries for each of the risk assessments was a critical step to ensure that the whole of the project was included without gaps between the individual risk assessments.

At the commencement of each workshop the physical and operational boundaries and the capacity/size of the segment of the project being assessed were clearly defined. This included any interfaces with other operations, programme or timing issues, methods of implementation, throughput, volume and similar. A full description of these is included in Chapter 7 and the relevant Appendices of Arup 2008.

The participants clearly understood that the focus of the workshop was to identify and analyse only those risks resulting from the project that would have an impact on the community. This included the natural and built environment, the public, communities, the workforce and similar.

Risks that would only have an impact on BHP Billiton were not normally relevant and as such were not included.

5.4.2 Hazards and Fault Identification

Having established the boundaries for the risk assessment, the workshop then identified and listed the hazards that are present for the segment of the project being analysed. In most cases this list was expanded as the workshop progressed.

For each of these hazards, fault/failure mechanisms were identified. These are the means by which that hazard could impact on one or more of the receptors (health and safety, society, flora, fauna, land, water and air).

The workshop participants were encouraged to apply free thinking to test the credibility of a threat or a consequence. All identified credible hazards and risks were listed in the risk register, regardless or their perceived severity.

5.4.3 Risk Analysis

For each of the hazards and their fault/failure mechanism, the resulting risk event was then described. It should be noted that a risk event could have more than one impact (see below).

Having described the risk event, it was then assessed for its severity (or impact) and the probability that the event might occur.

The likelihood and the consequence were qualitatively assessed based on the respective look-up tables. The same Consequence and Frequency look-up tables were used throughout the whole risk assessment process in all workshops.

The assessment of the probability and consequence assumed that all existing forms of mitigation would be implemented, including:

- standard procedures and management systems embedded within in BHP Billiton (and other relevant parties),
- known contracting procedures,
- know or expected design criteria
- any other relevant actions.

These criteria were listed during the workshops and as such are expected to be incorporated in the delivery of this project. A more comprehensive list of existing control and mitigations measures is presented in Chapter 7.

5.5 Risk Evaluation

Having analysed the risks during the risk workshop, the Base Risk Levels were then determined (using the risk matrix). This process of determining the Base Risk Levels was undertaken following the completion of the workshop (see Section 5.3 above).

Events which posed an unacceptably high level of risk (i.e. ‘extreme’ risk rating - see Section 5.8 below) were noted as requiring the application of further risk management controls and mitigation measures.

5.6 Risk Treatment

For those risk events that posed an unacceptable level of risk to the environment, the community or the employees, additional control or mitigation measures were considered. These were then evaluated for their effectiveness, and based on this assessment; one or more of these was selected for inclusion.

These additional control and mitigation measures were then noted on the appropriate risk registers and the Residual Risk Level was determined noting the changes these measures made to either the frequency and/or the consequence levels.

These control and mitigation measures were then noted as being a commitment for the project.

The process of identifying and analysing various control and mitigation measures was done cooperatively with BHP Billiton. Following each risk workshop, the risk register was completed and issued as a draft to the attendees of the workshop. Note that at this stage, additional control and mitigation measures had not been considered, nor had the residual risks columns been populated. Feedback was considered and where appropriate used to amend or correct this risk register.

Following this, if required, a meeting was convened with relevant senior persons from BHP Billiton where additional controls and mitigation measures were discussed, evaluated and once accepted by BHP Billiton, included in the risk register.

This whole process ensured, as much as reasonably possible, appropriate “buy-in” of the risks by BHP Billiton and acceptance of and commitment to agreed additional control measures.

Risk events that posed a High or Moderate Risk Level (either Base or Residual Risk) were not considered further for the purposes of the risk assessment, but have been carried forward into the Draft EIS Environmental Management Programs to ensure they are monitored and managed in accordance with the principles of ALARP during the design, construction, operation and closure phases of the expansion project.

5.7 Look-Up Tables

The unique set of Consequence and Frequency look-up tables provided a consistent work platform for all workshops.

The look-up tables for frequency and consequence were developed taking into account recognised publicised information. The information was to identify, where possible, common denominators among various standards and specifications and therefore provide guidance for the development of the look-up tables for this risk assessment. A list of standards, specifications, documents and literature reviewed is included in Arup 2008.

Note that, while various reference and standards can be used to assist in the development of frequency and consequence look-up tables, it is most important that look-up tables reflect the issues pertaining to the project for which the risks are being assessed. The look-up tables used in this risk assessment were developed in consultation with experts in the various areas (receptors), taking into account the area of possible impact of this project and as such, are believed to provide a solid basis for assessing the impacts arising from a risk event.

5.7.1 Consequence Look-Up Table

Consequence is defined as the magnitude or impact of a risk event that could occur. A risk event may have multiple consequences that would affect different receptors.

The consequence look-up table is shown below and describes in words the magnitude of potential events in relation to the following receptors:

- health and safety of operators and public, including radiation impacts
- social/cultural heritage
- flora and fauna including listed species
- soil and land
- water
- air.

The consequence table was constructed in a manner such that the consequence levels or impacts are comparable across the consequence groups. This means that regardless of the receptor, a “minor” consequence means roughly the same in terms of size or impact for each of the receptors.

In addition to being roughly equivalent across the look-up table, the consequences were also structured to increase in steps of approximately an order of magnitude down the look-up table.

The table was initially compiled using data and descriptors used in other referenced risk assessments (see Appendix A of Arup 2008) which included the risk assessment for the EIS prepared for the Proposed Gorgon Development was considered.

The draft look-up table was then circulated within the core Adelaide based EIS team (see Draft EIS Appendix B for details) for comments and discussion. Changes (refinements) were then made to reflect the issues specific to this project. The table was also simplified in a few areas to enable easier use during the workshops.

5.7.2 Frequency Look-Up Table

Frequency describes how often an event would occur. The frequency look-up table, described in words, has six frequency levels based on the incidence or occurrence rate in time (return period). It also describes the probability (in %) on a chance basis and the frequency of an event occurring on project basis.

Note that the determination of frequency, as applied in this risk register, was based on an annual or per-year time period with near equivalent values developed to assist with the selection of the correct frequency level.

As for the consequence look-up table above, the frequency look-up table was developed using various published tables (see Appendix A of Arup 2008) as guides.

The table is structured as such that there is an order of magnitude between the various levels, which follows normal and accepted protocol.

It is noted that the risk events that are assigned either of the top of two frequency levels (A or B) are effectively predicted to occur, as these levels suggest the event is “expected to occur at least once each year” (frequency level B) or “expected to occur several (many) times each year” (frequency level A). These predicted events are further discussed in Chapter 10.

CONSEQUENCES LOOK UP TABLE - OLYMPIC DAM EXPANSION PROJECT

		OH&S			Flora and Fauna				Soil and Land/ Physical			Water Quality	
					Listed Flora & Fauna		General Flora & Fauna						
Category	Level	Injury and/or Fatality	Radiation Exposure	Social/Cultural Heritage	Effect on Behaviour of Fauna	Effect on Viability of Listed Species	Effect on Behaviour of Fauna	Effect on Community	Contamination	Recharge	Habitat	Ground, Surface and Marine	Air Quality
Minimal	1	No injury to the public. Minor operator injuries requiring on-site treatment with immediate release.		No impact or minor medium-term social impacts on local population. Mostly reparable.	Insignificant effect	Insignificant effect	Local short term behavioural effect	Local short term decrease in abundance of some species without reduction in local community viability	Insignificant effect	Insignificant effect	Insignificant effect	Minimal contamination or change with no significant loss of quality	Insignificant effect
Minor	2	Moderate level of injuries to the public requiring off-site (doctor) medical treatment. Injuries to one or more operators requiring offsite medical attention including moderate reversible disability.	Radiation worker >10 mSV / year but < 20 mSV in 5 year period	On-going social issues. Damage to items of cultural significance	Local short term behavioural effect	Local short term decrease in abundance with no lasting effects on local population	Local long term behavioural affect that does not unduly effect the ecology of the species	Local long term decrease in abundance of some species resulting in little or no change to community structure	Local contamination that can be immediately remediated.	Local minor change in re-charge patterns within sub-catchments	Disturbance of well-represented landform habitats	Local minor short-term reduction or change in water quality. Local contamination or change that can be immediately remediated.	Local short-term and minor surpass of air-quality standard
Moderate	3	Significant level of injuries to the public requiring hospitalization. Moderate irreversible disability or moderate impairment to one or more operators.	Public / other > 1 mSV / year but < 5 mSV in 5 year period Radiation worker >20 mSV / year but < 100 mSV in 5 year period	On-going serious social issues. Significant damage to structures/ items of cultural significance	Local long term behavioural affect that does not unduly effect the ecology of the species	Local long term decrease in abundance without reduction in local population viability	Local long-term behavioural impact that significantly affects the ecology of the species	Regional long term decrease in abundance of some species and/or local loss of some species diversity resulting in some change to the community structure.	Local contamination that can be remediated in long-term	Local major change in re-charge patterns within sub-catchments	Local loss of well-represented landform habitats	Local minor long term or widespread minor short-term, or local major short term reduction or change in water quality. Local contamination or change that can be remediated in long-term	Local minor long term or widespread minor short-term, or local major short term surpass of air-quality standard
Serious	4	Irreversible disability or impairment or serious injuries requiring long term hospitalisation to one or more public. Single operator fatality or multiple serious injuries.	Public / other > 5 mSV in 5 year period Radiation worker > 100 mSV in 5 year period	Very serious wide spread social impacts. Irreparable damage to highly valued items.	Local long-term behavioural impact that significantly affects the ecology of the species	Regional long term decrease in abundance and/or local loss resulting in some reduction in regional population viability		Regional long term decrease in abundance of numerous species and/or some loss of species diversity resulting in significant changes to community structure.	Local contamination that cannot be remediated in long-term	Widespread major changes in re-charge patterns within sub-catchments	Local loss of a unique landform habitat	Widespread (regional) major short-term reduction or change in water quality. Local contamination or change that cannot be remediated in long-term	Widespread (regional) major short-term surpass of air-quality standard
Major	5	Single public fatality. Several operator fatalities.		Breakdown of social order. Irreparable damage to highly valued items of cultural significance.		Regional long term decrease in abundance and/or local loss resulting in significant reduction in regional viability.		Regional long time loss of numerous species resulting in the dominance of only a few species	Widespread contamination that can be remediated in long-term	Regional minor changes in re-charge patterns		Regional long-term reduction or change in water quality. Widespread contamination or change that can be remediated in long-term	Regional long-term surpass of air-quality standard
Catastrophic	6	Several public fatalities. Multiple operator fatalities		Complete breakdown of social order. Irreparable damage to highly valued items of great cultural significance.		Regional extinction of the species.			Widespread contamination that cannot be immediately remediated.	Regional major changes in re-charge patterns		Widespread contamination or change that can not be immediately remediated.	

FREQUENCY LOOK UP TABLE - OLYMPIC DAM EXPANSION PROJECT

Descriptor	Level	General Description	Chance p.a.	Project Basis (Construction Phase)	Frequency	
		(a)	(b)	(c)	(d)	
Expected to Happen	***A***	This event will occur - know to always occur in similar situations *- Expected to occur several (many) times each year*	99.90%	Many times during project	1/month	More than 10 per year
Almost Certain	***B***	This event is expected to occur in most circumstances *- Expected to occur at least once each year*	>90%	At least once during project	1/year	One or more times per year
Likely	***C***	This event may occur in some circumstances *- May occur during any given year*	10%	At least once in every 10 projects	1/10 years	Once every 2 to 10 years
Possible	***D***	This event might occur at some time *- Not likely to occur in any given year, but is possible.*	1%	At least once in every 100 projects	1/100 years	Once every 11 to 100 years
Unlikely	***E***	This event could occur at some time *- Very unlikely to occur in any given year*	0.10%	At least once in every 1,000 projects	1/1,000 years	Once every 101 to 1,000 years
Rare	***F***	This event may only occur in very exceptional circumstances *- Examples of this have occurred historically, but is not anticipated*	<0.1%	At least once in every 10,000 projects	<1/1,000 years	Less than once every 1,000 years

Notes:

a. The intention is to describe the probability or frequency of an event on an annualised basis such that the impacts or exposure (risks) faced by society and the environment are recorded as those present during any given year of the life of the mine, including the construction phase.
b. The probability of an occurrence in any given year either during the construction or operations phase as appropriate
c. Relates to the number of occurrences during the construction phase
d. The frequency of an occurrence (or return period when considering natural events) during either the construction or operations phase as appropriate.

5.8 Risk Matrix

Based on the likelihood and consequence levels (as noted in the look-up tables) a single risk matrix was developed, as shown below.

A single risk matrix was appropriate for use with all the seven receptors, as the consequence look-up table had been constructed in a manner which resulted in the consequences for all the receptors at each given level (category), being approximately equal in severity or impact. The manner in which the risk matrix was constructed is further discussed in Section 5.10 below.

RISK MATRIX - OLYMPIC DAM EXPANSION PROJECT							
		CONSEQUENCE					
LIKELIHOOD		Minimal	Minor	Moderate	Serious	Major	Catastrophic
		1	2	3	4	5	6
Expected to happen	A						
Almost Certain	B						
Likely	C						
Possible	D						
Unlikely	E						
Rare	F						

5.9 Risk Rating Criteria

Four levels of risk have been used in the risk assessment (note that the use of 4 levels is common). The levels and target actions are described in the table below:

Table 2: Risk Rank and Target Action

Risk Rank	Target Action
Extreme (E)	Risk is unacceptable. Immediate action is required, activity should not start or if started must be stopped immediately; Identify and implement controls to reduce risk to a tolerable level.
High (H)	Risk is tolerable. Action is required. Identify and implement controls to reduce risk in accordance with the principles of ALARP.
Medium (M)	Risk is tolerable. Action is desirable. Identify and implement controls to reduce risk in accordance with the principles of ALARP.
Low (L)	Risk acceptable. Managed by routine processes.

Only risk events that have been assessed with a risk level of Extreme have been further considered as part of the risk assessment and have had additional control and mitigation measures applied for the purpose of this risk assessment.

Risk events with risk levels of High or Moderate must be further addressed during the design, construction, implementation and decommissioning phases of the project and should be treated in accordance with the principles ALARP. Furthermore, these risk events have been further addressed in the draft EIS Environmental Management Programs.

The reason for the focus on only the Extreme events for the risk assessment is because these are unacceptable and, as such, must be reduced to meet BHP Billiton and public expectations. All other events (High, Moderate, and Low) while still posing a risk, and therefore require management, are not deemed to represent an unacceptable level of risk.

5.10 Acceptability Criteria

The risk matrix was developed to reflect acknowledged acceptability or tolerability criteria.

The focal point on this risk matrix was established for a single public fatality (Consequence level 5). It is noted that for a public fatality the individual rate should not exceed 1×10^{-6} per year.

Assuming 10,000 persons (considered reasonable as it equates to the population of Roxby Downs and best approximates the size of other affected communities) could be exposed to a risk event, noting the individual threshold of 1×10^{-6} per year, this would suggest that any risk event with a frequency up to once every 100 years is unacceptable.

Therefore a risk event with a Consequence level of 5 is unacceptable if the frequency is A, B, C, or D.

However, to allow for additive effects, noting that a qualitative risk assessment determines acceptability or not on a line-by-line (or by individual risk events) basis, and does not sum the effects down the whole risk register, the unacceptable frequency was reduced to include level E.

This effectively means that the fatality rate had to be less than 1×10^{-7} per year to be considered not unacceptable.

However, because of the manner in which the probability of an individual fatality might be calculated, an alternative means of determining the level of unacceptability was used. This is the societal fatality rate.

Workcover, Victoria, in the Major Hazard Facilities Regulations Guidance Note "The Requirements for "Demonstration" under the Occupational Health and Safety (Major Hazard Facilities) Regulations" , MHD GN -16, January 2006, publish a Societal Risk FN Graph, which is offered as reference values.

This document suggests that a single fatality caused by major hazard facilities should not occur more often than once every 100 years.

The proposed expansion of the Olympic Dam operation may not be considered a major hazard facility and it is reasonable to assume that public acceptability with regard to a fatality would not be less (more often) than that presented in MHD GN -16.

This would therefore mean a risk event with a consequence level of 5 is unacceptable if the frequency is A, B, C or D. This is the same value as calculated using individual fatality rate.

Using this value (Frequency = E and Consequence = 5) as the boundary between the tolerable and unacceptable zones, with an E5 being unacceptable, the risk matrix was constructed.

Because both frequency and consequence advance in step of an order of magnitude, the boundary could be plotted, being risk events C3, D4, E5, and F6.

With regard to the position of the boundary for the "predicted" risk events, it was chosen based on a subjective analysis of the combination of frequencies and consequences.

Finally, a comparison between the risk matrix developed for this EIS and other published risk matrices was made (see below). It can be seen that, in general, there is a reasonable correlation between the matrices, noting the difficulty at times to make sure there was equality in the frequency and consequence scales (ensuring the values in this EIS were properly matched to the values in the model to which a comparison was being made).

It is noted that the risk matrix presented does not allow a Catastrophic (Level 6) consequence to be reduced below Extreme by the usual means of applying mitigation to reduce the frequency. This "anomaly" or variance from normal qualitative risk matrices is considered to be appropriate when the severity of a Catastrophic (Level 6) consequence is examined, being, for example, "Regional extinction of a bird species, several public fatalities, wide-spread contamination that cannot be remediated, etc."

Because of the severity of a risk event with a Level 6 consequence, it is reasoned that a qualitative approach is not accurate or robust enough to permit a lower risk level (below Extreme), and that a full quantitative analysis should be undertaken to ascertain more accurately the frequency and consequence and through this, determine if the risk event is unacceptable or not, and if not, apply mitigation, the effect of which can also be quantified.

Note that an unacceptable event was assigned to a risk level of Extreme (see Section 5.9 above).

COMPARISON between O.D. and other RELEVANT RISK MATRICES

Victorian WorkCover Guidance Note GN 14

RISK MATRIX COMPARISON			CONSEQUENCES					
			1 Minimal	2 Minor	3 Mod erate	4 Serious	5 Major	6 Catas trophic
FREQUENCY	A	10/yr						
	B	1/yr						
	C	1/10yrs						
	D	1/100 yrs						
	E	1/1000 yrs						
	F	>1/1000 yrs						

Gorgon Development EIS - 2005

RISK MATRIX COMPARISON			CONSEQUENCES					
			1 Minimal	2 Minor	3 Mod erate	4 Serious	5 Major	6 Catas trophic
FREQUENCY	A	10/yr						
	B	1/yr						
	C	1/10yrs						
	D	1/100 yrs						
	E	1/1000 yrs						
	F	>1/1000 yrs						

National Mineral Industry Guideline

RISK MATRIX COMPARISON			CONSEQUENCES					
			1 Minimal	2 Minor	3 Mod erate	4 Serious	5 Major	6 Catas trophic
FREQUENCY	A	10/yr						
	B	1/yr						
	C	1/10yrs						
	D	1/100 yrs						
	E	1/1000 yrs						
	F	>1/1000 yrs						

NSW Dept Urban Affairs MIHAP No 3

RISK MATRIX COMPARISON			CONSEQUENCES					
			1 Minimal	2 Minor	3 Mod erate	4 Serious	5 Major	6 Catas trophic
FREQUENCY	A	10/yr						
	B	1/yr						
	C	1/10yrs						
	D	1/100 yrs						
	E	1/1000 yrs						
	F	>1/1000 yrs						

Worsley Alumina EIS - 2005

RISK MATRIX COMPARISON			CONSEQUENCES					
			1 Minimal	2 Minor	3 Mod erate	4 Serious	5 Major	6 Catas trophic
FREQUENCY	A	10/yr						
	B	1/yr						
	C	1/10yrs						
	D	1/100 yrs						
	E	1/1000 yrs						
	F	>1/1000 yrs						

BHPB Poitrel Coal Mine EIS - 2005

RISK MATRIX COMPARISON			CONSEQUENCES					
			1 Minimal	2 Minor	3 Mod erate	4 Serious	5 Major	6 Catas trophic
FREQUENCY	A	10/yr						
	B	1/yr						
	C	1/10yrs						
	D	1/100 yrs						
	E	1/1000 yrs						
	F	>1/1000 yrs						

New Acland Coal Mine EIS - 2006

RISK MATRIX COMPARISON			CONSEQUENCES					
			1 Minimal	2 Minor	3 Mod erate	4 Serious	5 Major	6 Catas trophic
FREQUENCY	A	10/yr						
	B	1/yr						
	C	1/10yrs						
	D	1/100 yrs						
	E	1/1000 yrs						
	F	>1/1000 yrs						

BHPB Pyrenees Development Mine EIS - 2005

RISK MATRIX COMPARISON			CONSEQUENCES					
			1 Minimal	2 Minor	3 Mod erate	4 Serious	5 Major	6 Catas trophic
FREQUENCY	A	10/yr						
	B	1/yr						
	C	1/10yrs						
	D	1/100 yrs						
	E	1/1000 yrs						
	F	>1/1000 yrs						

5.11 BHP Billiton Commitment

BHP Billiton have been involved in the risk management process from the commencement of the engagement of Arup to undertake this task. This involvement has been:

- At the time of deciding on overall risk management approach
- During workshops
- To review the risk registers
- To identify appropriate additional mitigation measures.

As discussed in Section 5.2 above, the proposed methodology, primarily being the use of a qualitative approach using custom look up tables and associated risk register, was presented to BHP Billiton and discussed at length prior to this being adopted as the most appropriate means to properly and robustly identify and assess the risk associated with this project. These discussions were in the main with risk managers and persons knowledgeable in the application of risk as a management tool.

Relevant persons from BHP Billiton were present at all workshops, with the risk champion for the project being present at almost all workshops, so ensuring a degree of consistency throughout the whole process.

All risk registers were issued, initially as drafts, to relevant persons, including participants of the workshops to ensure they properly recorded the outputs from the workshop. Once the risk registers were finalised, it is understood the data is being used to populate the BHP Billiton ongoing project risk management systems.

Where risk events were identified as posing an unacceptable level of risk, these were discussed with BHP Billiton personnel at separate meetings. The presence of more senior persons at these meetings ensured that any additional control and mitigation measures identified as being effective in reducing the risk levels would be accepted by BHP Billiton and therefore could reasonably be assumed to be included in the design and delivery of the proposed expansion project.

6 Existing Control and Mitigation Measures

6.1 Approach

Various control and mitigation measures were considered during each of the risk workshops and factored into the assessment of the risk levels.

These are noted in each of the risk registers and compiled into a single, comprehensive list in Section 9.1.

It should be noted that the approach adopted during the risk workshops was to consider all existing control and mitigations measures applicable to each specific risk event, even if these control measures were not specifically noted against that event in the Risk Register.

6.2 List of Control and Mitigation Measures

Existing controls and mitigation measures that were identified during the course of the workshops and factored into the assignment of the risk levels included:

OH&S Equipment

- Personal protection equipment (PPE), including gas analysers and gas detection equipment (personal, portable, stationary, etc)
- Installed oxygen analysers fitted with alarm
- Testing for gases on regular basis (i.e acetylene)
- Additional protective equipment used in hazardous locations such as acid plant, smelting and refining
- Provision of full time emergency services at Olympic Dam
- Enforcement of safe working practices
- Provision of adequate safety measures for electrical equipment, working at height, confined spaces and other hazardous work conditions
- Implementation of Fatal Risk Control protocols for light vehicles, surface mobile equipment, underground ground control, hazardous materials and molten material management

Operation

- Monitoring of radiation exposure
- Housekeeping activities
- Enforcement of policies and procedures for management of hazardous materials including chemical, fuels, explosives, molten materials.
- Effective contractor management
- Material safety data sheets (MSDS)
- Pond management
- Environment Protection Authority - trade waste processes
- Application of strict clearance procedures
- Provision of adequate ventilation, dust extraction and standard dust control and operating procedures for enclosed spaces
- Implementation of appropriate stock management system, shed design, buffer zones

- Provision of pril, fogging, dust extraction systems
- Provision of dust suppression systems
- Contractors required to remove all inert recyclable waste on site
- Provision of emergency response procedures, contentment procedures
- Provision of blast-proof, separation distance, barriers
- Provision of safe working procedures, compliance with explosive legislation, geotechnical evaluation of tunnel condition pre and post blast
- Provision of adequate traffic management and follow BHP Billiton procedures
- Follow AQIS inspection procedures for barges and other ship vessels

Design and Community activities

- Housing pods will be built sequentially allowing a learning process, knowledge of the existing market
- Implementation of traffic control measures
- Recreational facilities
- Design for storage capacity at the pump station. Provide telemetry system and alarm to warn a failure, standby pump

Design and construction of a full range of recreation activities

- Implementation of security measures
- Construction of bunded storage tanks, reservoirs and general storage facilities for hazardous liquids such as fuels, acids and reagents used in the metallurgical process
- Appropriate design and construction of the new facilities
- Adequate geotechnical design and site survey before commissioning of any activities
- Application of conservative modelling strategies (especially for noise and dust)
- Standard design, manufacture and installation practices using standard engineering solutions
- Fitting of dust extractors in enclosed locations that generate dust

Environment

- BHP Billiton policies for environment protection
- Appropriate washdown procedures
- Provide daily inspection and rescue operations of fauna in open trenches
- Design to include recovery of spill
- Provision of appropriate shoring /benching of trenches, ponds, etc,
- Compliance with relevant EPA requirements
- Identification of items of significance, such as mound springs, Aboriginal settlement areas and other heritage included areas prior

	to finalising design
	▪ Provision of fencing along above-ground installations such as compressor/pump stations, assembly yards, intermodals and other storage areas
	▪ Recycle materials, lubricants, where practicable
	▪ Undertake modelling, hydro-geology testing, depressurising bores
	▪ Design of capping layer to minimise wind scour
Standards	▪ Compliance with the Australian Dangerous Goods (ADG) for transport of all hazardous goods
	▪ Compliance with all applicable Australian (and other) Standards
Design of plant and equipment	▪ The use of HAZOP (and equivalent procedures) where relevant
	▪ Design in accordance with standards
	▪ Provision of adequate guarding, anchor points
	▪ Design for correct capacity
	▪ Design to include environment and climate considerations, including any specific state regulations (i.e. SA, NT, etc)
	▪ Design for low velocity intake water pipeline
	▪ Engage a conservative nature of the modelling, safe working procedures
	▪ Provision of protection in the electrical supply system, cable bridges, standard operating procedures for areas around chemical storage facilities
	▪ Design of new plant assumed to be equivalent or better than the current operating plant
	▪ Design systems to minimise fugitive emissions and provide building ventilation to control accumulation of polonium in smelter
Certification	▪ ISO 9001
	▪ ISO 14001
Other BHP Billiton Policies	▪ Employment policies (which will also be required to be adopted as a minimum by all contractors and sub-contractors)

6.3 Overview of BHP Billiton Procedures and Policies

The BHP Billiton procedures and policies that have been reviewed indicate that there is an ethos in place that is focused on managing the impacts from its operations on the environment, the public and on the employees.

This opinion has been formed as a result of numerous meetings that have occurred in addition to the risk workshops. The discussions, responses and general approach provided by BHP Billiton staff have indicated an awareness of the various procedures and policies and a willingness to implement these as appropriate.

The procedures and policies are extensive. There is a wide range of very specific policies in place which appear to address most of the more common or expected situation that might be found at a mining or processing site and which are reinforced by the more wide ranging standards on risk management, including the health, safety and environment and community standards.

Based on the assumption that these standards and policies are effectively implemented, there is a high degree of confidence that BHP Billiton is actively managing their risks and subsequent impacts on the environment and that the allowances made for the effectiveness of these policies and procedures in the risk assessment are realistic and valid.

Note that the approach taken by BHP Billiton with regard to the risk registers produced for this report has been to use them as a template and transfer relevant information to their ongoing project risk management.

7 Risk Assessments

Risk assessments were undertaken to allow a comprehensive risk profile to be developed for the whole of the upgrade project. The summary of these are outlined below with all relevant details, risk registers and various workshop notes being included in Arup 2008.

7.1 TRANSPORTATION (OPERATION PHASE)

7.1.1 Overview of the Workshops

Three workshops were held to assess different aspects of the transportation during the operation phase plus two specific activities/ facilities relevant to the construction phase. Note that the transport of materials for construction has been assessed elsewhere (see Section 7.4).

Details of all the workshops including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix C of Arup 2008.

7.1.1.1 First Workshop – Road, Rail and Air Transport

The first workshop was convened in Adelaide on the 12th of July 2006.

The focus of the workshop was the identification of the risks that resulted from the transportation of goods and materials to and from Olympic Dam during the operations phase of the mine. It did not address the risks arising from either construction (pre operations) or decommissioning (post operations). These have been separately assessed – see Sections 8.4 and 8.5.

The main modes of transport analysed were:

- Rail between Olympic Dam and Port Adelaide
- Rail between Adelaide and Darwin
- Road transport in combination with rail
- Air (for transport of precious metals).

With regards to the road/rail option it has been assumed that at present there are 66 truck transports per day. If, however a combination of rail and road will be used (mainly for transporting coke, flyash and acid) then the number of vehicle movements is expected to decline to 24 trucks per day.

7.1.1.2 Second Workshop – PAMS and Pimba Intermodal

The second workshop was held in Adelaide on the 14th of February 2008

This workshop identified and assessed the risks associated with the following two issues:

- PAMS (pre- assembled modules), and
- Intermodal rail to road facility at Pimba.

Both of these are expected to be utilised primarily during the construction phase.

Two options studies have been considered for the PAMS transportation, including:

- Transportation of PAMS modules using a dedicated haul corridor. This option has been assessed and the results are presented in Section 7.16.
- Transportation of PAMS modules (up to 800 tonnes) using the Stuart Highway north of Port Augusta. PAMS transportation will require, depending on size, temporary road closure, police escorts or pilot escorts. The estimated transport movements planned for the period between 2011 and 2020 were used as the basis of the workshop.

7.1.1.3 Third Workshop – Transportation of Copper Concentrate

The third workshop was convened in Adelaide on the 27h of February 2008.

This risk assessment was restricted to the transportation by rail of copper concentrate from Olympic Dam to the Port of Darwin.

During this risk workshop, the risks associated with the transportation of uranium oxide (originally assessed on 12 July 2006) were revisited to ensure that the rating for the probability and consequence are still valid, noting the additional research undertaken and the increased knowledge gained since the radiation workshop.

7.1.1.4 Fourth Workshop

The fourth workshop was convened in Adelaide on the 24th of October 2008. This was an update of the second workshop where the social issues arising from interruptions and delays to motorists and users caused by transportation of PAMS along the Stuart Highway were reassessed.

7.1.2 Context and Scope

7.1.2.1 First Workshop

The boundaries for the first risk assessment were:

- All transfers of goods from the finished goods store at Olympic Dam to the mode of transportation (road, rail or air)
- Transportation of copper to the intermodal facility at Port Adelaide
- Transportation of uranium oxide to either Port Adelaide or Port of Darwin including loading onto the shipping vessel
- Transportation of precious metals (by air) to another airport (up to the point where the precious metals will be transferred from the aircraft to a road vehicle)
- For supplies and consumables used on site, the boundaries for the risk assessment are from the gate of the supplier, or from wharf for goods brought in by sea, through to delivery into the store (or equivalent) at Olympic Dam.

Within these boundaries all possible types of goods and hazardous materials were considered including:

- Uranium Oxide
- Copper
- Gold and other precious metals
- Sulphur
- Ammonium nitrate
- Acid
- Flammable materials
- Other (as listed in Appendix C6 of Arup 2008)

Note that in general the transport of personnel to and from Olympic Dam was not considered in this section. This is discussed in Chapter 9. The quantitative effect of transportation and traffic is also discussed in Chapter 9.

7.1.2.2 Second Workshop

The boundaries for the second risk assessment included:

- Smaller pre-assembled modules – PAMS (up to 800 tonnes) to be transported on the Stuart Highway.
- Note the transportation of larger PAMS was discussed in another section of this report.

- PAMS are included in three categories of convoys, depending on the size and their travel speed. These categories are: convoys that require temporary road closure (plus police escorts), police escorted convoys, or pilot escorted vehicles.
- It was assumed that the Pimba intermodal facility would be primarily used during the Olympic Dam Expansion construction phase.
- It was assumed that the intermodal at Pimba would only operate during day-time; that the perimeter is fenced and lit.

7.1.2.3 Third Workshop

The risk assessment workshop was restricted to the transportation of copper concentrate from Olympic Dam to the Port of Darwin by rail.

7.1.2.4 Fourth Workshop

This risk assessment was restricted to the movement of PAMS north of Port Augusta.

7.1.3 Risk Levels

The Base Risk Levels associated with the transportation of goods and materials to and from Olympic Dam, including allowance for existing control and mitigation measures are summarised in the table below:

Table 3: Summary of Transport Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	1	1	0	0	0	0	0
High	36	5	2	0	14	5	13
Moderate	92	37	14	5	105	10	25
Low	72	288	163	203	191	102	139

The Residual Risk Levels, following the application of additional control and mitigation measures are summarised in Table 4 below:

Table 4: Summary of Transport Residual Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	0	0	0	0	0	0	0
High	36	6	2	0	14	5	13
Moderate	92	37	14	5	105	10	25
Low	73	288	163	203	191	102	139

Note that the Base and the Residual Risk levels for OH&S do not equate because one risk event was eliminated as a result of using additional controls and mitigation actions.

7.1.4 Additional Control and Mitigation Measures

To achieve a tolerable Residual Risk Level the following additional actions, presented in Table 5 below, are to be undertaken and included in the delivery of the project. Note that these required actions only apply if the option that is moderated by the additional control measures is planned to be built and operated.

Table 5: Additional Control and Required Action for Transport

ID No[1]	Additional Controls and Actions Required
7.1 / 7	The rail level crossings for the Olympic Dam to Port Adelaide rail line to either be signalled or preferably avoided by the construction of overpasses
7.1/ 471	BHP Billiton to seek permission for PAMs requiring road closure to travel at night along the Stuart Highway between Port Augusta and Pimba
7.1/ 471	The traffic management plan will ensure that all over dimensional loads will use passing bays and/or other alternative means to minimise delays to other users of the road system, by allowing the vehicles to overtake safely. A comprehensive communications program which will include media advertising, signage and on-line information, will be implemented to inform road users of the proposed timing of all over-dimensional load movements.

7.1.5 Conclusion

Following the application of additional control and mitigation measures, the risk profiles presented by the transport options are:

- Rail between Olympic Dam and Port Adelaide – no unacceptable risk events
- Road transport in conjunction with rail – no unacceptable risk events
- Store of goods, products and materials at Olympic Dam – no unacceptable risk events
- Intermodal depot at Port Adelaide – no unacceptable risk events
- Rail transport of uranium oxide by rail from Port Adelaide to the Port of Darwin – no unacceptable risk events
- Wharf activities regarding transfer of uranium oxide, sulphur and flammable materials – no unacceptable risk events
- Air transport – no unacceptable risk events
- Intermodal facility at Pimba – no unacceptable risk events
- Transport of copper concentrate from Olympic Dam to Port of Darwin – no unacceptable risk events
- PAMs transport along the highway to Olympic Dam – no unacceptable risk event.

In conclusion and purely from a risk perspective, the transportation aspect of the operation phase may proceed as planned, with the provision that it complies with the existing and the additional control measures and actions.

Note that the risks posed by the large number of heavy vehicles using public roads (road accidents) have been quantitatively assessed and reported in Chapter 9.

[1] ID No is structured to identify the risk assessment and risk event in that risk register to which the additional control measure applies; eg. 7.1/7 refers to Section 7.1 of this report (Transport), and line 7 of the Transport risk register.

7.2 WATER SUPPLY

7.2.1 Overview of the Workshop

The workshop was held in Adelaide on the 26th of July 2006.

Details of the workshop including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix D of Arup 2008.

The workshop addressed the risks resulting from the supply of the additional water requirements to Olympic Dam to satisfy the needs for the expansion project.

The main capacity or sizing criteria assumed for this risk workshop were:

- Approximately 280 ML per day processing capacity from the reverse-osmosis desalination plant, with an average processing capacity of 150 ML/day
- Approximately 200-220 ML storage capacity
- 330 km of predominantly buried pipeline (1,200 mm nominal diameter pipe) to Olympic Dam
- Desalination plant outfall pipeline of approx. 1.5 to 2 km out to sea, and
- Intake pipeline, approx 500m out to sea.

7.2.2 Context and Scope

The boundaries of this risk assessment include the following:

- Reverse-osmosis desalination plant – probably located at Point Lowly (Whyalla) with options investigated at Port Pirie or Port Augusta
- The marine environment as affected by the outfall and intake pipes and associated structures (Note – assumed that outfall located off of Pt Lowly and intake either same area or in Fitzgerald Bay)
- The pipeline to Olympic Dam, including intermediate storage, chlorination (if required) and pump facilities at various places (up to 4 locations). This includes the corridor.
- The extension of Borefield B by potentially drilling additional bores and installing connecting pipes and pump stations. This does not require changes to the delivery pipe to Olympic Dam. Assessment based on assumption of increasing the current (approximate) drawdown of 34 ML/day by a minimum of, say, 15%.
- The use of the local Saline Aquifers, including wells, pumps stations and pipework. Maximum drawdown limit is up to 30 ML/day.

7.2.3 Risk Levels

The Base Risk Levels associated with the water of Olympic Dam, including allowance for existing control and mitigation measures are summarised in Table 6 below.

Table 6: Summary Water Supply Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	**OH&S**	**Social**	**Flora**	**Fauna**	**Physical**	**Water**	**Air**
Extreme	4	0	2	2	1	0	0
High	37	7	1	5	3	16	3
Moderate	14	18	10	12	10	10	3
Low	0	24	17	17	13	9	7

The Residual Risk Levels after allowing for additional control and mitigation measures are summarised in Table 7 below:

Table 7: Summary of Water Supply Residual Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	**OH&S**	**Social**	**Flora**	**Fauna**	**Physical**	**Water**	**Air**
Extreme	0	0	0	0	0	0	0
High	38	6	3	7	2	15	3
Moderate	17	17	10	12	12	11	3
Low	0	26	17	17	13	9	7

7.2.4 Additional Control and Mitigation Measures

To achieve the Residual Risk Levels the following additional actions (Table 8 below) would be undertaken and included in the delivery of the project.

Note that these required actions only apply if the option which is moderated by the additional control measures is planned to be built and operated.

Table 8: Water Supply - Additional Controls and Required Actions

ID No	Additional Controls and Actions Required
7.2 / 11	All structures in the ocean associated with the intake or outfall pipe work at the desalination plant must be below the surface or designed such that access is not possible without special physical aids.
7.2 / 25	The intake and outfall pipeline must not be located within the Santos site (if desalination plant is located at Point Lowly) and must be a reasonable or safe distance (exclusion zone) from the Santos boundaries. The discharge pipe must not be located on Santos Jetty.
7.2 / 51	See 8.2/11 above
7.2 / 90	See 8.2/11 above

7.2.5 Conclusion

Following the application of additional control and mitigation measures, the risk profiles presented by the main water supply options are:

- Desalination Plant (any location) – no unacceptable risk events
- Pipeline (Desalination Plant to Olympic Dam) – no unacceptable risk events
- Extension of Wellfield B – no unacceptable risk events
- Use of local Saline Aquifer – no unacceptable risks events

As such, and purely from a risk perspective, the desalination plant and pipeline may be operated, Wellfield B may be extended to licence capacity and the local saline aquifer may be used, noting the need to comply with both the current and required control measures and actions.

7.3 HILTABA VILLAGE (CONSTRUCTION CAMP)

7.3.1 Overview of the Workshop

The workshop was convened in Adelaide on the 3rd of August 2006.

Details of the workshop including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix E of Arup 2008.

The workshop identified and assessed the risks posed by the establishment and occupation of a new constructor village (single living quarters) near the Roxby Downs township.

The activities analysed were:

- The village itself and the impact of the occupants outside the boundaries of the village.
- The main capacity criteria assumed for this workshop were:
- New single person living quarters to be principally used during the construction period with capacity of 8,000 beds; that is to be phased out after the construction stage
- Camp including full suite of facilities including swimming pools, ovals, taverns, etc.
- Car parking provision for at least 1,000 private vehicles
- Located on Andamooka Road, approximately 15 km east of Roxby Downs township
- Camp accommodation units, facilities and landscaping etc built to a high standard.

Note that approximately 1,000 additional accommodation places would be required for the construction of linear infrastructure. These temporary accommodation camps were discussed in other risk workshops including construction of water and gas pipelines.

7.3.2 Context and Scope

The boundaries pertinent to this risk assessment are:

- Hiltaba Village itself
- The environmental impacts of the village and its occupants
- The social impacts imposed by the occupants of the village, particularly with respect to Roxby Downs, Andamooka and Woomera townships.

7.3.3 Risk Levels

The Base Risk Levels associated with the establishment and occupation of a construction workers camp near the Roxby Downs township, allowing for existing control and mitigation measures, are summarised in Table 9 below:

Table 9: Summary of Hiltaba Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	**OH&S**	**Social**	**Flora**	**Fauna**	**Physical**	**Water**	**Air**
Extreme	0	0	0	0	0	0	0
High	15	21	5	2	3	1	2
Moderate	8	13	0	0	5	2	6
Low	12	17	3	2	5	5	5

As the risk assessment did not identify any unacceptable risk events, there was no need to apply additional control and mitigation measures. As such, the Residual Risk Levels are as presented in Table 9 above.

7.3.4 Conclusion

There are no unacceptable risks posed by the establishment of Hiltaba Village (construction camp) at the Olympic Dam site.

7.4 CONSTRUCTION PHASE

7.4.1 Overview of the Workshop

Two workshops were held to assess the risks arising from construction activities.

Details of the workshop including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix F of Arup 2008.

7.4.1.1 First Workshop – Whole of the Project

The workshop was convened in Adelaide on the 9th of August 2006.

The workshop identified and assessed the risk profile of the construction phase for the whole of the expansion project at Olympic Dam.

The main capacity or sizing criteria assumed for this risk workshop were:

- The new process plant at Olympic Dam will require approximately 2 million tonnes of construction materials
- Rate of use of construction material is 2,000 tonnes per day requiring approximately 100 truck trips per day (note that the issue of transport is addressed separately in Chapter 8).
- The desalination plant will be built in two years employing approx.150 construction workers
- The processing plant will be built in 4 years employing approx. 3,000 construction workers
- Mine pre-strip will take 5 years, employing approx. 1,000 persons
- The existing plant will continue to process approximately 10 million tonnes per year of ore
- Total pipe laydown area (assuming that water will be supplied to Roxby Downs from the desalination plant at Whyalla) is 3,000 m^2, stacked two pipes high.

7.4.1.2 Second Workshop – Upgrade of Existing Processing Plant (Brownfields)

On 13 March 2008 a second workshop was convened in Adelaide.

The workshop identified and assessed the risks associated with all the work required to upgrade the existing processing plant, where this work could take place with the plant still operating, except for specific and planned shutdowns.

7.4.1.3 Third Workshop – Blasting

The workshop was convened in Adelaide on the 23rd of October 2008. This workshop was to consider the risks posed by “blasting”, should it be required, to create the trenches (above and below high water line) for the intake and outfall pipes at the desalination plant.

7.4.2 Context and Scope

7.4.2.1 First Workshop

The boundaries for the first risk assessment included the following:

- Construction of a desalination plant on upper Spencer Gulf, associated pipework and facilities between the desalination plant and Olympic Dam.
- Extension of Borefield B and development of local saline aquifer
- Construction of a rail line from Pimba to Olympic Dam
- Construction of the intermodal facility at Port Adelaide

- Construction of accommodation facilities, including the Roxby Downs township and construction workers accommodation camp
- Construction of the new processing plant.

7.4.2.2 Second Workshop

The boundaries of this risk assessment included the following:

- Expansion and upgrade of existing processing plant
- New anode furnace and casting wheels
- New acid plant
- Services corridor between existing and greenfields plant.

7.4.2.3 Third workshop

This workshop considered a single hazard of blasting as a method of construction of the desalination plant at Pt Lowly. The boundaries of this risk assessment included the construction of trenches for the intake and outfall pipes of the desalination plant.

7.4.3 Risk Levels

The Base Risk Levels associated with the construction phase, including upgrading of existing processing plant on Brownfield site and allowing for existing control and mitigation measures are summarised in Table 10 below:

Table 10: Summary Construction Phase Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	3	0	0	0	0	0	0
High	99	8	9	0	5	4	0
Moderate	72	27	3	7	24	19	1
Low	35	37	44	30	24	24	27

The Residual Risk Levels after allowing for additional control and mitigation measures are summarised below:

Table 11: Summary Construction Phase Residual Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	0	0	0	0	0	0	0
High	102	8	9	0	5	4	0
Moderate	72	27	3	7	24	19	1
Low	35	37	44	30	24	24	27

7.4.4 Additional Control and Mitigation Measures

To achieve the Residual Risk Levels the following additional activities would be undertaken and included in the delivery of the project.

Table 12: Construction Phase - Additional Controls and Required Actions

ID No	Additional Controls and Actions Required
7.4 / 290 and 291	BHP Billiton to provide exclusion zones and effective barriers during the upgrade of the existing processing plant to separate the construction zone from the existing plant. BHP Billiton to consider extended shutdowns to achieve separation. Provide adequate coordination between activities and undertake risk assessments prior to the commencement of activities. Undertake constructability reviews and workshops.
7.4/305	Start surveillance (patrol area) 2 hours before blasting to ensure area clear. Increase number of vessels patrolling safe perimeter to four at time of blast and position additional surveillance vessel up current from blast to cover wider and more distant arc.

7.4.5 Conclusion

The risk profiles presented by the construction phase are:

- Construction of water supply system – no unacceptable risk events
- Construction of transport infrastructure – no unacceptable risk events
- Construction of energy supply – no unacceptable risk events
- Construction of Roxby Downs township and Hiltaba Village – no unacceptable risk events
- Construction of the new processing plant on Greenfield site - no unacceptable risk events
- Upgrade of existing plant on the Brownfield site – no unacceptable risk events
- Mine pre-strip phase - no unacceptable risk events

Purely from a risk perspective, the construction phase may proceed noting the need to comply with both the current and required control measures and actions.

Note that the risk posed by the large number of heavy vehicles using public roads (road accidents) during the construction phase have been separately quantitatively assessed and reported in Chapter 8.

7.5 REHABILITATION PHASE

7.5.1 Overview of the Workshop

The workshop was held in Adelaide on the 10th of August 2006.

Details of the workshop including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix G of Arup 2008.

The workshop addressed the risks resulting from the decommissioning and rehabilitation phase of the assets associated with the whole of the Olympic Dam operations.

- The main capacity or sizing criteria assumed for this risk workshop were:
- Decommissioning activity is estimated at 70 to 100 years after construction, except for those facilities which were only required for the construction phase. These are likely to be decommissioned much earlier, depending on possible future value.
- Approximately 2,000,000 tonnes of processing plant and equipment
- Approximately 30,000 m^3 of concrete at processing plant.

7.5.2 Context and Scope

The boundaries for this risk assessment include the following:

- It has been assumed the desalination plant, rail line (Pimba to Olympic Dam), Roxby Downs township and other services will be removed. However it is possible some or all of these will remain if they are of use and value.
- The processing plant and construction camp will be removed including ancillary plant and equipment
- Underground pipelines will not be removed but made safe
- The mine (pit) and rock storage facility (RSF) will remain and will be made safe

7.5.3 Risk Levels

The Base Risk Levels associated with the decommissioning phase, including allowance for existing control and mitigation measures are summarised in Table 13 below:

Table 13: Summary Decommission and Rehabilitation Phase Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	2	1	0	1	0	0	0
High	65	6	3	1	7	3	0
Moderate	78	14	5	3	21	9	1
Low	36	60	44	47	23	27	22

The Residual Risk Levels associated with the decommissioning phase and after the application of additional control and mitigation measures are summarised in Table 14 below:

Table 14: Summary of Decommission and Rehabilitation Residual Risk Level

Number of Risk Events for Each Risk Level							
Risk Level	**OH&S**	**Social**	**Flora**	**Fauna**	**Physical**	**Water**	**Air**
Extreme	0	0	0	0	0	0	0
High	67	6	2	1	7	3	0
Moderate	81	14	5	3	21	9	1
Low	33	60	44	47	23	27	22

Note that the Base and the Residual Risk levels for Social, Flora and Fauna do not equate because one risk event was eliminated as a result of retaining the sub-surface structures at the desalination plant (additional control and mitigation measures).

7.5.4 Additional Control and Mitigation Measures

To achieve the Residual Risk Levels the following additional actions (Table 15 below) would be undertaken and included in the delivery of the project.

Table 15: Decommission - Additional Controls and Required Actions

ID No	Additional Controls and Actions Required
7.5 / 45	If the habitat that may have established around the intake/outfall pipeline of the desalination plant is considered important or significant then the sub-surface structures are to be made safe and to remain in place.
7.5 / 162	Use rail to remove Roxby Downs township and Camp 5 (prior to the removal of the rail track)
7.5 / 246	Remove process plant, equipment and materials by rail.

7.5.5 Conclusion

Following the application of additional control and mitigation measures, the risk profiles presented by the rehabilitation phase are:

- Decommission of the water supply (desalination plant, borefield in GAB and local saline aquifer) – no unacceptable risk events
- Removal of electrical supply system - no unacceptable risk events
- Decommission of Roxby Downs township and Hiltaba – no unacceptable risk events
- Decommission of the processing plant - no unacceptable risk events
- Decommissioning of the mine - no unacceptable risk events

7.6 ROXBY DOWNS TOWNSHIP

7.6.1 Overview of the Workshop

The workshop was held in Adelaide on the 6th of August 2006.

Details of the workshop including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix H of Arup 2008.

The workshop addressed the risks resulting from the expansion of the Roxby Downs township.

The main capacity or sizing criteria assumed for this risk workshop is:

- Roxby Downs to accommodate approximately 10,000 people by 2016
- Development of the Roxby Downs Master Plan
- Up to 2,5000 new residential houses
- Population will comprise a mix of permanent, permanent long distance commuters (PLDC) and fly in - fly out (FIFO) personnel.

7.6.2 Context and Scope

The boundaries of this risk assessment included the following:

- Roxby Downs township itself
- Social issues including the impact of Roxby Downs township expansion on adjacent localities
- Urban design considerations and planning to enable desired accommodation, including high density housing, amenities, relocation of facilities.
- Sort term accommodation – transient population
- New caravan park able to provide accommodation for 300 caravans and located eastern edge of the town, off Axehead Road
- Provision of civic, community, commercial and retail infrastructure
- Airport and roads
- Provision of services including water, electricity, waste management and waste water treatment.

Note: Subsequent to the risk workshop, the exact township layout was altered. However, the changes are neither substantive or not important in regards to risks and risk levels.

7.6.3 Risk Levels

The Base Risk Levels associated with the township expansion, including allowance for existing control and mitigation measures are summarised in the table below:

Table 16: Summary of Township Expansion Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	0	0	0	0	0	0	0
High	22	33	5	3	4	1	1
Moderate	18	14	0	1	3	3	11
Low	4	19	3	3	5	2	2

As the risk assessment did not identify any unacceptable risk events, there was no requirement to apply additional control and mitigation measures and, as such, the Residual Risk Levels are identical to the Base Risk Levels in the Table 16 above.

7.6.4 Conclusion

There are no unacceptable risks posed by the expansion of Roxby Downs township.

7.7 PROCESS PLANT – SMELTING

Two workshops were held to assess the risks arising from all smelting activities.

Details of all the workshops including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix I of Arup 2008.

7.7.1 Overview of the Workshops

7.7.1.1 First Workshop

The first workshop was held in Adelaide on the 20th of September 2006.

The workshop addressed the risks resulting from the operation of the smelting process at Olympic Dam processing plant.

Note that the smelting process is one of the three sections that constitute the whole mineral processing plant. These sections are:

- Concentration, tailings and refining
- Smelting
- Hydrometallurgy.

The assumptions considered for this assessment included:

- The new plant will have the capacity to process approximately 750,000 tpa copper
- The whole of the new plant will be constructed on a greenfields site.

7.7.1.2 Second Workshop

On 13 March 2008 a second workshop was convened in Adelaide. This workshop considered the alternative option of operating the upgraded existing plant plus operating the new plant which will be constructed on a greenfields site.

The workshop focused on changes to the risk events due to a slightly different mode of operation, changes due to an increased production rate through the upgraded existing plant and equipment. Risks from operating the new (smaller) plant on the greenfields site were considered to be as identified in the first workshop and, as such, were not re-considered.

Additional lines were added to the risk register to reflect the changes to the risk events.

The capacity of the upgraded existing plant will be increased to 350,000 tpa of refined copper.

7.7.2 Context and Scope

7.7.2.1 First Workshop

The boundaries for the first risk assessment included the following modules of the processing plant:

- Filtration and drying
- Matte production (FSF) and converting (FCF) furnaces followed by granulation, slag cooling and milling
- Anode, shaft and slag cleaning furnaces
- Casting
- Acid plant.

7.7.2.2 Second Workshop

The boundaries of the second risk assessment workshop included the following items:

- Upgrade elements of the existing plant

- Pipe and services corridor between existing plant and new plant.

7.7.3 Risk Levels

The Base Risk Levels resulting from the smelting process, allowing for existing control and mitigation measures are summarised in Table 17 below:

Table 17: Summary of Smelting Process Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	1	0	0	0	0	0	0
High	85	1	1	1	6	0	12
Moderate	32	5	3	3	1	0	11
Low	15	21	1	1	1	0	18

The Residual Risk Levels associated with the smelting operation and after the application of additional control and mitigation measures are summarised in Table 18 below:

Table 18: Summary Smelting Operation Residual Risk Level

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	0	0	0	0	0	0	0
High	86	1	1	1	6	0	12
Moderate	32	5	3	3	1	0	11
Low	15	21	1	1	1	0	18

7.7.4 Additional Control and Mitigation Measures

To achieve the Residual Risk Levels the following additional actions (presented in the Table 19 below) would be undertaken and included in the delivery of the project.

Table 19: Smelting Operation - Additional Controls and Required Actions

ID No	Additional Controls and Actions Required
7.7 / 65	Improved design of the ventilation system at the matte production and converting furnaces. Control the amount of recycle dust and electric furnace revert charge rate Use of personal protection equipment Regular monitoring of employees radiation dose to enable action to be taken to prevent dose levels from increasing

7.7.5 Conclusion

Following the application of additional control and mitigation measures, the risk profiles presented by the rehabilitation phase are:

- Filtering – Larox Filters – no unacceptable risk event
- Concentrate stockpile – no unacceptable risk event
- Steam Dryers and dry concentrate handling – no unacceptable risk event

- Acid plant – no unacceptable risk event
- Matte production and converting furnaces – no unacceptable risk event
- Granulator – no unacceptable risk event
- Slag handling and cooling – no unacceptable risk event
- Matte stockpile from granulator – no unacceptable risk event
- Mining/ grinding – no unacceptable risk event
- Launders and molten metal/ slag transfer – no unacceptable risk event
- Anode furnace – no unacceptable risk event
- Shaft furnace – no unacceptable risk event
- Electric slag cleaning furnace – no unacceptable risk event
- Casting wheels – no unacceptable risk event
- Utilities and other services – no unacceptable risk event.

7.8 PROCESS PLANT – CONCENTRATION, TAILINGS AND REFINING

Two workshops were held to assess the risks arising from all concentrating, tailings and refining activities.

Details of all the workshops including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix J of Arup 2008.

7.8.1 Overview of the Workshops

7.8.1.1 First Workshop

The workshop was held in Adelaide on the 21st of September 2006.

The workshop addressed the risks resulting from the operation of the concentration, tailing and refining modules of the processing plant at Olympic Dam.

Concentration, tailings and refining represent the second section (of three) of the mineral processing plant that also included smelting and hydrometallurgy.

The main capacity or sizing criteria used for this assessment included:

- The new plant will have the capacity to process approximately 750,000 tpa copper.

7.8.1.2 Second and Third Workshops

On the 3rd and 23rd of April 2008 meetings (mini workshops) were convened in Adelaide to discuss the threats posed by the tailing storage facilities with respect to wading birds.

7.8.1.3 Fourth Workshop

On the 22nd May 2008 a further workshop was convened to discuss the issues and threats pertaining to wading and open water birds.

7.8.2 Context and Scope

7.8.2.1 First Workshop

The boundaries for this first risk assessment included the following:

- Ore stockpile, crushing and grinding/milling
- Flotation
- Tailings storage facilities, including existing evaporation ponds with option of additional evaporation ponds or balancing ponds.
- Electrowinning and refining
- Storage and security of precious metals.

7.8.2.2 Second and Third Workshop

The boundaries of the second risk assessment were restricted to tailing storage facilities as they may impact on wading birds.

7.8.2.3 Fourth Workshop

This was a repeat of the second workshop with an expanded list of participants.

7.8.3 Risk Levels

The Base Risk Levels resulting from the concentration, tailing and refining process, allowing for existing control and mitigation measures are summarised in the table below:

Table 20: Summary of Concentration/Tailings and Refining Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	5	5	2	2	0	0	1
High	32	21	16	8	5	8	2
Moderate	19	20	11	4	14	6	2
Low	15	22	16	23	2	9	0

The Residual Risk Levels following the application of additional control and mitigation measures are summarised in Table 21 below:

Table 21: Summary of Concentration/Tailings and Refining Residual Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	0	4	2	2	0	0	0
High	36	21	15	7	5	8	3
Moderate	20	21	12	5	14	6	2
Low	15	22	16	23	2	9	0

7.8.4 Additional Control and Mitigation Measures

To achieve the Residual Risk Levels the following additional actions (Table 22 below) would be undertaken and included in the delivery of the project.

Table 22: Concentration/ Tailings and Refining - Additional Controls and Required Actions

ID No	Additional Controls and Actions Required
7.8 / 01	Install dust suppression (water sprays or other means) capability on the ore stockpile
7.8 / 42	Install barriers along perimeter roads of balancing ponds (prevent the vehicles from leaving the road). Provide tether points with harnesses for operators working in the area. Provide permanent acid resistant ropes into the pond at several points around the pond edges
7.8 / 58	Install barriers along the access road to prevent the vehicles leaving the road (falling into decant area). Provide tether points with harnesses for operators working in the area. Provide permanent ropes into the pond at several points around the pond edges
7.8 / 82	Install barriers along perimeter roads of evaporation ponds (prevent the vehicles from leaving the road). Provide tether points with harnesses for operators working in the area. Provide permanent ropes into the pond at several points around the pond edges
7.8/ 98	Install barriers along the access road to prevent the vehicles leaving the road (falling into decant area). Provide tether points with harnesses for operators working in the area. Provide permanent ropes into the pond at several points around the pond edges

7.8/ 109	Install barriers along the access road to prevent the vehicles leaving the road (falling into decant area). Provide tether points with harnesses for operators working in the area. Provide permanent ropes into the pond at several points around the pond edges

7.8.5 Conclusion

Following the application of additional control and mitigation measures, the risk profiles presented by these modules of the expanded processing plant at Olympic Dam are:

- Ore stockpile – no unacceptable risk events
- Crushing and Melting – no unacceptable risk events
- Slag mill and slag flotation– no unacceptable risk events
- Flotation– no unacceptable risk events
- Tailings storage for the expanded processing plant with additional evaporation ponds – unacceptable risk events identified
- Balancing ponds with no additional evaporation ponds – no unacceptable risk event
- Electrolytic refining - no unacceptable risk events
- Electrowinning - no unacceptable risk events
- Slimes Treatment– no unacceptable risk events
- Storage and Security – no unacceptable risk events.

As such, purely from a risk prospective, the expanded processing plant (areas as noted above), may be operated, noting the need to comply with both current and required control measures and actions. The tailings storage facility may only be operated if no additional evaporation ponds are constructed.

7.9 PROCESS PLANT – HYDROMETALLURGY

7.9.1 Overview of the Workshop

The workshop was held in Adelaide on the 27th of September 2006.

Details of the workshop including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix K of Arup 2008.

The workshop addressed the risks resulting from the hydrometallurgy section of the Olympic Dam processing plant.

The hydrometallurgy process is the last of the three sections that constitute the whole mineral processing plant, being:

- Concentration, tailing and refining
- Smelting
- Hydrometallurgy
- The main capacity or sizing criteria used for this assessment included:
- The new plant will have the capacity to process approximately 750,000 tpa copper.

Note that this risk assessment will also be appropriate for a smaller capacity plant, should the option to combine an upgrade of the existing plant with a limited functionality greenfields plant of equal or smaller size be chosen instead of a totally new greenfields plant with a capacity of up to 750,000 tpa refined copper.

7.9.2 Context and Scope

The boundaries for this risk assessment included the following:

- Flotation and thickening operations
- Leaching, counter-current decanting, clarification and filtration
- Copper and uranium solvent extraction
- Uranium precipitation, calcination and packing
- Storage and security.

7.9.3 Risk Levels

The Base Risk Levels resulting from the hydrometallurgy process, allowing for existing control and mitigation measures are summarised in Table 23 below:

Table 23: Summary of Hydrometallurgy Process Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	0	0	0	0	0	0	0
High	36	0	0	0	1	0	1
Moderate	16	7	0	0	7	0	2
Low	3	10	2	1	1	1	0

As the risk assessment did not identify any unacceptable risk events, there was no requirement to apply additional control and mitigation measures and, as such, the Residual Risk Levels are identical to the Base Risk Levels in Table 23 above.

7.9.4 Conclusion

There are no unacceptable risks posed by hydrometallurgy module of the processing plant at Olympic Dam.

7.10 ENERGY

7.10.1 Overview of the Workshop

The workshop was held in Adelaide on the 28th of September 2006.

Details of the workshop including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix L of Arup 2008.

The workshop addressed the risks resulting from the supply of energy to meet the requirements of the expanded operations at Olympic Dam.

The main capacity or sizing criteria assumed for this risk workshop included:

- Estimated electricity demand for the production of 600,000 tpa copper is 600 MW.
- Output from the co-generation plant is up to 100 MW.
- Solar energy plays a very minor role, approximately 1-2 MW.
- Liquid fuel, demand is 330 million litres p.a.
- Gas demand is up to 7.4 PJ p.a. (600,000 tpa of copper concentrate).

Note that since this workshop an alternative option has been considered being the generation of power on site using natural gas. Should this occur, many of the risk events identified in this risk assessment would no longer be valid. A separate risk workshop was convened and a risk assessment has been undertaken for the on-site combined-cycle gas turbine (CCGT) power generation facility (see Section 7.13).

Since the workshop it has been estimated that co-generation may contribute up to 350 MW. The risk levels were revisited to confirm they were appropriate for this possible change.

7.10.2 Limitations and Assumptions

The boundaries for this risk assessment included the following:

- All transmission and ancillary lines at Roxby Downs to Olympic Dam and at Roxby Downs
- Co-generation
- Liquid and gas fuels.

7.10.3 Risk Levels

The Base Risk Levels resulting from the supply of energy, allowing for existing control and mitigation measures are summarised in the table below:

Table 24: Summary of Energy Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	0	9	0	0	0	0	0
High	14	1	0	0	0	2	0
Moderate	9	0	0	1	4	0	2
Low	2	29	14	14	1	1	15

The Residual Risk Levels, allowing for additional control and mitigation measures are summarised in the table below:

Table 25: Summary of Energy Residual Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	0	0	0	0	0	0	0
High	14	0	0	0	0	2	0
Moderate	9	9	0	1	4	0	2
Low	2	30	14	14	1	1	15

7.10.4 Energy - Additional Control and Mitigation Measures

To achieve the Residual Risk Levels the following additional actions would be undertaken and included in the delivery of the project:

Table 26: Additional Controls and Required Actions

ID No	Additional Controls and Actions Required
7.10 / 75 7.10 / 76 7.10 / 77 7.10 / 78 7.10 / 80 7.10 / 81 7.10 / 82 7.10 / 83 7.10 / 84	Electricity demand to be confirmed by 2009. Prior to that, an EIO will be released. Contracts to be in place in 2009, based on the commissioning of the new processing plant by 2014. Note that the dates may change, but what must occur is that a contract to purchase must be in place in no less than 4 years (preferably 5 years) prior to demand.

7.10.5 Conclusion

Following the application of additional control and mitigation measures, there are no unacceptable risk events resulting from the supply of energy to the expanded operations at Olympic Dam.

7.11 MINING

7.11.1 Overview of the Workshop

The workshop was held in Adelaide on the 19th of October 2006.

Details of the workshop including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix M of Arup 2008.

The workshop addressed the risks posed by the development of an open pit mine at Olympic Dam.

The main capacity or sizing criteria assumed for this risk workshop included:

- Stripping to commence in 2008 – the strip depth is expected to be 20 to 40 m.
- Hard rock mining to commence in 2009
- Ore mining to occur in 2013 starting from a depth of approximately 375 metres.
- For 750,000 tpa copper, the ore mining rate is expected to be between 65 to 80 million tpa.
- The rock storage facility height is expected to be between 150-200m high covering approx. 100 km^2
- The pit depth will be over 700m and a diameter of approximately 3.5 -4.0 km.
- The underground mining will continue for the next 10 to 20 years.
- 150 to 200 haul trucks and 11 electric shovels will operate on site
- There will be 3 to 4 haul truck movements per minute.

Since the workshop it has been estimated that the number of haul trucks in use may be as high as 250 with up to 15 shovels in use. It has been confirmed that the risk levels were appropriate for this stage.

7.11.2 Context and Scope

The boundaries for this risk assessment included:

- Crushing (either pit rim or bottom of pit crusher)
- Rock Storage Facility
- The open pit.

7.11.3 Risk Levels

The Base Risk Levels resulting from the mining process, including allowance for existing control and mitigation measures are summarised in Table 27 below:

Table 27: Summary of Mining Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	1	0	0	0	0	0	0
High	29	3	2	3	1	0	3
Moderate	42	6	2	2	2	3	1
Low	21	14	7	8	8	6	2

The Residual Risk Levels, after allowing for additional control and mitigation measures are summarised in Table 28 below:

Table 28: Summary of Mining Residual Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	**OH&S**	**Social**	**Flora**	**Fauna**	**Physical**	**Water**	**Air**
Extreme	0	0	0	0	0	0	0
High	29	2	2	3	1	0	3
Moderate	43	6	2	2	2	3	1
Low	21	15	7	8	8	6	2

7.11.4 7.11.4 Additional Control and Mitigation Measures

To achieve the Residual Risk Levels the following additional actions (Table 29 below) would be undertaken and included in the delivery of the project.

Table 29: Mining - Additional Controls and Required Actions

ID No	Additional Controls and Actions Required
7.11 / 51	Camp 1 to be closed prior to mineralised rock being placed close enough to cause an issue. Radiation levels to be monitored in this area.

7.11.5 Conclusion

Following the application of additional control and mitigation measures, there are no unacceptable risk profiles presented by the mining operation.

7.12 LANDING FACILITY

7.12.1 Overview of the Workshop

The workshop was held in Adelaide on the 13th of September 2007.

Details of the workshop including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix O of Arup 2008.

The workshop identified and assessed the risks posed by the landing facility.

The activities analysed were the construction, operation and decommission of the landing facility which is to be constructed South of Port Augusta.

Transport includes above-water structures, tugs, barges, roll on/roll off vessels.

Some of the new plant may be delivered to site (Olympic Dam) in the form of pre-assembly modules (PAMs). These modules will be transported on barges to the landing facility where they will be transported to a staging area on the north western outskirts of Port Augusta. The modules will be transported to the staging (or pre-assembly) area using a designated access corridor followed by road transport to Olympic Dam on the Stuart Highway and Olympic Way.

7.12.2 Context and Scope

The boundaries pertinent to this risk assessment are:

- Landing facility
- The environmental impacts and other impacts imposed by the construction, operation and decommission of the landing facility.
- Two shipping operation options including:
- Ship pre-assembled modules on heavy lift vessels using a roll-on-roll-off procedure. The heavy lift vessel would transport the modules directly from the fabrication yard to the landing point
- Ship the pre-assembled modules on barges that are loaded onto heavy vessels. A mooring area at Point Lowly are would be required to moor the heavy lift vessels, which would submerge for off-loading the barges. This would require a temporary mooring point for the barges prior to movement to the landing point.
- Approximately 100 arrivals over a two-year period

Since the workshop it has been confirmed that the number of vessel visitations will be approximately 300 over 7 years. This has resulted in changes to the risk profile including an increase in the number of risk events.

7.12.3 Risk Levels

The Base Risk Levels associated with the landing facility, allowing for existing control and mitigation measures, are summarised in Table 30 below:

Table 30: Summary of Landing Facility Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	0	0	0	0	0	0	0
High	4	4	0	0	0	0	0
Moderate	12	7	10	8	2	7	3
Low	7	11	13	13	0	6	4

As the risk assessment did not identify any unacceptable risk events, there was no requirement to apply additional control and mitigation measures and, as such, the Residual Risk Levels are as presented in the table above.

7.12.4 Conclusion

There are no unacceptable risks posed by the establishment of the landing facility.

7.13 ACCESS CORRIDOR

7.13.1 Overview of the Workshop

The workshop was held in Adelaide on the 13th of September 2007. Workshop details are attached in Appendix P of Arup 2008.

A private access corridor of about 10 km in length and 15 metres wide would be constructed between the landing facility and the Port Augusta pre-assembly yard on the outskirts of Port Augusta.

The pre-assembly yard is an expansion of the facility that was used previously during the last Olympic Dam expansion.

After partial or integral assembly, plant components would be transported to site along the existing Stuart Highway which been detailed in Section 7.1.1.2 Transport.

During the operation period of seven years there are expected approximately 500 over-dimensional vehicle movements. Vehicles expected to use this corridor include:

- Self-propelled modular transporters (SPMT)
- Semi-self-propelled modular transporters (SSP)
- Light vehicles accompanying each transport

7.13.2 Context and Scope

The boundaries pertinent to this risk assessment are:

- Access corridor
- The environmental impacts and other impacts imposed by the construction, operation and decommission of the access corridor.

7.13.3 Risk Levels

The Base Risk Levels associated with the landing facility, allowing for existing control and mitigation measures, are summarised in Table 31 below.

Table 31: Summary of Haul Corridor Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	0	0	0	0	0	0	0
High	4	2	0	0	1	0	0
Moderate	6	4	4	2	1	0	0
Low	7	14	3	6	2	1	2

As the risk assessment did not identify any unacceptable risk events, there was no requirement to apply additional control and mitigation measures and, as such, the Residual Risk Levels are as presented in Table 31 above.

7.13.4 Conclusion

There are no unacceptable risks posed by the establishment of the access corridor.

7.14 COMBINED CYCLE GAS TURBINE POWER GENERATION PLANT

7.14.1 Overview of the Workshop

The workshop was held in Adelaide on the 22nd of January 2008.

Details of the workshop including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix Q of Arup 2008.

The activities analysed as part of the workshop were the construction, operation and decommission of a combined cycle gas turbine (CCGT) power plant.

It is expected that the gas fired power plant will generate 600 MW from multiple units (2 to 4 gas turbines each generating 100 to 200 MW) with 1 to 2 steam turbines, each generating between 100 to 200 MW. The workshop assumptions include:

- The expected location of the power plant is south-west from the processing plant at Olympic Dam (greefields)
- The power plant will be air cooled
- Cooling of inlet air may be required
- The power plant footprint is estimated to be 500m x 500m
- There will be no gas storage on site. The gas required will be piped from Moomba at a pressure of 2-4 MPa.
- The power plant will have no dual fuel (oil) capability
- The maximum gas demand is estimated to be 120 TJ/day
- Base load - capable of operating 24 hours, 7 days a week and expected to operate for the life of the processing plant
- Emission consists mainly of carbon dioxide (CO_2), unburnt gas and nitrous oxides (NO_x)
- The workforce for the power plant is estimated to be 30 people for the operation phase and 100 to 150 people for the construction phase.

7.14.2 Context and Scope

The boundaries pertinent to this risk assessment are:

- Power generation station
- The environmental impacts and other impacts imposed by the construction, operation and decommission of the power generation. The hazards associated with the power generation station include:
  - Gas (natural)
  - Rotating equipment
  - Toxic gas
  - Steam
  - Emission
  - Electricity (low and high voltage)
  - Transformers
  - Working from heights
  - Confined space
  - Hot surfaces

- Noise
- Hydraulic oil leaks
- Evaporative cooling or refrigeration
- Alternative fuel (oil) – outside the scope if this workshop.
- Hydrogen gas.

7.14.3 Risk Levels

The Base Risk Levels associated with the power generation station, allowing for existing control and mitigation measures, are summarised in the table below.

Table 32: Summary of CCGT Power Generation Station Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	**OH&S**	**Social**	**Flora**	**Fauna**	**Physical**	**Water**	**Air**
Extreme	0	0	0	0	0	0	0
High	26	1	0	0	2	1	1
Moderate	41	3	0	0	4	3	2
Low	13	21	11	13	9	7	11

As the risk assessment did not identify any unacceptable risk events, there was no requirement to apply additional control and mitigation measures and, as such, the Residual Risk Levels are as presented in Table 32 above.

7.14.4 Conclusion

There are no unacceptable risks posed by the combined cycle gas turbine power generation station.

7.15 GAS (NATURAL) PIPELINE

7.15.1 Overview of the Workshop

The workshop was held in Adelaide on the 23rd of January 2008.

Details of the workshop including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix R of Arup 2008.

The workshop identified and assessed the risks posed by the construction, operation and decommission of a gas pipeline.

It is expected that the gas pipeline will deliver 40 PJ gas per year required for the gas fired power generation station. The gas demand for the processing plant is estimated to be 5.5 PJ per year. Additional requirement for Roxby Downs will be determined at a later date.

The workshop considered the following issues:

- The pipeline is designed and constructed to comply with the relevant Australian Standards.
- The pipeline route options are:
  - Northern corridor directly from Olympic Dam to Moomba (approx. 430 - 440 km)
  - Southern corridor from Olympic Dam to the existing compressor station on the Moomba to Adelaide line (approx. 380 km)
  - Southern corridor from Olympic Dam to Moomba via the existing compressor station (approx. 540 km).
- Pipeline to Olympic Dam processing plant also include the following route options:
  - Around the Olympic Dam process plant
  - Through Olympic Dam process plant
  - Pipeline from Olympic Dam to Roxby Downs
- Pipeline feeds to Borefield pumps
- The pipeline will be underground for most of its length
- The pipeline is expected to be 350 to 400 mm diameter and rated for a 15 MPa pressure
- The pipe will be buried at a minimum depth of 750 mm and the trench depth will be approx. 1 m
- The preferred width of the pipeline corridor is 30 m but typically cleared are 20-25 m. Land clearance will also be required for mobile work camps
- The estimated workforce is 150-200 people
- Crews will typically work 28 days on and nine days off on a fly-in fly-out / bus-in bus-out basis. They would be accommodated in dedicated construction camps
- Campsite effluent expected to be handled through an on-site package treatment plant
- Campsites are a short term facility, located away from watercourses
- Pipe expected to be transported to site and expected to require approximately 1530 articulated trucks.
- Additional transport include plant and equipment (110 loads) and construction camps (120)

- The estimated construction rate is 3-4 km/day
- The pipe will traverse pastoral stations and Aboriginal land
- The estimated workforce approximately 200 personnel.

7.15.2 Context and Scope

The boundaries pertinent to this risk assessment are:

- Pipeline
- The environmental impacts and other impacts imposed by the construction, operation and decommission of the pipeline.

7.15.3 Risk Levels

The Base Risk Levels associated with pipeline, allowing for existing control and mitigation measures, are summarised in Table 33 below:

Table 33: Summary of Gas Pipeline Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	1	1	0	0	0	0	0
High	10	2	2	1	2	0	0
Moderate	12	5	4	6	4	1	1
Low	4	19	11	11	3	1	8

The Residual Risk Levels, allowing for additional control and mitigation measures are summarised in Table 34 below.

Table 34: Summary of Gas Pipeline Residual Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	0	0	0	0	0	0	0
High	11	3	1	0	1	0	0
Moderate	12	5	5	7	5	1	1
Low	4	19	11	11	3	1	8

7.15.4 Additional Control and Mitigation Measures

To achieve the Residual Risk Levels the following additional actions (Table 35 below) would be undertaken and included in the delivery of the project.

Table 35: Gas Pipeline - Additional Controls and Required Actions

ID No	Additional Controls and Actions Required
7.15/01	Review and update of detailed mound springs mapping and overlay onto the pipeline proposed route. Implement peer review strategies. Implement inspection strategy.
7.15/53	Construct in manner that does not attract attention to corridor, fence or other to prevent easy access to pipeline access road and provide signage to warn of

	dangers and advise of trespassing etc.

7.15.5 Conclusion

Following the application of additional control and mitigation measures, there are no unacceptable risk events resulting from the gas pipeline construction, operation and decommission.

7.16 SULPHUR HANDLING FACILITY

7.16.1 Overview of the Workshop

The workshop was convened in Adelaide on the 14th of February 2008. The workshop identified and assessed the risks posed by the construction and operation of the BHP Billiton sulphur unloading and storage operation at Port Adelaide. For the purposes of this risk assessment, a shared site with ABB Grain Limited has been assumed.

Details of the workshop including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix S of Arup 2008.

Sulphur is to be imported at an estimated rate growing with demand from 450,000 tpa to 1,600,000 tpa. Sulphur will be imported using PANAMAX-type vessels with a capacity of approximately 60,000 tonnes.

Sulphur is transferred to a dedicated storage facility at Port Adelaide from where it will be loaded into rail wagons and transported to Olympic Dam.

The workshop considered the following issues:

- Sulphur exhibits pyrophoric properties. Sulphur dust has a relatively low ignition point (190°C) and dust explosion could occur when a fine dust in air suspension is ignited.
- Sulphur reacts (in certain conditions) with water to form hydrogen sulphide (H_2S) which is a dense and noxious gas.
- Sulphur is incompatible with oxidising agents, forming explosive mixtures when in contact with chlorates, nitrates and other oxidising agents.
- It is estimated that the sulphur import facility will be staffed with only a few persons.

Note: It was understood that sulphur will is currently and would continue to be imported in the form of pril and, as such, dust generation will be significantly reduced.

7.16.2 Context and Scope

The boundaries pertinent to this risk assessment are:

- Sulphur unloading (ship to shore)
- On site storage
- Loading into rail wagons.

7.16.3 Risk Levels

The Base Risk Levels associated with pipeline, allowing for existing control and mitigation measures, are summarised in Table 36 below:

Table 36: Summary of Sulphur Handling Facility Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	0	0	0	0	0	0	0
High	6	0	0	0	1	0	0
Moderate	27	0	1	1	5	1	1
Low	31	14	23	23	8	13	7

As the risk assessment did not identify any unacceptable risk events, there was no required to apply additional control and mitigation measures and, as such, the Residual Risk Levels are as presented in the table above.

7.16.4 Conclusion

There are no unacceptable risk events resulting from the construction and operation of the sulphur handling facility.

7.17 COPPER CONCENTRATE EXPORT FACILITIES

7.17.1 Overview of the Workshop

The workshop was convened in Adelaide on the 12th of March 2008. The workshop identified and assessed the risks posed by handling of copper concentrate.

Details of the workshop including the list of participants, the assumptions made and the issues addressed are presented in more detail in Appendix T of Arup 2008.

The workshop considered the following aspects:

- The material is loaded in rail wagons at Olympic Dam and transported to Port of Darwin where it is loaded onto shipping vessels.
- Copper concentrate exhibits pyrophoric properties (self combust) when aerated and heated while moist.
- The dust also exhibits explosive properties
- The material will be transported in the form of a moist powder. Below 8% water content the material has a tendency to generate dust approximately 9-10% (transport moisture limit – TML) it may liquefy.
- Copper concentrate is unleached (it contains uranium and its decay products)
- Approximately 1.6 Mtpa of copper concentrate is expected to be transported for export.

7.17.2 Context and Scope

The boundaries pertinent to this risk assessment are:

- materials handling at Olympic Dam (i.e. storage, reclaiming and rail wagon loading
- materials handling at Port of Darwin (i.e. unloading, storage and reclaiming)
- shiploading
- shipping within Australian waters
- wastewater treatment and recirculation for washing the exterior of the rail wagons

7.17.3 Risk Levels

The Base Risk Levels associated with pipeline, allowing for existing control and mitigation measures, are summarised in Table 37 below:

Table 37: Summary of Copper Concentrate Export Facilities Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	**OH&S**	**Social**	**Flora**	**Fauna**	**Physical**	**Water**	**Air**
Extreme	0	0	0	0	0	0	0
High	17	0	0	0	1	1	0
Moderate	59	5	2	2	7	4	11
Low	27	18	16	16	2	6	19

As the risk assessment did not identify any unacceptable risk events, there was no requirement to apply additional control and mitigation measures and, as such, the Residual Risk Levels are as are presented in the table above.

7.17.4 Conclusion

There were no unacceptable risk events resulting from the copper concentrate export facilities.

7.18 NORTHERN TERRITORY TRANSPORT OPTION

7.18.1 Overview of the Workshop

The risk register for this activity has been constructed by copying the relevant risk events from the risk registers developed for the seventeen segments. As such, no workshop was convened for the Northern Territory Transport Option.

7.18.2 Context and Scope

The risk register and associated with events pertain to the activity of transporting copper concentrate through the Northern Territory. The boundaries are the state border with South Australia and the extent of costal waters. This includes:

- Transport (rail)
- Unloading
- Storage
- Reclaiming
- Ship loading
- Ship movements

7.18.3 Risk Levels

The Base Risk Levels associated with Northern Territory Transport option, allowing for existing control and mitigation measures, are summarised in Table 38 below:

Table 38: Summary of Northern Territory Transport Option Base Risk Levels

Number of Risk Events for Each Risk Level							
Risk Level	OH&S	Social	Flora	Fauna	Physical	Water	Air
Extreme	0	0	0	0	0	0	0
High	10	1	0	0	1	1	0
Moderate	45	13	2	2	9	7	6
Low	37	32	18	18	19	10	28

As the risk assessment did not identify any unacceptable risk events, there was no requirement to apply additional control and mitigation measures and, as such, the Residual Risk Levels are as are presented in the table above.

7.18.4 Conclusion

There were no unacceptable risk events resulting from the copper concentrate export facilities.

8 Transport

8.1 Road Transport

8.1.1 Heavy Goods Transport

The use of qualitative techniques for assessing the risks posed by heavy goods vehicles employed for the expansion project was considered to not be appropriate. The reasons for this are fully discussed in Arup 2008. Briefly, the main reason was a combination of the fact that the tolerability of the actual risks faced by motorists are not reflected in the qualitative risk criteria developed for the project and the linear nature of the hazard distorts the qualitative risk assessment results.

As such, it was decided to use existing road safety data, specifically that relating to crashes and fatalities, to calculate the theoretical number of fatalities that might result from the increased volumes of heavy goods vehicles on the Australian road network.

This process provided a quantified risk profile for heavy goods road transport for the period 2009 through to 2020 for all materials required for the expansion project.

The primary source of road safety data was the 2005 “How Safe Are Our Roads?” document, which analysed all the major highway routes throughout Australia. Each route is broken into zones with annual average casualty crashes per 100 million vehicle kilometres.

Using this data, fatality rates resulting from heavy goods vehicles (articulated trucks) were calculated for each of the main routes used by trucks for the expansion project, and these combined with the number of truck movements allowed the theoretical number of resultant fatalities to be assessed.

The analysis of Heavy Goods Vehicles was undertaken considering only vehicles associated directly with BHP Billiton activities. What has been excluded is additional vehicles (ancillary vehicles) resulting from the expansion of the township. These are HGV’s that are not under the control of BHP Billiton but are as a result of the expansion of the township.

The results of this quantitative assessment are presented in the table below. These numbers are the theoretical number of fatalities that would result from the increased number of heavy goods vehicles on the roads as a result of the expansion project.

The analysis shows a clear reduction in the number of casualties from approximately 18 (over duration of project) when all goods are moved by road, down to approximately 3 (see line 30 in the table below) when the intermodal facility at Pimba is initially used and then replaced by rail to Olympic Dam.

Noting there are no clear guidelines on acceptability criteria for roads, a reasonable approach to road safety would be consideration of the as low as reasonable practicable (ALARP) principle to ascertain if the risks are being reasonably addressed. In this instance it is clear to see the use of rail (through an intermodal and direct to Olympic Dam) has a significant effect on the risk posed by road transport and it is reasonably argued that the resultant risk level is as low as reasonably practicable.

Fatality Estimates for HV Transport - Years 2010 to 2020		All Road		Road/Rail		Road / Rail / Intermodal	
ID	Data for Each Year	Trucks / year	Fatalities / Year	Trucks / year	Fatalities / Year	Trucks / year	Fatalities / Year
1	**Total - Year 2009**	12,481	0.753	12,481	0.753	12,481	0.753
2	**Total Attributable to Expansion Project - Year 2009**	56	0.008	56	0.008	56	0.008
3	**Driver Fatalities - Year 2009**		0.166		0.166		0.166
4	**Non Driver (Public) Fatalities - Year 2009**		0.587		0.587		0.587
1	**Total - Year 2010**	15,915	0.980	15,915	0.980	15,915	0.980
2	**Total Attributable to Expansion Project - Year 2010**	2,965	0.203	2,965	0.203	2,965	0.203
3	**Driver Fatalities - Year 2010**		0.216		0.216		0.216
4	**Non Driver (Public) Fatalities - Year 2010**		0.764		0.764		0.764
5	**Total - Year 2011**	20,715	1.305	20,715	1.305	20,715	1.305
6	**Total Attributable to Expansion Project - Year 2011**	7,065	0.487	7,065	0.487	7,065	0.487
7	**Driver Fatalities - Year 2011**		0.287		0.287		0.287
8	**Non Driver (Public) Fatalities - Year 2011**		1.018		1.018		1.018
9	**Total - Year 2012**	28,799	2.373	28,799	2.373	28,799	1.077
10	**Total Attributable to Expansion Project - Year 2012**	15,499	1.575	15,499	1.575	15,499	0.279
11	**Driver Fatalities - Year 2012**		0.522		0.522		0.237
12	**Non Driver (Public) Fatalities - Year 2012**		1.851		1.851		0.840
13	**Total - Year 2013**	33,648	2.681	33,648	2.681	33,648	2.211
14	**Total Attributable to Expansion Project - Year 2013**	14,923	1.558	14,923	1.558	14,923	1.088
15	**Driver Fatalities - Year 2013**		0.590		0.590		0.487
16	**Non Driver (Public) Fatalities - Year 2013**		2.091		2.091		1.725
17	**Total - Year 2014**	31,451	1.985	31,451	1.985	31,451	1.416
18	**Total Attributable to Expansion Project - Year 2014**	12,551	0.852	12,551	0.852	12,551	0.282
19	**Driver Fatalities - Year 2014**		0.437		0.437		0.311
20	**Non Driver (Public) Fatalities - Year 2014**		1.548		1.548		1.104
21	**Total - Year 2015**	30,176	1.943	30,176	1.943	30,176	1.386
22	**Total Attributable to Expansion Project - Year 2015**	10,751	0.778	10,751	0.778	10,751	0.221
23	**Driver Fatalities - Year 2015**		0.428		0.428		0.305
24	**Non Driver (Public) Fatalities- Year 2015**		1.516		1.516		1.081
25	**Total - Year 2016**	30,655	1.953	7,823	0.475	7,823	0.475
26	**Total Attributable to Expansion Project - Year 2016**	10,705	0.757	298	0.023	298	0.023
27	**Driver Fatalities - Year 2016**		0.430		0.104		0.104
28	**Non Driver (Public) Fatalities - Year 2016**		1.524		0.370		0.370
29	**Total - Year 2017**	54,522	3.393	7,785	0.473	7,785	0.473
30	**Total Attributable to Expansion Project - Year 2017**	34,572	2.196	85	0.011	85	0.011
31	**Driver Fatalities - Year 2017**		0.746		0.104		0.104
32	**Non Driver (Public) Fatalities - Year 2017**		2.646		0.369		0.369
33	**Total - Year 2018**	55,273	3.460	7,978	0.485	7,978	0.485
34	**Total Attributable to Expansion Project - Year 2018**	35,323	2.264	103	0.012	103	0.012
35	**Driver Fatalities - Year 2018**		0.761		0.107		0.107
36	**Non Driver (Public) Fatalities - Year 2018**		2.699		0.378		0.378
37	**Total - Year 2019**	79,328	4.924	8,687	0.530	8,687	0.530
38	**Total Attributable to Expansion Project - Year 2019**	59,203	3.717	462	0.037	462	0.037
39	**Driver Fatalities - Year 2019**		1.083		0.117		0.117
40	**Non Driver (Public) Fatalities - Year 2019**		3.841		0.414		0.414
41	**Total - Year 2020**	79,542	4.935	9,028	0.541	9,028	0.541
42	**Total Attributable to Expansion Project - Year 2020**	59,242	3.718	628	0.037	628	0.037
43	**Driver Fatalities - Year 2020**		1.086		0.119		0.119
44	**Non Driver (Public) Fatalities - Year 2020**		3.849		0.422		0.422
29	**Total - Years 2009 to 2020**	472,505	30.686	214,486	14.524	214,486	11.631
30	**Total Attributable to Expansion Project - Yrs 09 - 20**	262,855	18.113	65,386	5.582	65,386	2.689
	Total Attributable to Existing Ops - Yrs 09 - 20	209,650	12.573	149,100	8.941	149,100	8.941
31	**Driver Fatalities - Years 2009 to 2020**		6.751		3.195		2.559
32	**Non Driver (Public) Fatalities - Years 2009 to 2020**		23.935		11.329		9.072

8.1.2 Bus Operations

A similar approach to that described above was undertaken for bussing operations, with the exception that the routes were not analysed in such detail, but generic Australian wide data was used to develop the current fatality rates resulting from busses on the roads.

The current data for bus travel is assessed at 1.15 fatalities per 100 million bus kilometres and would apply to all bus operations between Port Augusta, Hiltaba Village and Olympic Dam.

Based on the bus movement between Port Augusta and Olympic Dam over the period 2009 through to 2020 (inclusive) it is estimated that the activity could result in 2 road fatalities (for the whole period). During the same period it is estimated the number of fatalities resulting from bus movements to and from Hiltaba Village would be approximately 0.5.

8.2 Shipping

8.2.1 Ports Traffic

A quantitative assessment of incidents and spills that may occur during the operation phase of Olympic Dam has been undertaken for Port of Darwin and Port Adelaide.

Port of Darwin

The Port of Darwin (PoD) will provide the facility for export of copper concentrate. For this activity, it has been estimated that there would be approximately two PANAMAX vessels (60,000 tonnes capacity) every three weeks arriving and departing from PoD.

Approximately 5000 ships were reported to have visited Port of Darwin in 2005/06, including both trading and non-trading vessels.

Based on this it was calculated the return period for a spill was approximately 8,500 years (i.e. 1 in 8,500 chance of an incident resulting in a spill each year).

Port Adelaide and Outer Harbour

Outer Harbour is expected to provide unloading facilities for sulphur which will arrive in the port on PANAMAX-type vessels. An estimate of 30 ships will arrive each year in the port. Furthermore, Port Adelaide is expected to provide unloading facilities for diesel, resulting in an additional (approximate) 20 PANAMAX ships each year.

The number of ships visiting Port Adelaide in 2005/06 was approximately 1,122 ships, which amounts to approximately 3 ships per day.

Based on these numbers, the number of collisions for sulphur vessels was calculated as 2.3×10^{-4} (return of 4,337 years) with the return period for a spill being approximately 40,000 years.

The number of collisions for diesel transporting ship was calculated as 1.5×10^{-4} with a corresponding return period of 6,506 years. The calculated return period for a spill was approximately 65,000 years.

Future Port Traffic

In 2027, when the estimated traffic in and around Pt Adelaide is predicted to be 1,666 vessels, the calculated return period for a collision between a BHP Billiton sulphur transporting ship and other ships reduces to approximately 3,000 years and for a spill is approximately 30,000 years. The calculated return period for a collision between a BHP Billiton diesel transporting ship and other ships is approximately 5,000 years and for a spill is 50,000 years.

9 Conclusion

9.1 Additional Control and Mitigation Measures

The risk assessment process identified some events presenting an unacceptable risk.

Various mitigation measures, designed to reduce the potential risk exposure, were investigated and a preferred mitigation measure (or measures) identified. A residual risk ranking was developed assuming the successful implementation of the mitigation measures.

These additional mitigation and control measures are summarised in Table 40.

Table 39: Summary of Additional Control and Mitigation Measures

App.	Risk ID	Additional Control and Mitigation Measures
Transport	7.1/7	The rail level crossings to either be signalled or preferably avoided by the construction of overpasses
	7.1/471	BHP Billiton to seek permission for PAMs requiring road closure to travel at night along the Stuart Highway between Port Augusta and Pimba
	7.1/471	The traffic management plan will ensure that all over dimensional loads will use passing bays and/or other alternative means to minimise delays to other users of the road system, by allowing the vehicles to overtake safely. A comprehensive communications program which will include media advertising, signage and on-line information, will be implemented to inform road users of the proposed timing of all over-dimensional load movements.
Water Supply	7.2/11 7.2/51 7.2/88 7.2/90	All structures in the ocean associated with the intake or outfall pipe work at the desalination plant must be below the surface or designed such that access is not possible without special physical aids.
	7.2/25	The intake and outfall pipeline must not be located within the Santos site (if desalination plant is located at Point Lowly) and must be a reasonable or safe distance (to achieve vapour separation distance) from the Santos boundaries. The discharge pipe must not be located on Santos Jetty.
Construction	7.4/290 and 7.4/291	Provide exclusion zones and effective barriers; provide adequate coordination between activities. Undertake risk assessments. The construction process is fully implemented and detailed work planning is undertaken before the commencement of work. Undertake constructability reviews and workshops, construction modules. Consider extended shutdowns to achieve separation.
	7.4/305	Start surveillance (patrol area) 2 hours before blasting to ensure area clear. Increase number of vessels patrolling safe perimeter to four at time of blast and position additional surveillance vessel up current from blast to cover wider and more distant arc.

Decommission and Rehabilitation	7.5/45	If habitat that may have established around the intake/outfall pipeline of the desalination plant is considered important or significant, then the sub-surface structures are to be made safe and to remain in place and as such the risk is completely eliminated.
	7.5/162	Use rail to remove Roxby Downs township and Camp 5 (prior to the removal of the rail track)
	7.5/246	Remove process plant, equipment and materials by rail.
Smelting	7.7/65	Improved design of the ventilation system. Control the amount of recycle dust and electric furnace revert charge rate
Concentration Tailings and Refining	7.8/01	Install dust suppression and/or water spraying capability on the ore stockpile
	7.8/42	Install barriers along perimeter roads of balancing ponds (prevent the vehicles from leaving the road). Provide tether points with harnesses for operators working in the area. Provide permanent acid resistant ropes into the pond at several points around the pond edges
	7.8/58	Install barriers along the access road to prevent the vehicles leaving the road (falling into decant area). Provide tether points with harnesses for operators working in the area. Provide permanent ropes into the pond at several points around the pond edges
	7.8/82	Install barriers along perimeter roads of evaporation ponds (prevent the vehicles from leaving the road). Provide tether points with harnesses for operators working in the area. Provide permanent ropes into the pond at several points around the pond edges
	7.8/98	Install barriers along the access road to prevent the vehicles leaving the road (falling into decant area). Provide tether points with harnesses for operators working in the area. Provide permanent ropes into the pond at several points around the pond edges
	7.8/109	Install barriers along perimeter roads of evaporation ponds (prevent the vehicles from leaving the road). Provide tether points with harnesses for operators working in the area. Provide permanent ropes into the pond at several points around the pond edges
Energy	7.10/ 75-78 and 7.10/ 80-84	Electricity demand to be confirmed by 2009. Prior to that, an EIO will be released. Contracts to be in place in 2009, based on the commissioning of the new processing plant by 2014.
Mining	7.11/51	Camp 1 to be closed prior to mineralised rock being placed closed enough to cause an issue. Radiation levels to be monitored in this area.

Gas Pipeline	7.15/01	Review and update detailed mapping of the mound spring area and update as required information onto the proposed pipe route. Implement peer review strategies. Implement inspection strategies.
	7.15/53	Construct in manner that does not attract attention to corridor, fence or other to prevent easy access to pipeline access road and provide signage to warn of dangers and advise of trespassing etc

9.2 Unacceptable Risk Events

Even with the application of additional controls and measures (resulting in the residual risk levels) there remains two risk events which are deemed to be unacceptable and as such, would suggest the associated activity should not be undertaken. These are summarised in Table 40.

Table 40: Summary of Unacceptable Risk Events

Risk Assessment	Hazard/ Threat	Fault/ Failure/ Cause	Risk Event/ Impacts	Unacceptable Activity
Concentration/ Tailings/ Refining	Acidic liquor (Evaporation Ponds Option)	Visitation by fauna	Fatality rate of listed species exceeds current death rate	Inclusion of the evaporation ponds option in the design of the tailing storage facility
	Acidic liquor (Evaporation Ponds Option)	Visitation by fauna	Fatality rate of general species exceeds current death rate	Inclusion of the evaporation ponds option in the design of the tailing storage facility

10 SUMMARY

Based on the extensive analysis of risks for the proposed expansion of the Olympic Dam mine it is reasonable to conclude that the project does not pose any unacceptable risks to the environment, community, public or employees.

This conclusion is dependent on the following

- The project is built to a size, scale, capacity, location etc as listed in the various risk assessments
- That existing identified control and mitigation measures, as described in Section 4 and Section 6.2) are properly and fully implemented
- That additional control and mitigation measures (as described in Section 9.1)are properly and fully implemented
- That those activities that have been identified as posing an unacceptable risk level are not undertaken
- That the principles of ALARP are applied during the detailed design phase to those risk events with a High or Moderate risk level.

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