# SUSTAINABILITY OPPORTUNITY AND THREAT ANALYSIS





A workbook developed by the Centre for Social Responsibility in Mining and the Minerals Industry Safety and Health Centre



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Abbreviations: ACARP /	Australian C	Coal Association	Research	Program
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- SMI Sustainable Minerals Institute
- SOTA Sustainability Opportunity and Threat Analysis

# Research team:

Project Leader: Professor Jim Joy, Minerals Industry Safety and Health Centre
 Project Leader: Professor David Brereton, Centre for Social Responsibility in Mining
 Researchers: Robin Evans, Centre for Social Responsibility in Mining
 Ruth Beach, Centre for Social Responsibility in Mining
 Bob Pagan, Environmental Management Centre

All of the above Centres are part of the University of Queensland. MISHC and CSRM are both member Centres of UQ's Sustainable Minerals Institute.



1	INT	RODUCTION	
	1.1	Why sustainable development?	I.
	1.2	The SOTA Project	I
	1.3	About this workbook	2
	1.4	About the Sustainable Minerals Institute	2
2	SUS	STAINABLE DEVELOPMENT	3
	2.1	What is sustainable development?	3
	2.2	Sustainable development and mining	4
	2.3	Sustainable development and the minesite	6
	2.4	Additional information	6
3	RIS	K MANAGEMENT	7
	3.1	What is risk management?	7
	3.2	Process steps	8
	3.3	Applications of risk management	8
	3.4	Risk and mining	10
	3.5	Further information	10
4	SO	TA PROCESS OVERVIEW	11
	4.1	Objectives	11
	4.2	Overall process	11
	4.3	An impact-based approach to sustainable development	11
	4.4	Risk analysis protocols	4
	4.5	Workshop	4
	4.6	Applications	4
5	PRC	DCESS SCOPING	15
	5.1	Scope document	15
	5.2	Scope content	15
	5.3	Key issues	17
6	INF	ORMATION GATHERING	19
	6.1	Stakeholder list	19
	6.2	Breakdown of the system	20
	6.3	Sources of opportunities and threats	20
	6.4	Key issues	21
7	IDE	NTIFY RISKS	23
	7.1	Identification of opportunities and threats	23
	7.2	Key issues	24
8	AN	ALYSE AND EVALUATE	25
	8.1	Assigning likelihood and consequence	25
	8.2	Evaluating risks	26
	8.3	Key issues	27

# Contents

9	TRE	AT RISKS	29
	9.1	Definition of controls	29
	9.2	Key Issues	30
10	REP	ORTING AND REVIEW	31
	0.1	Final report	31
	10.2	Review process	32
	10.3	Key issues	32
API	PEND	DIX A – RISK ASSESSMENT SCALES	33
	A.I	Likelihood scales	33
	A.2	Consequence scales	34
	A.3	Risk Ranking table	35
API	PEND	DIX B – GENERIC PROMPT LISTS	36
	B.I	Resource efficiencies	36
	B.2	Emissions, pollutants and waste	37
	B.3	Land use and biodiversity	38
	B.4	Local disturbances	39
	B.5	Workplace management	40
	B.6	Community development and interactions	41
	B.7	Other stakeholder relations	42
	B.8	Local and regional economic development	43

# 1.1 Why sustainable development?

Both new mining developments and existing mines are increasingly under challenge from sections of society. The social and environmental impacts associated with mining are generally perceived as negative in the wider community, and numerous examples exist where mines have not gone ahead or have been closed for reasons other than their financial viability. Concerns regarding the implications of negative impacts are not confined to lobby groups – increasingly customers of mineral products such as large electronics corporations consuming copper and overseas power generators purchasing coal are focusing on the performance of their suppliers in such areas.

The broad concept of sustainable development is emerging as the umbrella under which these issues are being explored. The recent Global Mining Initiative, convened by the world's leading mining houses, commissioned an in-depth research programme entitled Mining, Minerals and Sustainable Development (MMSD) spanning two years to investigate the issues facing the industry. Completed in 2002, the study highlighted nine key challenges and suggested approaches to take the agenda forward. The identification and management of all the impacts of mining activities, both positive and negative, in an integrated framework was emphasised as an essential part of the improvement process.

# I.2 The SOTA Project

The Sustainability Opportunity and Threat Analysis (SOTA) project uses familiar risk management techniques to allow sites to identify and prioritise their own key issues which could impact either positively or negatively on their sustainability performance. The project arose from discussions between researchers at the University of Queensland's Sustainable Minerals Institute (SMI) and a group of industry sponsors, which focused on practical ways to measure and improve the sustainability performance of operating sites. In reviewing the status of sustainability indicators for the mineral industry, and in particular how such metrics could be applied at individual sites, it was suggested that risk management could provide a useful tool to explore the area.

The concept of sustainable development provides a logical way of integrating a number of different impact areas into a coherent framework. This project has adopted conventional sustainability impact categories and combined them with risk management methodology. The outcome is designed to be a simple, practical tool to assist operations to explore the concept of sustainable development in their own context.

During 2002/3 the SMI team developed a framework and trialled the application of this approach, using a participative site-based workshop process. Thus the key inputs come from those most acquainted with the issues. Particular emphasis has been placed on the need to identify opportunities as well as negative outcomes.

# 1. Introduction

# 1.3 About this workbook

This workbook is intended to provide sufficient information and resources to allow anyone to conduct or participate in a SOTA exercise. It is divided into three parts:

- This first section describes the background to the project, and also briefly summarises the twin themes of sustainable development and risk management which underlie the project. It concludes by providing an overview of the SOTA process which brings these themes together.
- The second section steps through the SOTA process one stage at a time. It describes the purpose and outputs of each stage, providing relevant examples to illustrate key points wherever possible. The discussion of each step is concluded with a list of key issues to be considered.
- The third and final section provides generic resources that could be used and adapted to form the basis of a site-focused exercise. These include risk analysis protocols (consequence tables and probability scales), and generic prompt lists. The latter will, by definition, require modification and expansion for any particular site. They are designed to provide an initial framework for further information gathering prior to a workshop.

Throughout the manual examples are provided in shaded sections to illustrate the points being discussed. In addition key messages are presented in highlighted boxes.

# 1.4 About the Sustainable Minerals Institute

SMI was formed in 2001 as an initiative of the University of Queensland, the Queensland State Government and the local mineral industry. It brought together the existing experience base of a number of Research Centres and University departments already active in the minerals area, with a view to better co-ordinating their activities in response to the increasing importance of sustainable development issues for the mining industry.

The SOTA project was carried out by two SMI research centres: the Minerals Industry Safety and Health Centre (MISHC), which since 1997 has conducted internal and external courses on risk management for mining industry professionals; and the Centre for Social Responsibility in Mining (CSRM).

# 2.1 What is sustainable development?

The concept of sustainable development has become a popular focus of debate and research over the last twenty years. The phrase attracted wide attention following the 1987 publication of the UN World Commission on Environment and Development's "Our Common Future" report, which contained the often quoted Brundtland definition:

"development that meets the needs of the present whilst preserving the ability of future generations to meet their own needs"

The report emphasised the need for continued economic development to address pressing issues of poverty and inequality in developing nations, but at the same time recognized that the social and environmental impacts of this development needed to be addressed far more effectively than had been the case to date. The central theme of sustainable development is therefore the integration of economic, environmental and social considerations in terms of how organisations carry out their activities and the manner in which decisions are made.

Subsequent international conferences such as the Rio "Earth Summit" in 1992 and the more recent World Summit on Sustainable Development in Johannesburg in 2002 have provided forums for the concept to be further debated and international protocols defined. There remain significant differences in interpretation of the concept between different groups in society. Some of the more commonly expressed principles of sustainable development are listed below, several of them arising directly from principles defined in the Rio Declaration.

### Commonly expressed principles of sustainable development

**Conservation of biodiversity and ecological integrity** – recognition that the "carrying capacity" of natural systems should not be damaged or exceeded, and that human and environmental systems are inextricably linked together.

**Inter-generational equity** – ensuring the prosperity of future generations by leaving a healthy environment and stock of resources.

**Intra-generational equity** – ensuring that current resources are shared fairly, human rights respected, and the pressing issues of world poverty are addressed.

**Internalisation of environmental values and natural resources** – the "polluter pays" principle, whereby the full social and environmental costs of activities should be identified and allocated to those responsible in order to prevent wasteful use of natural resources.

**Precautionary principle** – not using scientific uncertainty to justify avoiding action where significant environmental damage might result.

**Global perspective** – recognition that the world is a large system, and that problems should not be shifted from one location to another.

In seeking to apply these broad principles to specific industry sectors or activities, various codes and initiatives have been developed that aim to specify more clearly and in context the relevant process and performance principles required. An example is that implemented by the Forest Stewardship Council, which has developed an accreditation scheme for wood products from forests that are assessed as being managed in a "sustainable" manner. Each of the ten principles in the scheme has defined criteria and indicators attached to it that allows progress to be assessed.

Such schemes have not always been widely accepted, and there remains controversy about their effectiveness. Nevertheless, they remain an important method of attempting to connect the broad principles of sustainable development with the practicalities of a specific context and activity.

### 2.2 Sustainable development and mining

While some groups view activities associated with the extraction of non-renewable resources such as minerals as inherently non-sustainable, a broader approach recognises that natural resources may be converted to other types of capital with associated benefits for society as a whole.

Historically, several industry organisations have developed initiatives to encourage and promote consideration of environmental and social issues in the management of mineral developments. The Australian Mineral Industry Code for Environmental Management, developed by the Minerals Council of Australia (MCA) and first released in 1997, has been recognised internationally and become well-established amongst larger companies based in this country. It features seven key principles relating to business processes to improve performance, mainly in the environmental area.

In 2001 the Mining Association of Canada released a set of thirteen principles as a "Sustainable Mining Initiative". The principles address business process and general impact areas covering both environmental and social issues, in particular the effects of operations on local communities and indigenous peoples. Another example can be found in the set of key principles and objectives developed by the World Coal Institute.

As mentioned previously, between 2000 and 2002 a group of major national and international mining companies sponsored the MMSD project. The project was carried out by an independent group which commissioned extensive research in various regions of the world to identify and analyse the key issues facing the global mining industry. Following on from the MMSD the International Council for Mining and Metals (ICMM), which is the peak international association for the industry, released a Code of Sustainable Development featuring ten principles as shown below.

### ICMM Principles of Sustainable Development

- Implement and maintain ethical business practices and sound systems of corporate governance.
- Integrate sustainable development considerations within the corporate decision-making process.
- Uphold fundamental human rights and respect cultures, customs and values in dealings with employees and others who are affected by our activities.
- Implement risk management strategies based on valid data and sound science.
- Seek continual improvement of our health and safety performance.
- Seek continual improvement of our environmental performance.
- Contribute to conservation of biodiversity and integrated approaches to land use planning.
- Facilitate and encourage responsible product design, use, re-use, recycling and disposal of our products.
- Contribute to the social, economic and institutional development of the communities in which we operate.
- Implement effective and transparent engagement, communication and independently verified reporting arrangements with our stakeholders.

To date, the ICMM members who have agreed to measure corporate performance against these principles include Alcoa, Anglo American, AngloGold, BHPBilliton, Freeport-McMoRan Copper & Gold, Mitsubishi Materials Corporation, Newmont Mining Corporation, Nippon Mining & Metals, Noranda, Pasminco, Placer Dome, Rio Tinto, Sumitomo Metal Mining Co., Umicore and WMC Resources.

# 2. Sustainable Development

Within Australia, the MCA is working on converting the existing Code for Environmental Management into a Sustainable Development Code based around the ICMM Principles. A group of industry companies including Placer Dome and BHPB have also combined with WWF Australia to develop and trial a certification process similar to that developed by the Forestry Stewardship Council, but focused on certifying individual mining operations based around their performance in social and environmental areas. These initiatives represent the best chance of realising a widely-accepted framework for sustainable development in the minerals industry.

In the meantime, many companies are moving towards producing integrated sustainability reports, reflecting performance not only in traditional safety and environmental areas, but also incorporating broader social impacts. The current view is perhaps best expressed by Western Mining Corporation in their 2002 Sustainability Report, which uses the image of three overlapping circles to represent the gradual integration of economic benefit, environmental stewardship and social responsibility into a totally unified approach to doing business.



Figure 1 WMC Model of Sustainable Development

The use of three overlapping circles is a common portrayal of the concept of sustainable development in several forums and organisations. Governance, the combination of internal policies and procedures with external codes and regulations, is here portrayed by WMC as a supporting medium for the three principal dimensions of sustainable development.

# 2.3 Sustainable development and the minesite

Increasingly, individual sites are under pressure to explore their performance and impacts in relation to sustainable development. Increasing emphasis is being placed on the need to integrate consideration of impacts across a wide range of areas.

Generic reporting frameworks such as the Global Reporting Initiative (GRI) often do not reveal the detail of the particular issues and challenges facing an operation. A mining industry sector supplement to the GRI is currently being negotiated, but significant differences in the nature of operations and their environment will always mean that some indicators are more relevant than others. It is important that context is used to guide decision-making, and a key aim of this project is to provide a tool to identify and use relevant information at the site level.

# 2.4 Additional information

The intent of this chapter has been to provide a short overview of the topic of sustainable development and mining. Further information on the specific initiatives mentioned above can be found at the internet addresses listed below.

Organisation	Initiative	Internet home page
Australian Federal Government	Policy on ecologically sustainable development	www.ea.gov.au/esd/
Forestry Stewardship Council	Principles and Criteria	www.fscoax.org
Minerals Council of Australia	Australian Mineral Industry Code for Environmental Management	www.minerals.org.au
Mining Association of Canada	Principles of sustainable mining	www.mining.ca
World Coal Institute	Sustainable Development Principles	www.wci-coal.com
International Council for Mining and Metals	Code of Sustainable Development	www.icmm.com

# 3.1 What is risk management?

According to Australian Standard AS4360 (a draft update to this standard is currently undergoing review), risk can be defined as follows:

"the chance of something happening that will have an impact upon objectives. It is measured in terms of consequence and likelihood" – AS4360

Risk management is a systematic method of identifying, analysing and treating risks associated with any activity. It is a recognised discipline and the subject of a large volume of literature, and is described in basic form in AS4360. Although usually applied to minimise negative outcomes, it can also be used to maximise positive results.

"Risk management is as much about identifying opportunities as avoiding or mitigating losses" – AS4360

Risk management can be applied to an enormous variety of situations, at any stage of the life of a particular activity or project. Maximum benefit is usually obtained by carrying out the process as early as possible in order to allow identified controls or actions to be built into the design of a project. However, it is also an iterative process which should be used to provide ongoing feedback to inform management practice and decision-making.



Figure 2 – The risk management process (adapted from AS4360)

Risk management can be broken down into a series of formal process steps, as shown in Figure 2. The activities associated with each step are explained in broad terms in the following sections, and a more specific discussion of each step in the context of the SOTA Project can be found in Part B of this workbook. Risk assessment is here represented as the combination of risk identification, analysis, evaluation and treatment, in line with current National Mineral Industry guidelines (see section 3.4).

# 3.2 Process steps

**Establish the context** – the first stage involves addressing the reasons for undertaking the risk assessment and the environment in which it is to be conducted, and agreeing on the scope of the exercise. This is often the most crucial part of the whole process, since it should provide everyone involved with a clear picture of the whole process and desired outcomes.

**Risk identification** – this stage involves the identification of specific events or outcomes that have typically negative impacts.

**Risk analysis** – following identification of all possible events or outcomes, each is analysed in terms of its likelihood and consequences to produce an overall level of risk.

**Risk evaluation** – once every identified event or outcome has been analysed, the outcome is a list with a level of risk assigned to each one. This list is compared with thresholds, and decisions made on whether further action is necessary.

**Risk treatment** – this stage systematically decides on treatment options for each prioritised risk. Risks that fall into higher categories may require controls to be defined which reduce either the consequences or likelihood of the event, in order to move the overall level of risk into a lower category.

**Monitor and review** – an important element in the overall risk management process is continued monitoring and review of risks and controls. The effectiveness of controls needs to be evaluated on a regular basis, given that the environment within which a system operates can change rapidly. Therefore it is essential that provision is made for monitoring the agreed outcomes of a risk assessment, and provision made for repeating it at an appropriate opportunity.

**Communicate and consult** – perceptions on the level of risk associated with particular outcomes will vary due to differences in assumptions and needs between different stakeholders, both internal and external. It is important to establish and maintain an effective two-way dialogue with stakeholders to ensure that variations in perceptions of risk are understood and incorporated as part of the overall process.

# 3.3 Applications of risk management

Within the boundaries of this broad process, there are many different methods of risk analysis available. A key distinction is between qualitative and quantitative approaches.

Qualitative risk analysis generally involves the use of descriptive scales for likelihood and consequence, whereby each identified event or outcome is evaluated subjectively against these standard descriptions. It is therefore often carried out in a workshop process involving a group of participants with detailed knowledge of the system under review. A well known example of such qualitative scales as developed by NASA and the US Military is provided below, where the consequence or severity dimension is focused on the impact on people's health. Note that, despite the assignment of numbers and rank orders, it is still a subjective approach based on the group's perception of the issues.

Quantitative risk analysis seeks to use more specific data to assign discrete probabilities to events, based on historical data applicable to the system under consideration. Examples of this type of approach can be found in engineering applications, where failure rates for specific system components can be estimated with some confidence.

Hybrid semi-quantitative approaches have also been adopted in recent years in a variety of fields. The SOTA project adopts a qualitative approach since the nature of the issues under discussion are often not well-enough defined to assign discrete values to. The remainder of the discussion in this workbook is focused on this method.

# NASA/US MIL SPEC 882D Risk Ranking Method PROBABILITY ESTIMATE

Identifier	Descriptor
A	Common event or likely to occur (>0.1)*
В	Probably will occur or "it has happened" (0.1 – 0.01)
С	May occur or ''heard of it happening'' (0.01 – 0.001)
D	Not likely to occur or "never heard of it" (0.001 – 0.000001)
E	Practically impossible (< 0.000001)

\*Event expected to happen 1 in 10 times the circumstances occur

# MAXIMUM REASONABLE SEVERITY CLASS (PEOPLE)

Identifier	Descriptor
	Catastrophic – fatality or permanent disability
Ш	Critical serious lost time injury/illness
Ш	Moderate – average lost time injury/illness
IV	Minor lost time injury/illness

# **RISK RANKING TABLE**

	Probability A	Probability B	Probability C	Probability D	Probability E
Severity I	I	I	2	3	4
Severity II	I	2	3	4	5
Severity III	2	3	4	5	6
Severity IV	3	4	5	6	7

Those events or outcomes with significant severity and high probability will therefore fall in the upper left quadrant of the risk ranking table, requiring immediate controls. Those events considered practically impossible and with minor severity fall in the lower right corner, and are unlikely to warrant further consideration.

# 3.4 Risk and mining

The minerals industry in Australia has developed a significant history of applying risk management techniques over recent years. The rapid growth in this area has been driven largely by a focus on the need to improve health and safety performance in many parts of the sector, but the techniques have also been applied to other specific issues such as environmental performance and broader aspects of business risk. For example, it is common to find qualitative risk ranking tables within Environmental Impact Assessment documents, and the field of Environmental Risk Management has been actively developed in recent years.

In 2001, the Minerals Council of Australia commissioned a national project to derive "good practice" guidelines for the application of risk assessment. Several large mining companies and government agencies provided input and guidance to the project, the outcomes of which were generally consistent with the process model described in AS4360. The most recent version of the guideline was published in July 2003, and reviews in detail the various types of risk assessment methods and their applicability to different situations.

Many mining companies have existing risk management procedures that include qualitative scales of the type shown in the previous example, some with several different consequence or severity scales that reflect different dimensions of concern such as health and safety, environmental, and financial impacts. Formal risk management is now effectively a key part of the business process for most operations in the industry.

# 3.5 Further information

Organisation	Initiative	Internet home page
Australian Standards	AS4360 – Australian Standard for Risk Management	www.standards.com.au
	HB203 – Environmental Risk Management – Principles and Processes	
Minerals Council of Australia	National Mineral Industry Safety and Health Risk Assessment Guidelines	www.mishc.uq.edu.au

Additional information on risk management and its applications including within the minerals industry can be found at the following locations.

# 4.1 Objectives

The broad objective for the SOTA Project is to draw together the themes of sustainable development and risk management into a tool that can usefully be applied at the operational level. The aims of the tool are to identify the issues of most significance at a site, and to develop controls for improving performance and monitoring of those issues.

# 4.2 Overall process

The SOTA process can best be portrayed as a series of discrete steps corresponding to the principal stages of the AS4360 model shown earlier. Thus the process is defined by the risk management approach.



Figure 3 SOTA process steps

In the above diagram, the "Analyse risk" and "Evaluate risk" steps from AS4360 are merged into a single step, since evaluation fits naturally at the end of the analysis process. In addition, the "Monitor and Review" and "Communicate and Consult" feedback loops are omitted for simplicity. SOTA is presented here as a discrete one-off exercise, but a key to its success will be how well it can be integrated into existing business processes. Ongoing communication and monitoring are clearly essential elements in this regard.

An additional step of "Information gathering" has been explicitly added between the "Scoping" and "Risk identification" phases. This is to emphasise the importance of collecting and organising relevant information into a framework suitable to explore the theme of sustainable development. Further details on how each step is carried out, together with illustrative examples, are presented in the next section of this manual.

The main part of the process comprising the identification, assessment and treatment of specific opportunities and threats is carried out in an interactive workshop, where the experience base of site-based participants is used to focus on the issues of most significance and relevance.

# 4.3 An impact-based approach to sustainable development

There are many definitions and models of sustainable development available, and most could be combined with the risk management process outlined above. For the purposes of the project, it was decided to develop a model which used the overlapping circle image, combined with some broad impact categories which reflect the concerns of all stakeholders. It therefore reflects specific outcomes rather than process issues. This approach is used to illustrate the process in the following sections.

# 4. SOTA Process Overview

A key point to remember at this stage is that impacts can be positive as well as negative. This is a point addressed during most formal impact assessment processes, where the benefits of proceeding with a project should be identified as well as potential negative impacts. However, approaches to identifying and assessing the potential positive impacts are not always as well addressed during subsequent risk assessment processes.



Figure 4 an impact-based description of sustainable development

The above diagram provides broad categories of impacts that together cover the three main dimensions of sustainable development. The categories are summarised as follows:

**Resource efficiencies** – How well are we conserving scarce resources and making our processes more efficient? What are the implications of current consumption patterns?

**Emissions and pollutants** – What are the main emissions from the site that have the potential to cause environmental damage both locally and globally?

Land use and biodiversity – What are the impacts of the mine on local land use and biodiversity? How can the operation make a positive impact? What risks exist in the rehabilitation processes?

**General waste streams** – What are the main types of waste from mining and processing? What are the impacts of waste disposal practices? What opportunities exist to reduce the amount of waste, and re-use or recycle more?

**Local disturbances** – What environmental issues directly affect neighbouring communities? What changes has the operation caused?

**Workplace management** – How does the operation impact on the people who work there? Are there specific health and safety impacts? What opportunities exist to assist employees in managing work/home conflict issues?

# 4. SOTA Process Overview

**Community interactions** – How does the mine affect the community, local and otherwise? Are there any health and safety concerns? What benefits to the community have arisen from the presence of the mining operation?

**Other stakeholder impacts** – What impacts arise from interactions with other stakeholders? How has the operation engaged with stakeholders in the broader community?

**Local and regional economic impacts** – What are the impacts of the economic activity associated with the mining operation at a local and regional level?

This model is used to organise the identification of "hazards" and specific events during the risk assessment process, thereby adding the sustainable development dimension to the risk management approach.

It is important to recognise that alternative frameworks are equally appropriate for this task, and indeed if the organisation involved in a SOTA exercise has an established reporting framework for sustainable development then it would be more beneficial to use such a model. An example of a framework developed by Rio Tinto Borax is provided below. Alternatively, an emerging framework such as the ICMM Principles described earlier could also be used.

### Rio Tinto Borax Sustainable Development Principles

### ENVIRONMENTAL PRINCIPLES

- **Product Stewardship:** Borax will operate a product stewardship program in cooperation with customers. Health, safety and environmental considerations will be a priority in planning for all existing and new products and processes.
- **Pollution Prevention:** Borax will minimise air, water and soil pollution through the pursuit of source-control technology, technical innovation and employee involvement.
- **Resource Stewardship:** Borax will maximize efficiency in our mining and process operation, minimise product losses, and maximize efficient use of water, energy and raw materials.

### SOCIAL PRINCIPLES

- Safety & human health: Borax is committed to protecting the health and safety of our employees, contractors, community neighbours, and the public
- Stakeholder engagement and transparency: Borax will develop partnerships with, and seek input from key stakeholders, and will provide them with information relevant to their needs and interests through timely and open reporting.
- **Community Partnerships:** Borax seeks to make a lasting contribution to the communities where we operate by partnering with our local communities for long-term, mutual benefit.

### ECONOMIC PRINCIPLES

- Shareholder Return: Borax will maximize return on investment over the long term, which provides the resources necessary to maximize our contribution to sustainable development.
- Economic contribution: Borax will provide opportunities for equitable economic development, improved living conditions, and access to transferable skills development for employees and the communities where we operate.

(Source: www.borax.com)

CAMPL

# 4. SOTA Process Overview

# 4.4 Risk analysis protocols

As discussed previously, SOTA is best approached using a qualitative risk analysis method, since many of the events and outcomes being considered will not lend themselves to quantitative analysis. Due to the fact that many operations will already have established qualitative scales in place, the project has not set out to produce a definitive set. However, it will usually be necessary to modify the descriptors to account for positive outcomes – experience suggests that most existing protocols do not allow for this aspect. Examples of suitable risk assessment scales that could be used for a SOTA exercise are included in Appendix A.

Another factor to evaluate when considering existing risk assessment procedures is whether the consequence scales provide enough breadth to account for impacts in all of the impact categories under consideration. Sometimes, it may be necessary to modify the protocols to suit the particular context.

### 4.5 Workshop

Many applications of qualitative risk assessment are carried out using participative workshops, with a range of people familiar with the system under consideration. SOTA is designed for this purpose, since it is also intended to develop the concept of sustainable development in an interactive environment.

Such workshops are usually best run in an environment away from the distractions of day-to-day operations. The duration will depend on the scope of the exercise under consideration, but it is important to allow sufficient time for the different stages to be completed, as well as designing a timetable that allows breaks and provides a comfortable environment.

### **4.6** Applications

The SOTA technique can be applied to a wide variety of situations, either specific aspects of a particular operation or a broad review. Examples where the technique has been used to date to address sustainability issues include the following:

- A broad review of an existing mining operation, scanning each impact category in turn and examining those of concern in more detail. This type of application is the main focus of this workbook.
- The evaluation of options for locating a workforce at a new operation, where choices included a fly-in fly-out arrangement, the creation of local accommodation at an existing small rural community, or a drive-in arrangement from a larger but more distant urban centre. This exercise focused on impacts in the social dimension.
- The review of impacts associated with a mining company's water supply system in Central Queensland, extracting water from a river system and distributing it to graziers, residential mining communities and mine operations. The exercise examined economic, environmental and social impacts associated with the system from extraction to disposal.

5. Process Scoping



The first stage of the process involves scoping the project. This requires the definition of the overall strategic context, and then agreeing the boundaries and methods which will guide how the process develops. This is one of the most important stages of all:

"The success or otherwise of a risk assessment exercise is mainly determined by the integrity of its fundamental design" – Mineral Industry Risk Assessment Guidelines

# 5.1 Scope document

The scope of the project should be discussed and documented at a meeting of the key stakeholders representing the organisation(s) commissioning the process. The intended facilitator should also be present. In some cases, it may be beneficial for initial site visits and discussions with key stakeholders to have occurred prior to this meeting to assist in understanding the overall context and designing the scope appropriately.

Following the meeting, the agreed points should be collated in a formal document and circulated back to all those involved to ensure common understanding of the process to be followed and the resources required.

# 5.2 Scope content

For the purposes of SOTA, the scope document should address the following issues as a minimum.

**Project objectives** – a brief paragraph outlining the broad nature of the desired outcome and scope of the exercise.



### Objectives

The objective of the project will be to review the operations of the mine and processing plant using the team-based SOTA technique in order to identify priority opportunities and threats affecting sustainability criteria in the areas of social and environmental performance.

**System definition** – for any risk assessment process, it is essential to define the system under consideration and its boundaries. Typically, the focus of a SOTA exercise will be on a particular site and its immediate impacts. Sustainable development can be a very broad topic, extending to product lifecycle issues, e.g. what are the environmental implications of the use of the product being mined? However, the influence over such an issue is likely to be low at an operating site level, and it is likely to be more appropriate to limit the analysis to a fixed point in the product cycle such as a train load-out facility.

# 5. Process Scoping

Similarly the exercise could be applied to all activities at a particular site, or could be confined to a specific process or decision – examples include the management of water in a particular system, or the location of a workforce for a new operation.

Another key issue to be decided is the timeframe involved for the analysis. Given the forward-looking nature of sustainable development, it is difficult to exclude longer term considerations. However, if mine closure is sufficiently far off then it could be agreed to focus the exercise on immediate impacts, and defer issues such as mine closure to a separate exercise.

# EXAMPLE

### Broad site system definition

The system to be reviewed will include all activities associated with current and projected mining operations, up to and including coal loading at the railhead. It will cover the full range of sustainability impacts including social and environmental issues.

No timeframe limit will be set in terms of impacts to be considered. An objective of the exercise will be to identify both short and longer term impacts that require management attention in the near future. This could include the relinquishment of certain areas of current operations, and also deal with some aspects of mine closure.

Sustainability framework and other workshop resources – it is important to provide a sustainable development framework within which the opportunities and threats can be identified and organised. Existing corporate frameworks would be the best starting point, but if none exist then a generic model should be specified. One example is the overlapping three circle model with various impact categories identified, as shown earlier in section 4.3. Whatever approach is adopted, it is important to overtly introduce this concept early in the process in order to emphasise the range and nature of the impacts to be considered. The focusing question then becomes what opportunities or threats exist which will influence performance against each particular criteria. The format for this and other information to be brought to the workshop as prompts should be agreed.

**Risk analysis method** – as mentioned previously, qualitative risk analysis scales are most suited to the types of issues which may arise during a SOTA exercise. It is therefore necessary to agree on the tables and scales to be used. Many operations will have such scales available, and these should be used if they permit consideration of broad impacts in social, environmental and financial terms. It is also important to have positive consequence scales which may need to be constructed by inverting the more common negative tables. Note that it is preferable to use existing, familiar tools as the starting point wherever possible.

In addition to consequences, a scale that provides descriptions of probabilities for both negative and positive outcomes must also be available. Note that it is preferable to use a separate definition of probability for opportunities, since the interpretation of the phrase is distinctly different. For an opportunity, the scale will reflect the achievability of the outcome assuming that some proactive action is taken.

A set of example risk analysis protocols is provided in Appendix A. This comprises a set of consequence scales with descriptive text to cover a broad range of outcomes, separate probability scales for opportunities and threats, and a matrix for combining these values into an overall risk rating.

# 5. Process Scoping

**External stakeholder input** – a key part of the SOTA process is recognising the range of stakeholders involved and incorporating their viewpoints into the process in some form. Impacts that affect neighbours and local communities are clearly part of the sustainable development equation, as are interactions with other groups such as regulators.

One approach is to involve external stakeholders in the workshop itself. However, if that is not practical for logistical or other reasons, some information gathering may be carried out with relevant stakeholders prior to the workshop, and a workshop participant allocated the role of ensuring that their input is heard. Concerns on issues of confidentiality and information management should be noted where appropriate.

**Team selection** – team members for the workshop should be chosen to provide sufficient knowledge around the table to address the types of issues identified in the earlier sections on system and framework. Operational experience close to the issues is essential.

**Logistics** – the proposed date and location of the workshop should be nominated to provide everyone with an estimate of the time available for information gathering. A location should be chosen that will allow participants to focus on the task and not be distracted by minor work issues. Duration will vary according to the system and issues under consideration, but should be a minimum of one day to allow the full risk assessment cycle to be completed.

**Reporting method** – the method of collating and reporting the output of the workshop should be specified, including expectations of the level of risk controls to be included in the risk register. The methods of allowing participant input into the final report, for example through circulation of a draft, should also be identified.

### 5.3 Key issues

- Sufficient time must be allocated to the scoping process to ensure that everyone is clear about the nature of the process and the information required. Confusion at this point will cause problems later.
- Clarity regarding the system boundaries and timeframes to be considered is essential.
- Incorporation of other stakeholder viewpoints in some form is important, and the guidelines and methods for achieving this should be discussed at this point.
- It is important to specify what the outputs of the process will be, and how these will link in to subsequent follow-up activities, e.g. review and development of an action plan.



# 6. Information Gathering



The second stage of the process involves gathering information and producing the prompt lists designed to help workshop participants focus on the relevant issues. To this end it is useful to circulate the material produced prior to the workshop.

# 6.1 Stakeholder list

EXAMPLE

As mentioned, an important part of the process is the consideration of consequences from the point of view of all stakeholders, not just the mine operators. To aid this outcome, a list of all relevant stakeholders should be organised incorporating a brief description of their role and key interactions and objectives.

### Stakeholder descriptions

Consider a fictitious open cut mine in a remote area operating on a fly-in fly-out basis from coastal centres. The site is close to a local aboriginal community, and the mining lease extends over a significant grazing property.

Stakeholder	Description
Landowner	<ul> <li>Grazier</li> <li>Continues to graze cattle on adjoining property, water supplied via mine pipeline and dam. Will re-introduce grazing on mine lease on relinquishment. Some complaints re downstream water quality in Murphy's Creek.</li> <li>Aims to sell property once lease has been returned and restocked.</li> </ul>
Local community	<ul> <li>Indigenous community located 50km from site.</li> <li>Agreement negotiated five years ago includes targets for local business development and employment.</li> <li>Focused on improving performance in these areas which has proved difficult.</li> </ul>
Workforce	<ul> <li>Employed on FIFO basis from coastal towns on a 9:5 roster featuring 12 hour shifts.</li> <li>etc</li> </ul>

# 6. Information Gathering

Listing as complete a collection of stakeholders as possible, helps define the context of the operation more clearly for all participants of the process, who may not be familiar with every aspect of the various relationships.

It may be useful to divide the various stakeholders into internal and external groups, internal being those who are involved in some way in supporting the operations of the mine on a routine basis, e.g. workforce, suppliers, contractors.

# 6.2 Breakdown of the system

In order to help participants in the workshop focus logically across all areas of the system defined in the project scope, it is useful to provide visual representations of the system under consideration. This should include a map of the operation showing all the relevant facilities being considered, and a generic process flow diagram that encourages participants to think in terms of the whole process, rather than focus just on the parts that they are most familiar with. For example, a project focusing on a particular aspect such as water management would require an overall water flow schematic with relevant inputs and outputs identified.

# 6.3 Sources of opportunities and threats

In a risk management process, the source of a threat is generally referred to as a "Hazard". An important part of the process is constructing a "Hazard Inventory", which lists the sources of potential threats in a particular system. It is important to distinguish between a hazard, an event which arises from that hazard, and the consequences of the event. For example, the on-site storage of diesel represents a hazard; an unwanted event that might arise would be a spill of the diesel into the local water system; the consequences could include financial costs of a clean-up, reputational damage and quantifiable environmental impacts on the ecosystem.

In the case of SOTA, the aim is to construct the equivalent of a Hazard Inventory that lists the source of both opportunities and threats which could impact on a given sustainability criteria. As for stakeholders, adding some context is important in order to allow participants to share existing knowledge prior to the workshop, and to consider the types of opportunities and threats that might arise from these "Hazards". These prompt lists are constructed using the agreed sustainable development criteria.

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X
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### Sources of opportunities and threats

# Criteria – Resource efficiencies

Water use	<ul> <li>Overall site use of fresh water is 2400MLpa, with prep plant consuming 1500, office and workshops 750.</li> <li>Water use is monitored monthly.</li> <li>Mine water is used preferentially for road watering wherever possible.</li> </ul>
Coal excavation	<ul> <li>Some coal edge loss during highwall blasting, currently no estimate of quantity.</li> </ul>
Coal storage in stockpiles	<ul> <li>ROM product stored an average of two weeks. stockpiles Occasional spontaneous combustion of coal in stockpiles.</li> <li>etc</li> </ul>

# 6. Information Gathering

Note that these prompts do not seek to identify specific events or outcomes (that is the purpose of the workshop), but rather the source and the overall context. A set of generic prompts and relevant contextual information covering both surface and underground mines is provided in Appendix B. The list can be used to highlight areas of good performance and successful controls, so that this information can be used to guide the workshop process away from areas that are already well-covered. It is included as a starting point and to provide examples of "Hazards", but it is not intended to be comprehensive or detailed since relevant contextual information is essential in presenting information in this form.

### 6.4 Key issues

- Focus on the source of the opportunity or threat, rather than specific events. These will be identified in the next stage of identifying risks;
- Use the prompt list to identify the areas of largest impact and highlight relativities. For example, when considering water use the quantities for human use on-site will often be trivial when compared to processing and other uses.
- Some areas may already be well covered by existing systems or recent projects, in which case it may be decided that there is little value in considering further. For example, workplace health and safety issues are generally thoroughly covered on most minesites. Even though the area is a key impact area for most models of sustainable development, there may be little value in considering further in this workshop.
- Highlight existing systems and controls that are in place already.
- Distribute the material generated prior to the workshop so that participants can come prepared.



7. Identify Risks



The identification of risks is the first part of the SOTA workshop phase. This involves the systematic identification of both opportunities and threats, using the prompt lists developed in the previous section. This should be an open process, whereby any participant can nominate events or outcomes they wish to discuss regardless of existing systems or controls in place.

### 7.1 Identification of opportunities and threats

Workshop participants should be asked to suggest specific events or outcomes that would impact either positively or negatively on the criteria involved. The sustainability framework and the system process diagrams are used to guide people through the exercise. At this stage the intent is to canvas all possibilities without exploring the relative likelihood or degree of consequence.

### Identification of opportunities and threats

Capture the ideas in a table or spreadsheet, linking the specific opportunity (O) or threat (T) with the prompt that produced it. The first example in this table deals with vehicle washdown, currently carried out using high pressure fresh water. A relatively clean minewater dam nearby could be used to provide a constant recycling supply for this activity, compared with the current straight-through single use approach consuming fresh water.

Criteria – Resource efficiencies		
Water use	Water use O – reduce fresh water consumption by using good quality mine water for vehicle washdown	
Water use	T – make-up water on thickener could be left on, significantly increasing prep plant consumption of fresh water	
Water use	O – use more water-efficient nozzles for hosing activities in plant and workshops	
Coal recovery	O – reduce coal edge loss through improved control of drilling and blasting practice along front rows	
Coal recovery	T – major spontaneous combustion event in stockpile results in significant loss of coal	
etc	etc	

EXAMPLE

# 7.2 Key issues

- Capture as many ideas as possible. The process should be akin to "brainstorming" with active participation encouraged. Probabilities and consequences for each opportunity or threat identified will be reviewed in the next section, so unless the group as a whole believes that something is not possible or irrelevant, it should be captured.
- It is important to use precise language to specify the outcome being discussed, rather than just repeat the nature of the hazard.
- Focus on the possibilities for realising positive impacts. Since risk management is usually applied to avoid or mitigate negative impacts, there is a natural tendency for participants to focus on threats. Good facilitation is required to ensure that this aspect of identifying opportunities is covered.

# 8. Analyse and Evaluate



The second stage of the workshop involves analysing the identified opportunities and threats in terms of two parameters: the likelihood of their occurrence, and the consequences if they do occur. The consolidated list is then evaluated against a risk ranking scale.

# 8.1 Assigning likelihood and consequence

Using the scales agreed upon during the scoping process, assign a likelihood and consequence value to each of the opportunities and threats identified in the previous step. It is useful to provide participants with copies of the scales to refer to during this stage of the process.

# EXAMPLE

### Assigning likelihood and consequence

Using the first opportunity from the previous example, additional columns are provided for likelihood (L) and consequence (C).

Criteria –	Resource Efficiencies	L	С
Water use	O – reduce fresh water consumption by using good quality mine water for vehicle washdown	4	2
Water use	T – make-up water on thickener could be left on, increasing prep plant consumption of fresh water	2	-2

The likelihood of the opportunity is rated as 4 (definition – "high probability of success with low to medium resource requirement"), since the consensus is that the recycled water would be suitable for the task, and the implementation is relatively straightforward involving some additional pipework and a small local pump.

The consequence is rated as 2 on the financial scale (definition – "in the range 10000 - 100000 NPV"). The current variable cost of water to the operation is approx. 500 per megalitre, and it is estimated that the current usage of 50MLpa for this purpose could be totally eliminated. This produces an annual saving of 25000, which allowing for initial expenditure would result in an NPV at the high end of the second scale interval.

Note that in the list of examples, threats are distinguished from opportunities by specifying a negative magnitude to the consequences.

# 8. Analyse and Evaluate

Often, a specific opportunity or threat may have consequences in more than one dimension. In the example used, there may be environmental benefit to local water resources in terms of reducing overall consumption, or alternatively significant social consequences. For the purposes of this exercise, it is best to use the single highest consequence that the participants agree on. More complex analyses can allow for integration of a range of consequences, but this aspect will not be pursued further here.

# 8.2 Evaluating risks

Overall risk is a function of the likelihood and consequence combined, and can be assigned using a rating system.

EXAMPLE

# Evaluating risks

Continuing the same example, reference is made to the risk rating table as discussed in more detail in Appendix A.

Consequence		Like	lihood Ra	ting	
Rating	5 High	4	3 Medium	2	l Low
5 – High	9	8	7	6	5
4	8	7	6	5	4
3 – Medium	7	6	5	4	3
2	6	5	4	3	2
I – Low	5	4	3	2	I

Applying this rating system to the list of opportunities and threats produces the following type of information:

Prompt	Opportunity or Threat	L	С	RR
Water use	O – reduce fresh water consumption by using good quality mine water for vehicle washdown	4	2	5
Water use	T – make-up water on thickener could be left on, increasing consumption of fresh water	2	-2	-3

The list can then be sorted according to the risk rating value, allowing the most significant opportunities (the highest positive values of RR) and threats (the most negative values of RR) to be identified. If desired, threshold values can be set to filter the list prior to the next step.

# 8.3 Key issues

- Do not focus on matching events to exact definitions in the ratings scales for consequences. Inevitably some risks will be discussed where the consequences do not correspond directly to the descriptions in the scales. The intent is to provide a comparative assessment of the magnitude of the consequences involved, and some degree of subjectivity will be involved.
- Use the scales to think of broader consequences beyond the direct financial impact on the operation involved. For example, an accidental release of a pollutant may have minimal financial impact in terms of potential fines involved, but could have quite serious impacts on the relationship with a local community.
- If multiple consequences are involved for the same issue, consideration could be given to increasing the overall rating if the event in question is perceived as more significant than others rated at that level.
- When considering opportunities with positive outcomes in areas other than financial, do not focus solely on the cost of implementation when considering probabilities. The cost-effectiveness of controls is a separate issue to be considered later the purpose of SOTA is to identify and prioritise those opportunities and threats worthy of further evaluation.



9. Treat Risks



The final stage of the workshop involves reviewing the prioritised list of risks (analysed opportunities and threats), and deciding on appropriate controls to achieve the desired outcome.

# 9.1 Definition of controls

When considering a group of identified and prioritised risks, there are a number of options available for addressing them. These can seek to modify the likelihood or the consequence of the event, or (in the case of a threat) seek to eliminate it by totally removing the hazard at source.

The prioritised list of risks should be considered, starting with the most significant opportunities or threats. Existing controls can be discussed, bearing in mind that these should usually have been considered when assigning a likelihood in the previous stage, and possible new controls proposed.



In considering controls for practical outcomes, experience has shown that physical, engineering-based solutions for problems are an order of magnitude more effective than procedural or system-based solutions. In the second example above, the use of a timed shut-off valve would be a more effective method of preventing an extended overuse of water in the thickener than simply reminding operators of the importance of water consumption in that area.

# 9. Treat Risks

This issue is described by the Hierarchy of Controls, as listed in the National Mineral Industry Guidelines. In order of decreasing effectiveness, controls to address negative risks could include:

- Elimination remove the hazard so consequence is virtually zero;
- Substitution replace or reduce the magnitude of the hazard so there is less consequence;
- Isolation remove the hazard or the target at the time of exposure;
- Engineering controls reduce the probability of the unwanted event through procedural approaches;
- Administrative controls reduce the probability of the unwanted event through procedural approaches;
- Personal protective equipment reduce the consequences at the target.

For positive risks, the nature of the controls will need further consideration. They may vary from broad actions such as commissioning a project to investigate further, to more specific procedural changes, etc.

# 9.2 Key Issues

- The output of SOTA will normally be a risk register with suggestions for possible controls, but it will not normally extend to an implementation plan unless that is agreed as part of the scoping process.
- Where more than one control is suggested, capture all as possibilities rather than trying to decide on a single "best" option.

# 10. Reporting and Review



The final stage of the process involves the production of a report summarising the process and the outcomes, and a review session to capture the learning and agree on the outcomes.

# 10.1 Final report

All risk assessment processes should be formally documented in a final report that provides all information required for further reference. The final report should address both the process used and the principal outcomes of the workshop. It should be capable of informing those not involved as to how and why the process was carried out.

An example of a suitable format can be found in the National Mineral Industry Safety and Health Risk Assessment Guideline. The following example is adapted from that source with minor modifications.

Report format checkli	st adapted from NMISHRAG 2003
Executive Summary	<ul><li>Context and objectives</li><li>Methodology</li><li>Conclusions</li></ul>
Introduction	<ul> <li>Context (strategic, corporate and risk management)</li> <li>Issues / reason for review</li> <li>Project objective and broad scope</li> </ul>
Method	<ul> <li>System description and boundaries</li> <li>Risk assessment protocols and methods</li> <li>Prompt lists (include in Appendices)</li> <li>Team (names, positions &amp; related experience)</li> <li>Workshop details</li> </ul>
Documentation used (refer to Appendices)	<ul><li>Stakeholder list</li><li>Hazard inventory</li><li>System schematics</li></ul>
Results	<ul><li>Priority risks (opportunities and threats)</li><li>Possible new controls</li></ul>
Conclusions	<ul><li>Summary of priority areas</li><li>Further action and timelines</li></ul>
	Report format checkling         Executive Summary         Introduction         Method         Documentation used (refer to Appendices)         Results         Conclusions

# 10. Reporting and Review

The report should be circulated in draft form prior to finalisation. Opportunities should be provided for participants to review the results and recommended controls, and raise any concerns that might arise.

### **10.2 Review process**

Once the final version of the report has been circulated and sufficient time has elapsed, a review session is an important step in agreeing the outcomes of the process. It is an opportunity for process learnings to be captured, and the value of the process to be debated.

Whilst some feedback can be collected remotely, it is recommended that a face-to-face meeting with key participants and stakeholders be organised for this purpose.

# 10.3 Key issues

- Generation of the report should be as interactive a process as possible. It should not be seen as one individual or organisation's view, but rather be accepted by workshop participants as a true reflection of the process.
- Whilst monitoring and evaluation was omitted from the SOTA process, it is clearly an important part of risk management. Outcomes from the process should be captured in existing business processes that offer regular monitoring opportunities.

# Appendix A – Risk Assessment Scales

The following sections provide examples of the types of scales used for qualitative risk analysis processes. These may be used to conduct a SOTA exercise, but it is preferable to use existing corporate guidelines as a starting point and modify as required, e.g. to include positive consequence outcomes.

# A.I Likelihood scales

### Threats

The probability of a negative event or outcome being realised from a threat can be expressed as the combination of the exposure to that situation and the likelihood of it occurring once the situation is present. In most qualitative risk assessment studies, these two aspects are intuitively combined to provide an overall description. The following example is that referred to in section 2.3 from NASA/US MIL SPEC 882D.

Likelihood	Description
Rare	Practically impossible
Unlikely	Not likely to occur, or ''never heard of it''
Possible	May occur, or ''heard of it happening''
Probable	Probably will occur, or ''it has happened''
Almost certain	Common event, or likely to occur

### **Opportunities**

The probability of a positive outcome is not often considered in the same manner, and requires a change in definition: whereas threats are evaluated assuming no additional controls, i.e. the status quo, opportunities must be evaluated assuming an appropriate level of proactive action. Factors to be considered include the exposure to the circumstances whereby the opportunity could be realised, the resources required and the inherent difficulty of achieving the desired outcome.

Likelihood	Description
Rare	Practically impossible, resources unlikely to be available, low probability of successful outcome
Unlikely	Not likely to occur, has not been achieved elsewhere, very difficult to achieve
Possible	May occur, resources possible and even chance of successful outcome
Probable	Probably will occur, achievable with practical resources, has been done elsewhere without difficulty
Almost certain	Common outcome, resources accessible and relatively easy to achieve

A.2	Consequence	scales

Consequence rating	Human health and well-being	Social capital	Natural capital	Corporate & manufactured capital
for the operation and its stakeholders	The health and well-being of the workforce and affected communities	The level of social cohesion, trust and interaction amongst the communities and companies involved	The health and integrity of the biosphere and natural systems upon which all life depends	Intellectual capital, corporate reputation, financial and physical assets
5 Highly significant positive iimpact (beyond life of operation)	<ul> <li>Positive "life-saving" impact on &gt;100 lives</li> <li>Significant and sustained health improvements to &gt;1000 persons</li> </ul>	<ul> <li>Highly significant contribution towards community's future wellbeing</li> <li>Major improvement of some areas affecting social order</li> </ul>	<ul> <li>Significant positive and sustainable impact on highly valued species, habitat or eco-system</li> <li>Elimination of significant emission</li> </ul>	<ul> <li>Demonstrable and significant improvement in operational function that has company wide implications</li> <li>\$10M increase in NPV</li> </ul>
4 Significant positive long term impact	<ul> <li>Multiple "life-saving" impact</li> <li>Significant permanent positive health impacts on a large number of people</li> </ul>	<ul> <li>Positive impact on highly valued items of cultural significance</li> <li>Contributes to significant on-going improvement in social capital</li> </ul>	<ul> <li>Significant long-term environmental improvement of ecosystem function</li> <li>Significant reduction in emission or waste stream</li> </ul>	<ul> <li>Demonstrable and significant improvement in operational function for life of project</li> <li>\$IM to \$I0M increase in NPV</li> </ul>
3 Major positive benefit	<ul> <li>Single "life saving" impact</li> <li>Major positive impact on healthy lifestyles behaviours</li> <li>Major improvement in safety performance</li> </ul>	<ul> <li>Major improvement in /resolution of specific social issues</li> <li>Establishment of capacity building initiatives active for life of operation</li> </ul>	<ul> <li>Significant medium-term positive environmental effects</li> <li>Improvement in viability of threatened species</li> </ul>	<ul> <li>Major improvement in operational function to a specific area</li> <li>\$100 000 to \$1M increase in NPV</li> </ul>
2 Positive impact	<ul> <li>Positive impact on health of several people</li> </ul>	<ul> <li>Positive impact on some social issues</li> <li>Positive impact on items or issues of cultural significance</li> </ul>	<ul> <li>Moderate short-term positive effects, limited to specific areas (not affecting ecosystem function)</li> </ul>	<ul> <li>Positive impact on some area of the operation</li> <li>\$10 000 to \$100 000 increase in NPV</li> </ul>
I Minor positive impact	<ul> <li>Some positive impact on individual injury/health</li> </ul>	Improved relationship with local individuals	<ul> <li>Minor positive effects in specific areas</li> <li>Small improvement in direct emissions</li> </ul>	<ul> <li>&lt;\$10 000 increase in NPV</li> </ul>
- I Minor negative impact	<ul> <li>Minor injury</li> <li>Slight negative impact on individual health</li> </ul>	<ul> <li>Slight negative impact on individuals in local community</li> <li>Class 3 complaint (dust, vibration)</li> </ul>	<ul> <li>Minor temporary effects on ecosystem</li> <li>Class 3 discharge</li> </ul>	<ul> <li>&lt;-\$10 000 decrease in NPV</li> </ul>
-2 Negative impact	<ul> <li>Significant reportable injury</li> <li>Major impact on health of several people</li> </ul>	<ul> <li>Flare-up of sensitive issue in affected communities</li> <li>Media criticism</li> </ul>	<ul> <li>Moderate negative effects on local environment</li> <li>Loss of some non-endangered wildlife</li> <li>Class 2 incident</li> </ul>	<ul> <li>Negative short-term impact on worksite culture</li> <li>\$10 000 to \$100 000 decrease in NPV</li> </ul>
-3 Major negative impact	<ul> <li>Major injury to one or more persons</li> <li>Severe health impacts on a number of people</li> </ul>	<ul> <li>Major negative impact on social cohesion or economic viability</li> <li>Significant public criticism</li> <li>NGO or Media "taking up the issue"</li> </ul>	<ul> <li>Medium term negative impact on environment</li> <li>Class 1 incident</li> </ul>	<ul> <li>Major loss of human resources to the operation</li> <li>Major erosion of worksite culture</li> <li>\$100 000 to -\$1M decrease in NPV</li> </ul>
-4 Significant negative impact	<ul> <li>Single fatality</li> <li>Severe irreversible disability or impairment (&gt;30%) to one or more persons</li> </ul>	<ul> <li>Long term negative impact on highly-valued cultural items</li> <li>Loss of community's economic viability</li> <li>Significant damage to reputation of the operation</li> </ul>	<ul> <li>Significant long-term degradation of ecosystem</li> <li>Significant threat to valued species</li> </ul>	<ul> <li>Significant breakdown workforce relationships</li> <li>Suspension of mining</li> <li>\$IM to - \$10M decrease in NPV</li> </ul>
-5 Catastrophic impact	<ul> <li>Multiple fatalities</li> <li>Major permanent negative health impacts on a large number</li> </ul>	<ul> <li>Major breakdown of social order in affected community</li> <li>Destruction of items of great cultural significance</li> <li>Public international condemnation</li> </ul>	<ul> <li>Major destruction of ecosystem and/or catastrophic impact on valued species</li> </ul>	<ul> <li>Unplanned mine dosure</li> <li>&gt; -\$10M decrease in NPV</li> </ul>

# A.3 Risk Ranking table

The combination of consequence and probability can be used to provide an overall risk ranking, as shown in the table below.

Consequence Rating		Lik	elihood Rat	ting	
	5 High	4	3 Medium	2	l Low
5 – High	9	8	7	6	5
4	8	7	6	5	4
3 – Medium	7	6	5	4	3
2	6	5	4	3	2
I – Low	5	4	3	2	I

The overall risk ranking can then be used to sort the outcomes of the analysis process. The type of system shown above is modelled on the example from NASA shown earlier. Alternatives include numbering each box individually, with a bias for those locations on the same diagonal towards higher consequence, i.e.

Consequence Rating		Lik	elihood Rat	ting	
	5 High	4	3 Medium	2	l Low
5 – High	25	24	22	19	15
4	23	21	18	14	10
3 – Medium	20	17	13	9	6
2	16	12	8	5	3
I – Low		7	4	2	I

Both of these examples then allow a numerical threshold to be set in order to select those issues which warrant priority attention. Another common alternative is to provide broad bands across the matrix which identify high, medium and low priorities with associated management guidelines.

Consequence Rating		Lik	elihood Rat	ing	
	5 High	4	3 Medium	2	l Low
5 – High	Н	Н	Н	М	М
4	Н	Н	М	М	М
3 – Medium	М	М	М	М	L
2	М	М	L	L	L
I – Low	М	L	L	L	L

As discussed in previous sections, if a corporate standard exists then it is clearly best to use a system familiar to the participants.

# Аррепдіх В – Generic Prompt Lists

of possible controls, taken from regeneral issues identified here. These The list is organised according to t <b>3.1 Resource efficiencies</b>	eal cases in the mineral industry. In m se are intended as starting points only the impact categories outlined in the	nost cases, the source of the opportunity or t y for the information-gathering phase. sustainable development framework describe	hreat will need to be more specific than the d in section 4.
Source of opportunity or threat	Context	Nature of potential outcomes	Examples of good practice controls
Consumption of water in operations	Most operations import fresh water, with main areas of consumption in coal prep plant, road watering and washdown/ maintenance.	<ul> <li>Lack of available water can threaten viability.</li> <li>Reduction in consumption can offer financial benefits and reduced risk.</li> <li>Depletion of resource can cause conflict with broader community.</li> </ul>	<ul> <li>Water management plan for site</li> <li>Supply yield modelling</li> <li>Use of flow limiters and timers</li> <li>Recycling strategy directing dirty water to appropriate tasks</li> </ul>
Energy use	Mining operations are significant consumers of energy, usually in the form of diesel or electricity with associated implications for emissions.	<ul> <li>Use of renewable energy options.</li> <li>Reductions in energy consumption.</li> </ul>	<ul> <li>Energy management plan</li> <li>Engine monitoring systems</li> </ul>
Ore/coal recovery	In extracting a defined reserve, ore or coal can be lost at several stages including blasting, excavation, transport, processing, rehandling.	<ul> <li>Improvement of drilling and blasting procedures results in reduced loss</li> <li>Reduction in exposure to spontaneous combustion of coal.</li> <li>Major failure of highwall coal edge during blast.</li> </ul>	<ul> <li>Ore reconciliation procedures</li> <li>Technical projects to address known losses</li> <li>Ore/coal storage procedures</li> </ul>
Transport efficiencies	Transport of people, materials and products in and out can offer opportunities to improve efficiencies.	<ul> <li>Improved utilisation of transport systems.</li> </ul>	<ul> <li>Monitoring of utilisation</li> <li>Backloading of transport</li> <li>Development of synergies with neigh bouring operations</li> </ul>
Consumption of general materials	Mining can be a significant consumer of other raw materials, increasing the overall material and energy intensity of its product.	<ul> <li>Reduction in consumption of large. volume materials.</li> </ul>	<ul> <li>Construction of input/output data to indicate overall resource use</li> <li>Use of tools such as LCA to understand implications of raw material consumption</li> <li>Substitution of high intensity materials</li> <li>Recycling of materials</li> </ul>

The lists on the following pages are designed to provide a template for the types of opportunities and threats to be considered. Also included are some examples

B.2 Emissions, pollutants and waste

Source of opportunity or threat	Context	Nature of potential outcomes	Examples of good practice controls
Greenhouse gas emissions	All sources including power, diesel, coal seam gas, explosives	<ul> <li>Rate of generation increases</li> <li>Customers require accounting and offset mechanisms</li> <li>Use of carbon credits</li> </ul>	<ul> <li>Capture of methane, for use or flaring</li> <li>Accurate local estimation system</li> </ul>
Atmospheric pollutants	SOX and NOX contributors to acidification	Increases in emissions	<ul><li>"End-of-pipe" pollution control</li><li>Use of low sulphur fuels</li></ul>
Discharges to water	Direct discharges to water systems Sources of unplanned discharge into local water systems	<ul> <li>Exceedance of licence</li> <li>Damage to waterway</li> <li>Sediment from operations moves downstream</li> </ul>	<ul><li>Site water management plan</li><li>Containment areas</li></ul>
ndustrial waste	General waste – tyres, maintenance waste, sewage	<ul> <li>Use of waste streams, e.g. tyres for construction, effluent for gardens</li> <li>Breakdown of management system</li> </ul>	<ul> <li>Tyre management strategy including re-use options</li> <li>Waste monitoring</li> </ul>
Hazardous material	Use and disposal of chemicals, explosives, oils used in operations	<ul> <li>Spills with dispersion into environment</li> <li>Recycling/management of waste oils</li> </ul>	<ul> <li>Bunded storage and transfer areas</li> <li>Spill management procedures and equipment</li> </ul>
Waste rock	Spoil piles, dumps	<ul> <li>Generation of acid rock drainage</li> <li>Erosion of sediment</li> <li>New landform use</li> </ul>	<ul> <li>Specific risk reviews of rehab processes</li> <li>Incorporation of sediment control structures</li> <li>Alternative use projects</li> </ul>
Process plant waste	Tailings dams, reject dumps	<ul> <li>Capped tailings remain unstable</li> <li>Use for mixed fuel power generation</li> </ul>	<ul> <li>Progressive rehabilitation</li> </ul>

# Appendix B – Generic Prompt Lists

SOTA Workbook

resources

Аррепдіх В – Generic Prompt Lists

Source of opportunity or threat	Context	Nature of potential outcomes	Examples of good practice controls
Land clearing	Impacts on habitat and soil	Increased erosion	<ul> <li>Management of topsoil storage areas</li> </ul>
Specific flora and fauna	Impacts on local ecosystems and species viability usually identified during EIS/EMOS process	<ul> <li>Habitat loss impacts on viability</li> <li>Improvements in management of noxious weeds</li> </ul>	<ul><li>Wildlife surveys</li><li>Habitat conservation programmes</li></ul>
Creek diversions	Diversions are often necessary to maintain integrity of mining operations	<ul> <li>Unstable diversion leads to excessive erosion</li> <li>Redesigned system improves integrity of pre-existing situation</li> </ul>	As identified in ACARP Project C9068
Water storages	Mines often create both large and small water storages to supply their own operations	<ul> <li>Design of small local storages could facilitate subsequent land-use</li> <li>Large storage could facilitate local community initiatives</li> <li>Creation of alternative habitat results in changes in local ecosystem</li> </ul>	<ul> <li>Incorporation of water management into mine closure plan</li> <li>Monitoring of habitat changes</li> </ul>
Mining void	Open pit voids usually left unfilled after mining is completed	<ul> <li>Poor water quality results in requirement for permanent treatment</li> <li>Failure of void results in incident with landowner</li> </ul>	Stakeholder involvement in planning final void options
Subsidence	Subsidence from underground mining has the potential to affect local groundwater systems	<ul> <li>Adverse changes to drainage patterns</li> </ul>	Subsidence management plans

B.4 Local disturbances

Source of opportunity or threat	Context	Nature of potential outcomes	Examples of good practice controls
Blasting operations	Noise, vibrations, dust	<ul> <li>Damage to local buildings</li> <li>Complaints due to disturbances or dust</li> <li>Health concerns due to blasting fumes</li> </ul>	<ul> <li>Use of weather monitoring to optimise blasting times</li> <li>Optimisation of blast sequencing to minimise adverse impacts</li> </ul>
Dust from other sources	Mine operations such as haulage often generate dust which affect the local area	<ul> <li>Damage to local environment</li> <li>Concerns regarding health impacts</li> </ul>	<ul><li>Dust monitoring plans</li><li>Dust suppression methods</li></ul>
Voise and other emissions	Most operations run 24 hours a day, generating noise and light from equipment and processes	Disturbances to community	Provision of screens to reduce impacts
Air and water discharges	Effects on local air quality Effects on local water sources, etc	<ul> <li>Complaints from emissions or odours</li> <li>Concern regarding state of local water sources</li> </ul>	<ul> <li>Air and water monitoring programmes</li> </ul>
Subsidence due to Inderground operations	Subsidence is an inevitable consequence of most coal longwall operations	<ul> <li>Damage to surface infrastructure and buildings</li> </ul>	<ul><li>Use of predictive models</li><li>Monitoring of effects</li></ul>
Hazardous material transport	Chemicals, explosives, fuel	<ul> <li>Major incident on local roads</li> <li>Heightened community concern</li> </ul>	<ul> <li>Education/awareness sessions with local emergency services</li> <li>Traffic management plans with suppliers</li> <li>Co-ordination with other operators in region</li> </ul>
-ocal traffic volume	Operations lead to increases in traffic around local communities due to workforce commuting, and the transport of products and supplies	<ul> <li>Traffic accidents</li> <li>Community outrage</li> </ul>	<ul> <li>Scheduling of shift changeovers to avoid local peak times</li> <li>Co-ordination with other operators to avoid concentrations of volume</li> <li>Provision of bus or car pooling opportunities</li> </ul>

# Appendix B – Generic Prompt Lists

SOTA Workbook

resources

Аррепдіх В – Generic Prompt Lists

Source of opportunity Co or threat Work conditions and nature OH envi			
Work conditions and nature OH	ontext	Nature of potential outcomes	Examples of good practice controls
exp	HS considerations, work wironment, work behaviours and cposure to contaminants	<ul><li>Injury incidence</li><li>Cumulative or chronic health impacts</li></ul>	<ul><li>OH&amp;S plan</li><li>Behavioural approach initiative</li></ul>
Nork schedule Shift Cor of t	lift roster ommuting distance and mode transport	<ul> <li>Fatigued workforce, reduced production, increased error</li> <li>Accidents in transit</li> </ul>	<ul> <li>Bus to site</li> <li>Shorten roster or shift length</li> <li>Development and implement policy on fatigue management</li> </ul>
Emp Trai Wo	nployment processes aining and career development orkplace culture	<ul><li>Unwanted employee exits</li><li>Misuse of equipment</li></ul>	<ul> <li>Consultation processes in place</li> <li>Evaluation strategies (e.g. employee satisfaction survey)</li> </ul>
Subcontractors Sub-	Ib-contractor workplace anagement, labour hire	<ul> <li>Segmented workforce, (eg communications breakdown, differential OH&amp;S standards /behaviours)</li> </ul>	<ul> <li>Lateral communication channels between departments and across company, contractor and subcontractors</li> </ul>
Workplace culture	vlicies, process and behaviours n site	<ul> <li>Improved efficiencies and innovation at mine</li> </ul>	<ul> <li>Inclusion of behaviours and communication standards in annual performance review</li> </ul>
amilies of employees Sup Sou	Ipport for mine workforce ource of conflict for workers	<ul> <li>Stable happy workforce</li> <li>High turnover due to home/work conflict</li> <li>Informal and active networking between local community and mine</li> </ul>	<ul> <li>Welcome initiatives for new families to FIFO or the District</li> <li>Site visits for families</li> <li>Employee Assistance Schemes</li> </ul>

40

Appendix B – Generic Prompt Lists

Source of opportunity or threat	Context	Nature of potential outcomes	Examples of good practice controls
Indigenous landowners	Land rights, living indigenous culture, cultural sites Levels of health and education	<ul> <li>Legal disputes, or direct actions against mine or company</li> <li>Substantial improvement in education and life options for indigenous community</li> </ul>	<ul> <li>Aboriginal employment program</li> <li>Indigenous community traineeships</li> <li>Support of indigenous businesses</li> <li>Community consultation plan</li> </ul>
Local community	Relations between local community and mine	<ul> <li>Provision of support services to the mine, in terms of workforce, contracting firms, local supplies</li> <li>Dispute volatility</li> </ul>	<ul> <li>Community support policy and engagement plan</li> <li>Targeted trainee/employment programs</li> <li>Transparent complaints procedure</li> <li>Targeted philanthropy (e.g. matching employees volunteer time with a cash donation)</li> </ul>
Landowners and neighbours	Access and relocation issues	<ul> <li>Support relinquishment of mine lease</li> <li>Dispute volatility</li> </ul>	<ul> <li>Community engagement plan</li> <li>Management support for informal relationship building (e.g. sharing information)</li> </ul>
Local services	Services usually provided by government: Health, Education, Security	<ul> <li>Stable, diversified community</li> <li>Employment opportunity for partners of mine workers</li> <li>Loss at mine closure</li> </ul>	<ul> <li>Evaluation of effects of location of workforce</li> <li>Mine closure planning</li> </ul>
Local infrastructure	Water, Power, Communication Roads, Waste disposal	<ul> <li>Expanded/upgraded infrastructure for current and future residents and businesses</li> <li>Impact of mine activities overloads system</li> </ul>	<ul> <li>Ensuring adequate capacity during mine planning, construction and expansion phases</li> <li>Monitoring of supply</li> <li>Community consultative committee or other regular communication opportunity</li> </ul>

B.6 Community development and interactions

41

resources

Аррепдіх В – Generic Prompt Lists

Source of opportunity or threat	Context	Nature of potential outcomes	Examples of good practice controls
Contractors	Sub-contractors (companies) Labour hire	<ul> <li>Loss of investment in training, dislocation of workforce into separate groups</li> <li>Network of peripheral contractor workforce enables flexibility in management plans</li> </ul>	<ul> <li>Ensuring sub-contractors previously inducted to site return for subsequent work</li> </ul>
Supplier relationships	Environmental and social performance issues	<ul> <li>Regional and local business capacity building</li> <li>Ensuring conduct and product standards</li> </ul>	<ul> <li>Targeting local/ regional business for supply</li> <li>Conduct and product standards are included in supply contract</li> <li>Assistance programme for local suppliers</li> </ul>
Customer relationships	Environmental and social performance issues	<ul> <li>Loss of customers</li> <li>Branding differentiation for commodity/ product of mine</li> </ul>	<ul> <li>Product stewardship initiatives</li> <li>Public sustainability reporting</li> </ul>
Governments, State and National	Provision of support infrastructure and services. Regulations and payments	<ul> <li>Licensing, establishing minimum performance standards</li> <li>Provision of guidance notes</li> <li>Formal incident investigations</li> </ul>	<ul> <li>Defining and maintaining communication channels and site visits</li> </ul>
SOSN	Range of organisations with diverse interests in the impacts of mining at local or regional level	<ul> <li>Critiques mine company actions and methods. Can contribute to outrage</li> <li>Can enable disaffected or less powerful members of community to have their concerns raised and addressed</li> <li>Influence government on regional planning issues</li> </ul>	<ul> <li>Stakeholder identification</li> <li>Community engagement plan</li> <li>Partnerships with NGOs in community capacity building/environmental protection plans</li> <li>Involvement in appropriate regional groups</li> </ul>

Appendix B – Generic Prompt Lists

Source of opportunity or threat	Context	Nature of potential outcomes	Examples of good practice controls
Employment	Distribution of wages within local economy	<ul> <li>General improvement in local or district economy from flow-on effects</li> <li>Coastal drift</li> </ul>	Strategic Hiring Policy (eg hiring locally)
Goods and services to mine	Sources of supply	<ul> <li>Capacity building in local community</li> <li>Fly-over effect</li> </ul>	<ul> <li>Purchasing policy of preferring local supply</li> <li>Negotiation with local council about business development schemes</li> </ul>
Closure planning	Workforce transition Post mine land use	Failure of local or regional economy	<ul><li>Mine closure plan</li><li>Post mine land use guidelines</li></ul>
Taxes and royalties	Paid to local, state and federal governments	<ul> <li>Contribution of mining companies to economy may not be visible to the local community</li> </ul>	<ul> <li>Negotiated local agreements</li> <li>Report royalties in sustainability report</li> </ul>
Education, training and work experience	Provided in conjunction with local education services and local government services	<ul> <li>Capacity building in local community</li> </ul>	<ul> <li>Apprenticeships and traineeships offered</li> </ul>
Regional planning	Community development Local business and industry supply chain	<ul> <li>Mine company activities to facilitate best outcome for regional planning</li> </ul>	<ul> <li>Involvement with regional stakeholder groups and industrial networks</li> </ul>
Local infrastructure	Capital works – schools, roads	<ul> <li>Longer term community benefits from mining company investment</li> </ul>	<ul> <li>Integrated planning including closure plan</li> </ul>

B.8 Local and regional economic development

resources