FINAL REPORT

International Council on Mining and Metals

Good Practice Guidance for Mining and Biodiversity

May 2005

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Good Practice Guidance for Mining and Biodiversity

May 2005

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For and on behalf of
Environmental Resources Management
Australia

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Signed: ____________________________

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 SUMMARY

Mining operations have the potential to significantly impact biodiversity both negatively and positively. Poor management of biodiversity by mining companies is likely to result in:

- *Loss of access to exploration opportunities;*
- *Costly delays in project approvals;*
- *Increasing costs to rectify poor performance from the past;*
- *Higher cost of capital;*
- *Increase scrutiny from investors(and potential loss of access to capital);*
- *Greater exposure to environmental risks (eg flooding and landslides); and*
- *Protests, damaged reputation and legal consequences.*

Debate over the importance of biodiversity is increasing due to greater awareness of the need to protect biodiversity, the increasing presence of larger mining operations in remote, undeveloped locations, and in particular, the significantly increasing demands and pressures on biodiversity through an expanding population.

The mining industry needs to improve its management of impacts on biodiversity through:

- *Acknowledging the importance of biodiversity as a central component of successful mine operations and managing it accordingly;*
- *Understanding the biodiversity on and around mine sites and designing in controls through sound Environmental and Social Impact Assessment (ESIA) processes;*
- *Protecting areas of high conservation value;*
- *Recognising and managing off-site as well as on-site impacts;*
- *Ensuring that communities are actively engaged in discussions affecting them including biodiversity management;*
- *Building credibility of the work through effective communication and strong external review of plans and outcomes;*
- *Planning for closure from the outset; and*
- *Addressing legacy issues.*

This Good Practice Guidance provides the mining industry with an outline of the steps required to improve biodiversity management throughout the mine cycle. Ultimately, through implementation of this guidance, mining companies should minimise the likelihood of negative impacts on biodiversity, project delays and damage to their reputations.

The performance of many in the mining industry has improved markedly, however, better and more consistent performance in minimising biodiversity impacts and achieving positive outcomes is required to counteract the historically poor management of the past and to demonstrate that the industry does have credibility in regards to biodiversity management.

Good biodiversity management has many benefits including:

- *Increased investor confidence and loyalty;*
- *Shorter and les contentious permit cycles;*
- *Easier access to finance;*
- *Better relations with regulators;*
- *Improved community relations;*
- *Strong supportive partnerships with NGOs;*
- *Engagement with employees;*
- *Strong credentials for products; and*
- *Reduced risks and liabilities.*

1.2 BACKGROUND

Humanity faces the challenge of meeting the development needs of a growing population from a depleting natural resource base (IUCN/ICMM 2004). Achieving a balance between continued improved living standards and conserving our environmental resources requires an appreciation of sustainable development approach. There has been increased debate around this topic during the last decade, and it is now widely recognised that the basic understanding of sustainable development comes from recognising that, at its core, is conservation of biodiversity, essential ecological processes and support systems, and preservation of genetic diversity (IUCN/UNEP/WWF, 1980). Biodiversity is the variety of all living organisms, including all species, the genes they posses and the ecosystems they form. Biodiversity sustains human livelihoods and life itself (IUCN/ICMM 2004). Biodiversity impacts on the quality of life and is the essential component to the sustainability of all human activity (WBCSD, 2002).

It is now commonly recognised that we all benefit from the conservation of biodiversity and the products and services biodiversity provides so that we meet the needs of present and future generations. All industries need to conserve their use of nature and natural resources. Mining operations are constrained to conduct their activities where the resources exist, and they are therefore often required to demonstrate that they can extract this resource with minimal impact to biodiversity. Mineral processing operations such as refineries and smelters are often dependent on major infrastructure like hydroelectricity dams that are likely to have their own, frequently significant, impacts that also need to be managed.

At best case, the company will show that there is a net improvement in biodiversity after it conducts mining operations. At worst case, the company must demonstrate that the impact to biodiversity is genuinely offset by other actions. While every development has its own particular requirements, a common element is to implement sound environmental practices and for the mining industry, biodiversity is about ecosystem management. Failure to do so can result in the risk of losing operating licences and the confidence of stakeholders. Ultimately, this can jeopardise future business opportunities and cause reputation loss in the marketplace. On the other hand, biodiversity conservation can provide many opportunities for companies including strengthening reputation and stakeholder relationships, attracting socially responsible investors and improving employee productivity (WBCSD, 2002).

This Good Practice Guidance has been prepared to assist in enhancing the mining industry's performance in biodiversity conservation.

This chapter describes the principles and objectives that drive good practice and provides background on how good practice can assist in achieving biodiversity conservation from a mining context.

1.3 PRINCIPLES OF BIODIVERSITY MANAGEMENT AND WHY IT IS VALUABLE

1.3.1 Definition of Biodiversity

At the 1992 Earth Summit in Rio de Janeiro, the United Nations Convention on Biological Diversity (CBD) was signed by 157 government leaders. The CBD is dedicated to promoting sustainable development. Conceived as a practical tool for translating the principles of Agenda 21 into reality, the Convention recognises that biological diversity is about more than plants, animals and micro organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live (CBD, 1992).

The CBD defines biodiversity as:

> 'The variability among living organisms from all sources including *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.'

This Good Practice Guidance recognises that the terms 'biodiversity management' and 'biodiversity values' have differing meanings to the various groups the mining industry interacts with. There are diverging views and opinions on what these terms mean and how to manage potential impacts and what 'value' biodiversity may have. There are many broad concepts such as 'offsets' that are contentious and subject to ongoing debate, and knowledge of biodiversity aspects is continuously advancing.

Through this Guidance, the industry is not seeking to define those terms to its own benefit. Rather, a set of broadly used terms has been used around which practices have been built that should, if rigorously implemented, allow the industry to deliver ever improving performance for new operations and steadily address problems from past activities, either directly at current operations or through improved knowledge and skills that can be applied to sites no longer owned by mining companies.

The CBD as three main objectives. Namely:

a) The conservation of biodiversity,

b) Sustainable use of the components of biodiversity, and

c) Sharing the benefits arising from the commercial and other utilization of genetic resources in a fair and equitable way.

Genetic Diversity

Genetic material is defined by the CBD as:

> 'Any material of plant, animal, microbial or other origin containing functional units of heredity.'

Genetic diversity refers to the variety of genetic information contained in all individual plants, animals and micro-organisms.

Species Diversity

A species is a group of organisms formally recognised as distinct from other groups. Species diversity is usually a measure of the number of species (richness) and their relative abundances for a given area at a given point in time.

Ecosystem Diversity

An ecosystem is defined by the CBD as:

> 'A dynamic complex plant, animal, and micro-organism communities and their non-living environment interacting as a functional unit.'

In general, diversity refers to the variety of habitats, biotic communities and ecological processes.

1.3.2 *Why is Biodiversity Valuable?*

The importance of biodiversity stems from the fact that the world's population is dependent on ecological processes for survival. At the most fundamental level, biodiversity is the basis for healthy, functioning ecosystems that sustain life. Biodiversity also provides food and the raw materials for products. Biodiversity value can be measured against monetary, aesthetic, environmental, recreational, social, cultural and intrinsic factors (National Parks and Wildlife Services, 1999).

The economic value of biodiversity is evident from the goods and products that are sold for income, for example traditional medicines or bushmeat, or used as inputs to other economic activities, for example eco-tourism. For the mining sector, examples of economic value can be translated to obtaining access to resources, prevention of suspension to operations, prevention of development approval delays, better relations with regulators and reputation gain. The case study below demonstrates the reputation gain that can be obtained from implementation of good practices during mine rehabilitation. This positive reputation has flow on benefits in gaining access to land, recruiting staff and general goodwill.

Case Study. Reputation gain and rehabilitation success: Restoring the botanical richness of the Jarrah Forest after bauxite mining in South Western Australia. Alcoa World Alumina Australia.

Alcoa World Alumina Australia operates two bauxite mines at Willowdale and Huntly in the Darling Range of southwestern Australia. The Huntly mine is the largest bauxite producer in the world. The mine pits range in size from one hectare to tens of hectares. Alcoa's aim after bauxite mining in these areas is to re-establish all the pre-existing land uses of the forest. Re-establishing the jarrah forest on the mined areas that is as similar to the original forest as possible was determined to be the best way to achieve this goal.

The jarrah forest is a highly valued resource for the people of Western Australia. It is renowned for its diverse flora, being one of the most plant-species-rich forests in the world outside of tropical rainforests. Restoring botanical richness is thus seen as an important component for re-establishing a jarrah forest.

The programme started with five-year improvement milestones. The first milestone was to achieve 80 per cent of forest-species richness. When this was accomplished, a new milestone was set for 2000 – that on average 100 per cent of the indigenous plant species found in representative jarrah forest sites would also be found in a 15-month-old rehabilitation, with at least 20 per cent of those found being from a recalcitrant species priority list.

Alcoa reached its goal. In 2000, at the two operating mines at Huntly and Willowdale, the company achieved an average of 100 per cent – in other words, all the rehabilitated areas had on average the same number of indigenous plant species as found in nearby jarrah forests. The goal now is to maintain this good record and thus the botanical richness of the area after mining. It is within this context that Alcoa has developed a scientifically based, best practice rehabilitation procedure.

Alcoa was listed on the United Nations Environment Programme's Global 500 Roll of Honour in 1990 and remains the only mining company to have ever received this prestigious nomination.

The social and cultural values of biodiversity relate to the employment, health and social security obtained through biodiversity. The connection to the land by indigenous and other traditional peoples plays a role in defining their identities, spirituality, kinship, relationships, livelihoods, knowledge systems, language, medicine, governance, values systems and art and creativity (Rio Tinto, 2004). Furthermore, just as there are places that are too environmentally sensitive to withstand development, there will also be areas that should be avoided due to social reasons (Conservation International, 2000).

The intrinsic values of biodiversity stems from a non-utilitarian philosophy that biodiversity has intrinsic value in its own right, irrespective of its contribution to human wellbeing.

1.3.3 *Biodiversity Management is Important to New and Existing Operations?*

Biodiversity management is important not only for new operations, but also for those that have been operating for many years usually under requirements that were less focused on biodiversity aspects. The mining industry has many examples where past practices, through ignorance or poor performance, have lead to dramatic impacts on biodiversity, for example, the Ok Tedi / Fly River in Papua New Guinea, the Mt Lyell mines in Tasmania, Australia. A number of current operations, especially those that have been operating for many years need to improve their efforts to reduce impacts on biodiversity. The following Iron Ore Company (IOC) case study describes the type of efforts required to bring older operations to a higher standard of biodiversity management that otherwise threatened the ongoing operation. Clearly, if biodiversity values had been incorporated before start up, the expense addressing past problems would have been avoided.

Case Study. Community involvement and biodiversity stewardship. Tailings management at the Labrador City Mine, Canada. Iron Ore Company of Canada (IOC),

Historically, IOC had disposed of its tailings to a local river and lake system with consequent impacts to biodiversity values. Under the new federal Metals Mining Effluent Regulations, which came into force in 2002, all metal mines in Canada are required to confine their tailings. The IOC has developed a project to confine and rehabilitate the tailings produced by its iron ore mine in Labrador City. With completed provincial and federal environmental assessments, and a fish habitat compensation agreement with Fisheries and Oceans Canada, IOC had the regulatory approvals it needed to begin construction of its tailings facility. In working on the project, IOC dealt regularly with the community and developed a biodiversity stewardship program that looked at the feasibility of introducing a range of wildlife habitats to the beach. A key component of the project involves confining tailings with a dyke built along a stretch of Wabush Lake where inert tailings had already been forming a large undulating beach. This confinement allowed water quality and fish habitat on the other side of the lake to improve. The tailings area has been progressively rehabilitated with different types of grasses, bushes, evergreens and other trees, which are thriving and attracting diverse birds and land species. The project has gone far beyond regulatory requirements, as it has achieved reclamation that also meets the goals of biodiversity, multiple land use and a positive community legacy once the mine is closed.

1.4 *BIODIVERSITY PLANNING AND MANAGEMENT OBJECTIVES*

Due to the continuing demand for minerals, changing technologies and economics in the mining sector, mining is now being proposed in remote and biodiversity–rich ecosystems that were previously unexplored and undeveloped for minerals (Conservation International, 2000). This trend in mineral development represents an opportunity for the industry to demonstrate that practices has improved, including making 'no-go' decisions. However, it can also represent a threat, with poor performance further limiting access to some highly prospective areas.

Mining has the potential to impact biodiversity throughout a project or operations life cycle, both directly and indirectly. The potential for impacts is even larger when mining in remote, environmentally sensitive areas. Direct or primary impacts from mining can result from exploration, mining or process activities, and are usually readily identifiable. Indirect or secondary impacts can result from social or environmental changes induced by mining operations that are often harder to immediately identify. Despite the huge potential for negative consequences to biodiversity from mining operations, there is a great deal that companies can do to minimise or prevent such impacts in areas that have been determined as being appropriate for mining. The following case study demonstrates that company personnel and stakeholder representatives can together develop an Environmental Management Plan (EMP) that minimises the impacts of exploration in a biodiversity hotspot and rehabilitates the land when exploration is complete. Should this project progress beyond exploration, valuable information on biodiversity aspects of the area will have been obtained. This will assist in tailoring detailed ESIA studies to better target local issues.

Case Study. Development of an Environmental Management Plan (EMP) that minimises the impacts of exploration and rehabilitates the land when exploration is complete: Exploration in a biodiversity hotspot – Skorpion Zinc Mine, Namibia. Anglo America plc.

In September 2000, Anglo America plc announced that it would develop Skorpian zinc mine and refinery near Rosh Pinah, in southern Namibia. Construction of the open pit mine and plant commenced in 2000 and first production occurred in April 2003. Ongoing exploration for zinc is being conducted in the surrounding area mainly by means of drilling on a broad grid basis and by sampling rock chips and cores.

Southern Namibia is recognised as one of the world's top 25 biodiversity hotspots. It is the only arid hotspot environment, and over 10 per cent of the plant species there are found only in the Sperrgebiet area. The main concern of the Namibia Ministry of Environment and Tourism (MET) is that the Sperrgebiet habitat is extremely sensitive and cannot rehabilitate itself and that the exploration may cause irreparable damage.

An EMP, including a specific Exploration EMP, was developed by company personnel in conjunction with stakeholder representatives. In addition, and in conjunction with other stakeholders, a Rosh Pinah Environmental Forum was formed in late 2000 to develop site-specific plans for exploration areas. Stakeholder involvement led to an agreement, among other actions, to restrict drill site access to single tracks on grid lines, use wide low pressure tyres and lightweight drill rigs; ban camping within the Sperrgebiet; rehabilitate all drill sites and access tracks; and monitor the drillers' environmental conduct daily.

As part of follow up, site visits were conducted with all stakeholders, 'before and after' photographs were taken and biannual audits were conducted with full reporting. Spot checks were held, and formal sign-off was given by all stakeholders to previously affected areas.

As a consequence of the environmental management implemented, large tracts of ground have been returned to their original state at minimal cost after exploration activities. The level of environmental awareness and regard for the importance of biodiversity by all exploration staff increased considerably, and an excellent relationship of trust developed between Anglo American and MET staff.

Conserving biological diversity requires careful planning and the use of best management practices. Implementation of best practice measures will help to minimise environmental and social impacts which otherwise could have devastating impacts on biodiversity. This Good Practice Guidance reviews mining operations from planning through to closure and reclamation, and identifies management practices to minimise identified risks to biodiversity.

Implementation of this Good Practice Guidance uses a common set of readily understood objectives to which all the modules relate. The objectives capture elements of sustainability, financial responsibility and the requirement to be socially acceptable. The objectives of this Good Practice Guidance cover the following broad principles:

- conservation of biodiversity;
- sustainable use of biological resources; and
- equitable sharing of biodiversity benefits.

1.4.1 *Conservation of Biodiversity*

Biodiversity is affected by nearly all human activity through the complex flow of impacts that such activities have on natural processes. As such, it is important to assess and establish the biodiversity context of a site and surrounding area so that risks and opportunities can be adequately identified and best management practices implemented.

Conservation of biodiversity is based on the premise that further net loss of biodiversity is unacceptable. Therefore, the following hierarchical approach is recommended to help achieve no net loss to biodiversity:

- **Avoid** irreversible losses of biodiversity;
- Seek alternative solutions that **reduce** biodiversity losses;
- Use mitigation and rehabilitation to **restore** biodiversity resources;
- **Compensate** for unavoidable loss by providing substitutes of at least similar biodiversity value (see ICMM, 2005); and
- Seek opportunities for enhancement.

It is recognised that there are situations where a company may have unavoidable negative impacts on biodiversity, such as open pit mining. In such situations, biodiversity offset may be integrated into the management of residual impacts. Measures may include protecting and managing an ecological community in the region or assisting in ecological research.

1.4.2 *Precautionary Principle*

Generally for mining companies, the most significant impact on biodiversity will be through use of natural resources. This may involve direct and indirect impacts to the biodiversity and will require careful management of both upstream and downstream processes to ensure biodiversity is conserved. The web of biological reactions that may result from mining operations should be predicted prior to commencement of work. Commonly, impact assessment can be used to identify, manage and promote the sustainable use of biodiversity over time. However, a mining operator may be faced with situations where either there is no scientific proof or where there is uncertainty as to the scientific basis of a potential biodiversity risk. In this situation, the precautionary principle (see below) should be adopted as it offers a forceful and common-sense approach to the decision making process. The precautionary principle requires that preventative actions be taken at the design stage of the mine cycle, to ensure the most efficient management of hazardous risks to biodiversity.

An informative discussion on the precautionary principle is presented in Cooney, R. (2004). *The Precautionary Principle in Biodiversity Conservation and Natural Resource Management: An Issues Paper for Policy-makers, Researchers and Practitioners*. IUCN, Gland, Switzerland and Cambridge, UK.

Precautionary Principle

The precautionary principle means that if there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

1.4.3 *Equitable Sharing of Biodiversity Benefits*

Biodiversity conservation presents an opportunity for mining companies to bolster their relationships with stakeholders. Value can be added through integration of biodiversity aspects to corporate social responsibility programmes. Some activities that may be implemented include: community involvement, supporting conservation initiatives in the region, supporting industry initiatives, involving mining staff in community programmes, and sharing the scientific information that is obtained with the scientific, academic and regulatory communities and other interested parties.

Mining companies, through projects involving environmental impact assessment, ongoing rehabilitation, and closure programmes, can provide an important resource for NGOs and government agencies running conservation programmes that involve mitigation and rehabilitation of wildlife habitat. This can be achieved through the transfer of knowledge, for example on the range or habits of particular species on rehabilitation techniques, or through providing assistance to local programmes as described in the Barrick case study below.

Case Study. Mitigating offsite impacts: A conservation programme to save the endangered Lahontan Cutthroat Trout. Barrick Goldstrike.

In Nevada, mining companies such as Barrick Goldstrike has been heavily involved in programmes aimed at conserving habitat for the endangered Lahontan Cutthroat Trout. Barrick's involvement included the redesign of a bridge over one of the streams inhabited by the trout. This bridge was required by Barrick for its operations. The company made available an engineer to assess then design the bridge so that it would not present a barrier to fish migrating upstream. The company then contributed funds to undertake the work and staff to manage the project and oversee the construction contractors.

1.5 *THE IMPORTANCE OF COMMUNITIES IN BIODIVERSITY PLANNING AND IMPLEMENTING MANAGEMENT*

The world's population is directly dependent on biodiversity for subsistence and livelihood support. This issue is even more evident with isolated indigenous communities. As such, the active and equitable engagement of potentially affected community and other stakeholders in biodiversity conservation is fundamental to the success of biodiversity initiatives (Rio Tinto, 2004). Engaging the community and other stakeholders with an objective of developing trust, respect and partnership, aimed at keeping the community informed and up to date on a mining company's operations, is essential to the success of a sustainable project.

When embarking on biodiversity conservation initiatives, attention must given to respecting cultures, customs and values; recognising and engaging local communities as stakeholders, participating in the social, economic and institutional development of communities and mitigating negative impacts. This Good Practice Guidance (GPG) discusses management practices and approaches for developing an appropriate and effective community relations programme that is based on the specific needs and situations of the community.

1.6 *SCOPE OF THE GOOD PRACTICE GUIDANCE AND OVERALL APPROACH AND STRUCTURE*

1.6.1 *Principles of Sustainable Development*

In May 2003, the ICMM adopted a set of ten principles on sustainable development, including one on biodiversity conservation, against which its corporate members are committed to measuring performance.

ICMM Sustainable Development Principle 7 reads *"Contribute to conservation of biodiversity and integrated approaches to land use planning'. It has the following sub-elements:*

- *Respect legally designated protected areas;*

- *Disseminate scientific data on and promote practices and experiences in biodiversity assessment and management; and*

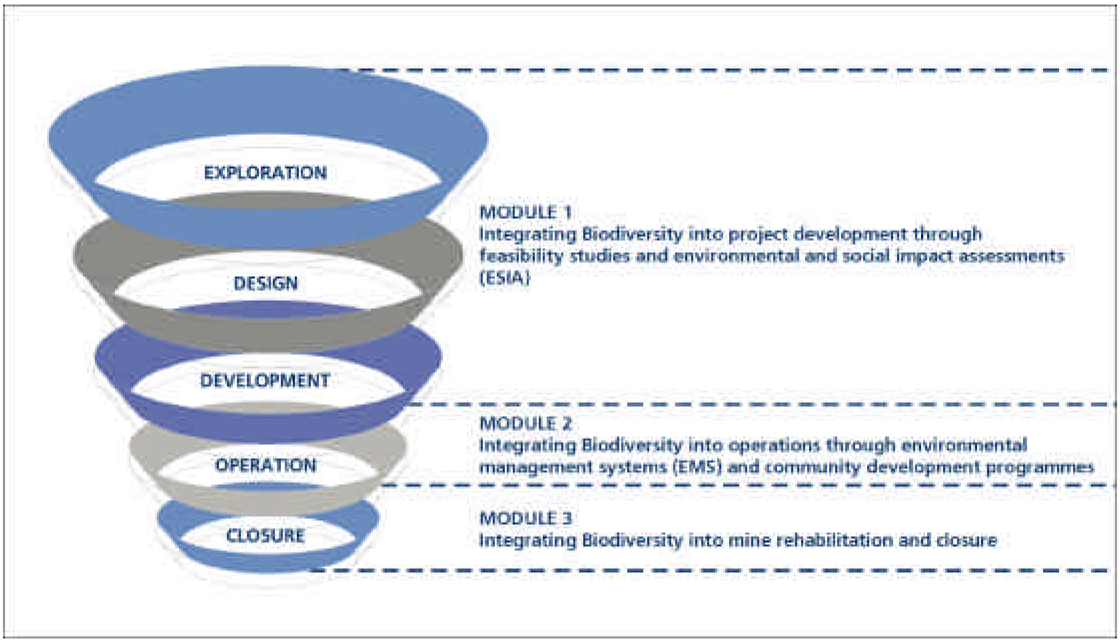
- *Support the development and implementation of scientifically sound, inclusive and transparent procedures for integrated approaches to land use planning, biodiversity, conservation and mining.*

This GPG is intended to assist ICMM corporate members and all other mining industry participants in implementing this principle, in particular the sub-element 'promote practices and experiences in biodiversity assessment and management'.

Figure 1.1 Integrating Biodiversity in the Mine Cycle

In addition, the Operation Principles developed from the ICMM-IUCN Workshop of July 2003, have been used to guide the development of the GPG. These principles are covered under the following broad topics:

- Documenting local biodiversity;
- Identifying actual impacts;
- Develop Biodiversity Action Plans and integration into operational plans;
- Monitoring, measuring and reporting performance; and
- Engaging the community and company personnel in biodiversity management programmes.



Promotion of the GPG by ICMM member associations within their respective jurisdictions will encourage improvements in performance of the industry at large.

An area of special note is the increasing awareness of the value of community engagement including appropriate and sensitive use of traditional knowledge. These are covered briefly in this guidance, as the fields are large in their own right, and in many cases, site specific.

1.6.2 Approach and Structure of the GPG

This guidance adopts a set of broadly used terms around which practices have been built that should, if rigorously implemented, allow the industry to deliver ever improving performance with regard to:

- New operations;
- Problems from past activities at current operations; and
- Through improved knowledge and skills that can be applied to sites no longer owned by mining companies.

It has been developed to assist the mining practitioner to effectively identify and evaluate biodiversity, assess the risks of their operations to biodiversity, and identify the opportunities of their operations for biodiversity conservation.

The GPG is divided into three main areas that encompass the life cycle of mining operations. These are:

- Module 1. Integrating Biodiversity into Project Development through Feasibility Studies and Environmental and Social Impact Assessment;
- Module 2. Integrating Biodiversity into Operations through Environmental Management Systems (EMS) and Community Development Programmes; and
- Module 3. Integrating Biodiversity into Mine Rehabilitation and Closure.

This guidance contains case studies in each module to illustrate the practical implementation of biodiversity conservation methods to mining. In addition, the case studies provide examples of the mutual benefits that can arise to mining companies and their stakeholders through communication, participation and collaboration.

This guidance has been structured to show clearly how biodiversity can be integrated throughout the whole mine life cycle. All sections within the modules have been identified with key steps of the biodiversity process and the applicable stages within the mine lifecycle to which it applies. The following figure outlines the key steps in the biodiversity process for each module and the key stages of the mine lifecycle.

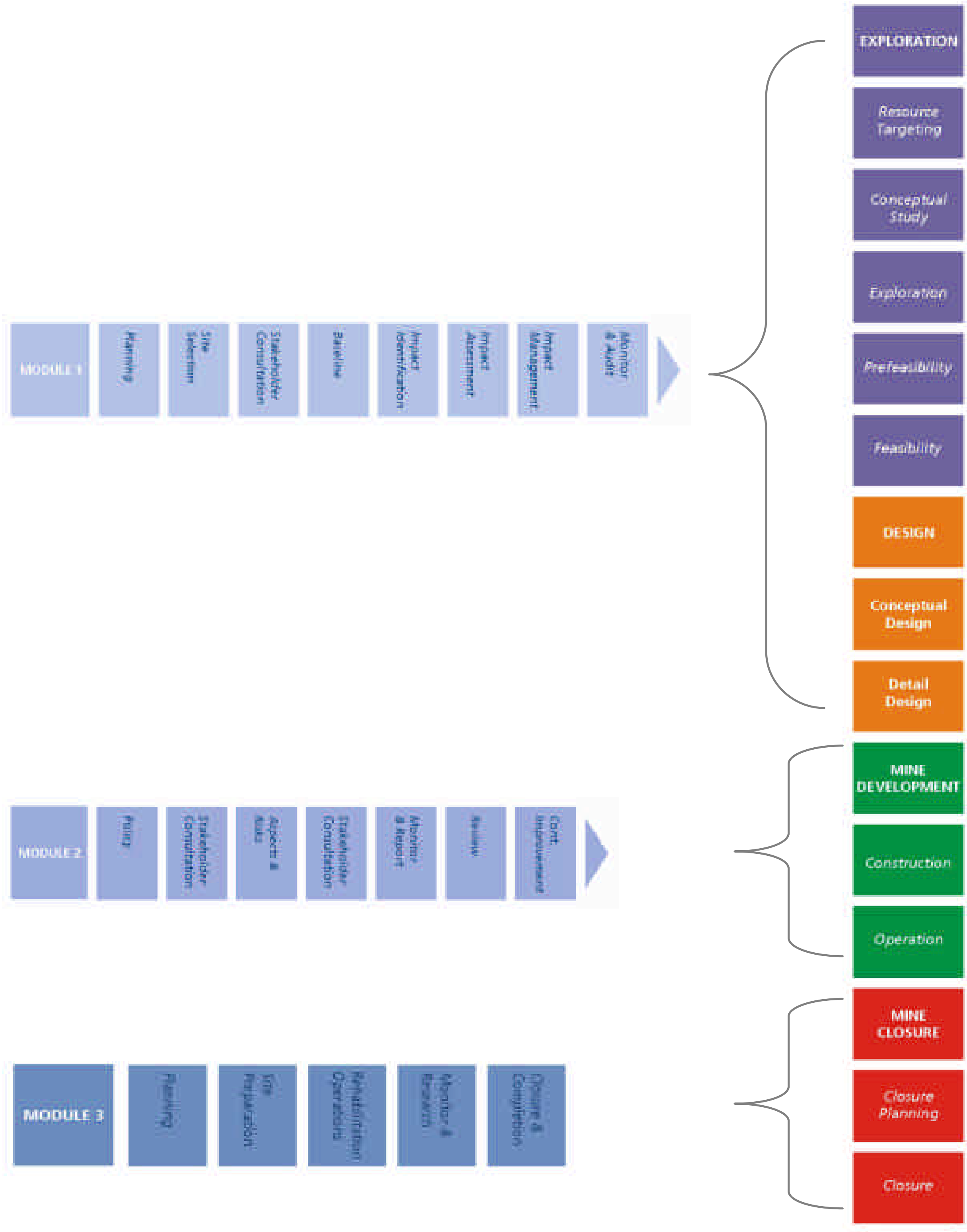


Figure 1.2 Key Stages of the mine life cycle and key biodiversity processes for each module

Overall, this guidance aims to show how good practice can assist mining companies to increase the positive contribution of mineral development to conservation of biological diversity.

Whilst the GPG uses a sequential approach to describe required activities, in practice many stages of the cycle are interactive and the reader is encouraged to refer back to earlier sections to gain full benefit from this guidance document.

Acknowledgments

This guidance material is drawn from many sources, predominantly those in the public domain but also from internal company documents and procedures. The authors have endeavoured to follow the publication and acknowledgment requirements of any material so used. This guidance is strongly influenced by the work of the Energy and Biodiversity Initiative, the E3 initiative of the Prospectors and Developers Association of Canada (PDAC) and Rio Tinto's guide to integrate biodiversity into its mining practices. It is recommended that practitioners in the mining and minerals industry access those resources.

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Key

Planning

EXPLORATION

2 *MODULE 1: INTEGRATING BIODIVERSITY INTO PROJECT DEVELOPMENT THROUGH FEASABILITY STUDIES AND ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENTS*

2.1 INTRODUCTION

Mining has the potential to create biophysical and social changes to the environment. Changes may include clearing of the site, relocation of streams, development of waste sites, discharging of process water, extraction of groundwater etc. Such changes can impact on the biodiversity of a site and its surrounds, which in turn can lead to change social values and further social impacts. As such, it is important to consider biodiversity conservation throughout the life cycle of a mine.

Environmental and social impact assessment (ESIA) is a tool which is often used to integrate environmental, economic and social concerns into the decision making process of a proposed project. However, ESIAs have traditionally integrated biodiversity concerns in a generic fashion often lacking full consideration of many issues including non-protected areas, proper baseline surveys, consideration of ecosystem functional processes, and clear criteria to assess biodiversity. The Convention of Biological Diversity (CBD) through Article 14 provides a strong international platform for the development and implementation of impact assessment techniques especially related to biodiversity (IUCN/ICMM, 2004).

This module describes how ESIA can be used to integrate biodiversity through exploration to development of the mine cycle (see Figure 2.1). Module 2 deals with integration of biodiversity through operations and Module 3 with integration of biodiversity into mining rehabilitation and closure.

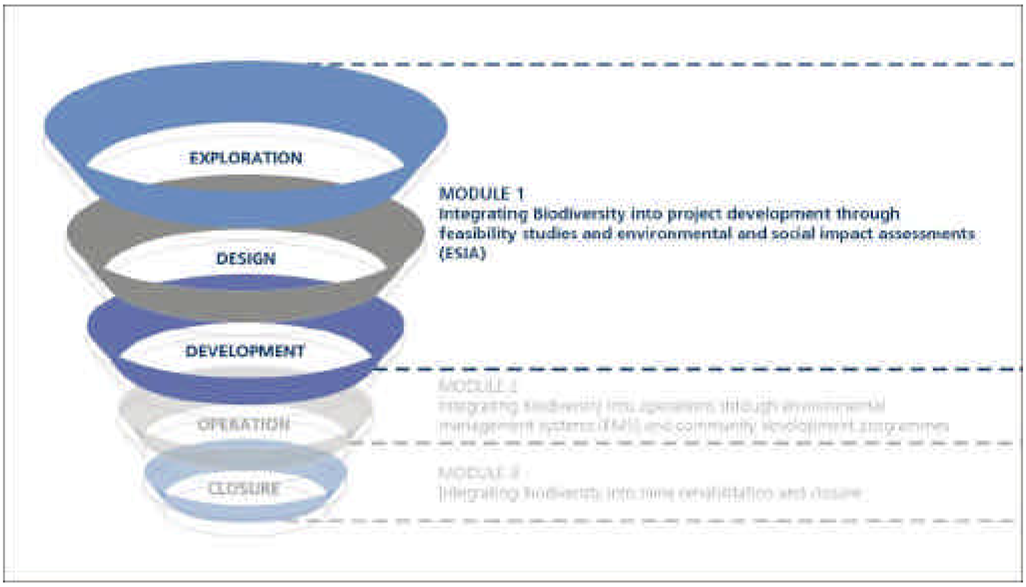

Figure 2.1 Integrating Biodiversity into the Mine Cycle Using ESIA – Module 1

Key

Planning

EXPLORATION

2.2 BACKGROUND

Potential impacts on ecosystems and biodiversity should be integrated into all evaluation and decision-making processes of operating companies, including but not limited to the important environmental and social impact assessment (ESIA) phase. This module provides guidance for each of the operating principles developed by the IUCN/ICMM July 2003 workshop to integrate biodiversity principles into project development through feasibility studies and ESIA. This module covers a far broader span of activity than just the formal ESIA stage typically associated with a reasonably advanced mining project. The intent of this module is to describe how the ESIA principles should be adopted from the earliest stages of a project lifecycle.

The objective of this module is to provide guidance such that mining operators and companies can:

- **Demonstrate a corporate commitment to biodiversity;**

Biodiversity is recognised as a significant business issue for mining companies and is associated with material risks and opportunities such as:

- Access to land;
- Reputation;
- Access to capital;
- Access to markets;
- Relations with regulators; and
- Liabilities.

Companies should develop and publish specific policies that recognise the significance of biodiversity risk to their business. At a corporate level, mining companies have the opportunity to benefit from biodiversity management by including conservation objectives into their overall corporate responsibility strategy or policy. The strategy or policy should recognise the strong role of biodiversity management in sustainable development and the business value of a positive public reputation on biodiversity issues. An example of a good policy which incorporates biodiversity conservation is found in Module 2, Section 2.3.1.

Once such policies are implemented, companies should put in place measures to manage biodiversity risks. Many companies now report biodiversity management through corporate environmental reporting. This involves a more holistic approach to reporting performance and can include effects on social, economic and environmental areas, also known as 'triple bottom line' reporting. Corporate commitment to biodiversity requires reporting specific biodiversity performance with respect to the company's operations. In order to do this, a company needs to select appropriate biodiversity indicators which assist in the management of biodiversity risks. Such indicators need to:

Key

Planning

EXPLORATION

- Link mining performance with effect;
- Show change over time and comparisons between operations;
- Demonstrate and drive progress towards biodiversity management and gives early warning of negative effects;
- Communicate performance and effects to the industry and stakeholders; and
- Demonstrate mining sector standards of performance.

Some examples of biodiversity indicators are included in this module, Section 2.7.4. The following case study gives an example of the relevance of biodiversity to a significant material risk for Rio Tinto's Flambeau copper mine.

Case Study: Access to land. Kennecott Minerals Company Flambeau Copper Mine in Utah, America. Rio Tinto (Mining).

Rio Tinto (Mining) is one of the worlds largest diversified mining companies with operations in five continents. The company wholly owns the Kennecott Minerals Company, operator of the Flambeau copper mine in North America. As with many new mining sites, Kennecott's initial plans for Flambeau in the mid 1970s generated local controversy, which highlighted the importance of adopting a responsible approach in order to gain access to the land for mine development.

Biodiversity Related Activity

Community and licensing authority concerns over the Flambeau plans centred on the potential destruction of an area of local amenity and landscape value with high-levels of biodiversity. In addition to appointing a responsible operator for the site, the permit authorities for Flambeau set biodiversity performance standards for reclamation of the site.

At Flambeau, the company needed to gain support from both the permit authorities and the local community, whose opposition could have caused the project to be delayed or scrapped. This was helped by both the Group's track record, and its ability to demonstrate that it had the expertise and resources to undertake reclamation commitments to make the site safe post-operation and restore the site's biodiversity.

Case Study: Access to land. Kennecott Minerals Company Flambeau Copper Mine in Utah, America. Rio Tinto (Mining), cont.

Reclamation provisions in the permit included a commitment to restore a minimum of 15 native plant species in grasslands and woodlands and a minimum of 12 native plant species in wetlands. In addition, 73 hectares of the site were set aside for conservation during the mine's operation, and bald-eagles were monitored to ensure they were not affected by blasting.

Following complete backfill of the pit in 1997, Kennecott went significantly beyond compliance, and 2003 records show that there are 267 native species on the site. The lower quality wetlands that were removed by mining were replaced by high quality wetlands that now contain 153 native plant species. Kennecott also took an extra step by partnering with local community conservation groups and constructed nature trails on the reclaimed mine site that have been open to the public since 2001.

Nature of Risk

The risk for Flambeau specifically was that the operating permit would not be granted and that the permit might be revoked or fines imposed if biodiversity-related standards were not met during operation.

The permit authority had the option to postpone granting the licence if it had not believed that Kennecott would be a responsible operator, a risk that would have been heightened by sustained opposition from the local community. Equally, the permit authority might have decided that no mining should take place at Flambeau, or built in such a large margin for error in environmental standards that the project would have become uneconomic. Any of these scenarios would have led Kennecott to write off its exploration and development costs; for an average mining development these are tens and sometimes hundreds, or millions of dollars.

At Rio Tinto Group level, the long-term business case for biodiversity is articulated as:

- "Improved licence to operate granted by neighbours, regulators and society;
- Better resource development opportunities; and
- Better access to markets for products"

Rio Tinto recognises the benefits that good practice has conferred at Flambeau, and is transferring the reclamation lessons from Flambeau to other similar sites both in the US and elsewhere.

Financial Relevance

Kennecott was able to gain and retain access to the Flambeau site due to its credible commitments over responsible behaviour and reclamation. The setting of targets and monitoring by the licensing authorities meant that at any time their permits could have been revoked if the company failed to meet its targets for water quality, conservation or reclamations: continued access to land is therefore contingent on good performance. In all areas of its activities at Flambeau, the company set internal standards that were beyond minimum legal requirements. This enhances the company's and the site's reputation with local community groups and regulators.

Key

Planning

EXPLORATION

- **Adopt an ecosystem approach**;

The Convention on Biological Diversity advocates an 'ecosystem approach' because people and biodiversity depend on healthy functioning ecosystems that has to be assessed in an integrated way, not constrained by artificial boundaries.

Adopting an ecosystem approach requires the management of natural resources with priority given to the maintenance of local ecological processes. Those processes include activities such as nutrient cycling, population changes and water balance. Ecosystem management focuses on the management of whole natural systems including the biological, social and cultural context of a project site and its surrounds. It looks beyond the boundaries of Protected Areas and promotes inter-sectoral cooperation.

This guidance describes the ecosystem approach in detail in Section 2.7.

- **Understand the nature of project sites;**

The biological, social and cultural context of a site and its surrounds should be understood and recognition and value be given to areas of high biodiversity value.

The identification of biodiversity risks early in the process of mine planning and concept development can steer the process down paths that avoid significant and costly problems and delays. Early identification of biodiversity risks will assist in the management of the initial developmental stages of a project such as location and layout of mine workings, processing facilities and choices of mining method and technology. Early identification of risks is further discussed in this module in Section 2.4.

- **Assess and mitigate biodiversity impacts, including secondary and cumulative impacts;**

This objective deals with using impact assessment to identify, manage and promote sustainable use of biodiversity for current and future uses. It is imperative that this process consider the entire mine life cycle from exploration to mine rehabilitation and closure. See Module 3 for more information on closure planning.

The assessment will involve the recognition of benefits of, and impacts to, biodiversity in providing essential life support systems and understanding the costs of replacing such systems. Such systems may include the maintenance of hydrological systems, protection of soil, breakdown of pollutants, recycling of wastes, and support for economically important living resources and regulation of climate. The continued delivery of these systems rests with biodiversity conservation. These systems frequently have greater immediate importance to communities.

Key

Planning

EXPLORATION

Section 2.7 of this module discusses the process of impact assessment and details the approach to mitigate biodiversity impacts including those impacts arising directly from the activities of the company, those arising indirectly from activities of the company and those caused by third parties.

- **Assess alternatives, including the no-action alternative;**

This objective seeks to assess intergenerational needs by identifying and assessing alternatives if the uses of biodiversity could negatively impact the ability of future generations to meet their needs.

- **Assess the impacts on efforts of local, indigenous and traditional communities in the area to protect and enhance biodiversity conservation;**

Traditional knowledge has often been down played or not considered as it often is not presented in a 'scientific' manner that fits many formal evaluation methods. However, experience in many locations strongly indicates that this knowledge base should be fully incorporated into the evaluation of biodiversity (and other) assessment and management plans. This objective highlights the importance of ensuring traditional rights and uses of biodiversity are recognised in impact assessment and the benefits from commercial uses of biodiversity are shared in a fair way. This issue is detailed in Section 2.6 of this module.

- **Assess the availability and potential application of traditional environmental knowledge; and**
- **Facilitate and support a partnership approach.**

Biodiversity conservation requires a partnership approach where consultation is undertaken with an aim to involve individuals, organisation and groups with a stake of the project to understand and manage decisions that have the potential to affect them (Rio Tinto, 2004). Stakeholders could include indigenous landowners, local users of biodiversity resources, government agencies, NGOs or others. Additionally, traditional and indigenous knowledge may be used to assist biodiversity conservation if appropriate.

The engagement of the community as a partner in projects will greatly assist in meeting and understanding each other's perceptions and expectations. The early establishment of strong and open communication links will assist in effective management of the mining project. This issue is detailed in Section 2.6 of this module.

The case study below demonstrates that creating sustainable partnerships and integrated business solutions can benefit both parties.

Case Study: Community partnerships and integrated business systems. Pilbara Iron, Western Australia. Hamersley Iron, a Rio Tinto subsidiary.

Mutually Beneficial Relationships with Aboriginal Community

Where relationships between a company and an Aboriginal community affected by its operations do not operate on a mutually beneficial basis, heritage outcomes can be compromised. Aboriginal communities have often used heritage processes as leverage to encourage greater engagement by companies. The most effective outcomes from heritage work are achieved where the work is conducted within an agreed framework that sets out not only the procedures and the responsibilities of each party in relation to heritage processes, but also commitments in economic and broader cultural areas.

Pilbara Iron's Experience

Pilbara Iron has a formal heritage policy and program that recognises the significance of Aboriginal sites and outlines the relevant company procedures to be followed. Senior managers are accountable for ensuring their departments' activities comply with the policy, including appropriate disciplinary action for breach of the policy. This policy is part of the training and induction for all Pilbara Iron staff and contractors.

Heritage procedures are not only defined in the Pilbara Iron Heritage Procedures Guide, but also in each of the native title agreements signed between Hamersley and / or Robe River and claimant groups. These procedures guarantee consistency in heritage management standards for all company activities whether they are under specific agreement or not. In reality over 95% of Hamersley and Robe's tenements are under native title claim and about 40% are covered by agreements.

The heritage program is an integral part of a range of programmes enabling the local Aboriginal communities to participate in and benefit from Pilbara Iron's activities. The programmes include employment, training, education, business development and cross-cultural training.

The relationship developed through these programmes contributed to the reaching of Pilbara Iron's first major agreement in 1997, the Yandi Land Use Agreement, on the development of Hamersley's Yandicoogina mine. The company now operates under the Yandi agreement, the Eastern Guruma ILUA and a number of other exploration and land use agreements. Negotiations are currently occurring with native title groups over the new development associated with the current expansion phase.

2.3 *THE ESIA FRAMEWORK*

Key

Planning

EXPLORATION

IMPLEMENTATION GUIDANCE:

Incorporation of biodiversity into ESIA requires:

- Assessment of the relevant levels of biodiversity including ecosystem, species and, if required, genetic biodiversity;
- Assessment of the interconnections between the levels of biodiversity;
- Monitoring of key biodiversity indicators;
- Assessment of the full range of impacts;
- Inclusion of community and indigenous knowledge of local biodiversity aspects;
- Stakeholder participation; and
- Effective management of biodiversity impacts.

2.3.1 *Introduction to the ESIA Framework*

Environmental and social impact assessment (ESIA) is an important tool for fostering sustainable developments in planning and decision making. The process followed when undertaking an ESIA provides a structure in which consideration is given to the environmental, economic and social consequences of options and alternatives when formulating proposed projects.

Legislation and environmental practices vary around the world; however, the fundamental components of an ESIA include the stages listed below:

- Screening to determine the level of assessment required for a project;
- Scoping to identify the key environmental aspects that require assessment;
- Baseline conditions to determine the state of the environment prior to undertaking the project so that change can be measured;
- Impact prediction and assessment to assess the level of impacts that may result because of the project;
- Mitigation and enhancement including assessment of alternatives and the incorporation of safeguards in the design of the project;

- Monitoring and environmental management plans to ensure that the predictions are accurate and that any unpredicted impacts or failed mitigation measures are identified and rectified; and
- Post-audit to ensure that environmental management plans are implemented and reviewed for continued improvement.

Key

Planning

EXPLORATION

2.3.2 *Biodiversity Issues to Incorporate in the ESIA Framework*

In order to take into account various aspects of biodiversity, the ESIA should:

- Assess the relevant levels of biodiversity, namely ecosystem, species and, if appropriate, genetic biodiversity;
- Assess the interconnections between the levels of biodiversity by considering the structural and functional relationships and how they will be impacted by the proposed project;
- Collect detailed abundance and distribution data of key biodiversity indicators;
- Assess the full range of impacts including primary, secondary, cumulative and induced impacts;
- Assess the importance of community and indigenous knowledge of local biodiversity aspects and stakeholder participation (as shown in the Gamsberg case study below);
- Clarify the criteria used to assess impacts; and
- Consider impacts and mitigation measures for biodiversity (IUCN/ICMM, 2004).

Case Study: Public participation and Community Liaison during the ESIA Process. Gamsberg Zinc Project, South Africa, Anglo American

Gamsberg is a large, low-grade zinc deposit in the Northern Cape Province of South Africa. It has changed hands several times since its discovery in 1971, most recently becoming wholly-owned by Anglo American in 1998. A detailed feasibility study demonstrated that a viable operation could be developed to produce 300,000 tons per year of zinc. The operation would comprise an open-pit mine, concentrator and dedicated zinc refinery, all on the same site.

During the feasibility study, a detailed environmental impact assessment was conducted. The main findings were the job opportunities and wealth creation on the positive side and the potential damage to the habitat of a group of rare succulents on the negative.

Extensive stakeholder consultation characterised the development of the project. Meetings have been held with over 300 interested and affected parties (I&APs), and the project team has hosted three public open days which included visits to the proposed mine site and detailed presentations of the proposed mining development.

Regular dialogue has been established with all of the main interest groups representing the ecology, farming, the local communities, the regional and local authorities, and tourism. Newsletters have kept I&APs informed of project progress and environmental issues as these emerged during the impact assessment. This dialogue resulted in alterations to the layout of the proposed surface facilities, including the tailings dam and the waste rock dumps, to preserve the areas that support the greatest density and diversity of plant and animal species.

2.3.3 *Biodiversity in the ESIA Framework*

Key

Site Selection

EXPLORATION

Figure 2.2 outlines the ESIA framework in relation to biodiversity issues that should be considered during the assessment of a proposed mine.

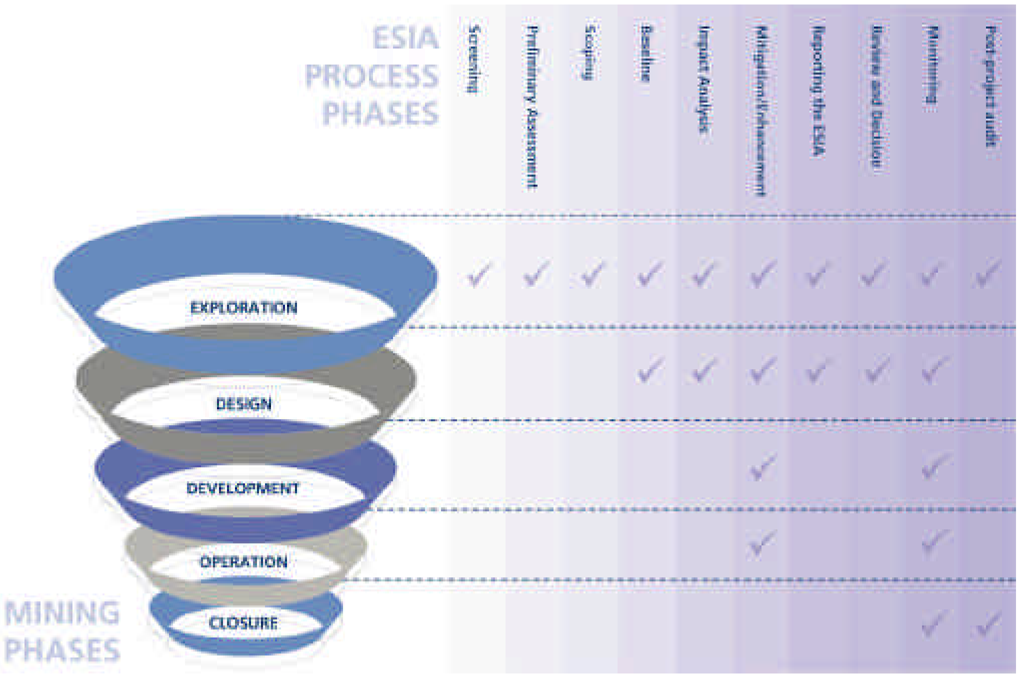

Figure 2.2 ***Framework for Integration of Biodiversity Issues in ESIA for Mining***

2.4 *SCREENING: INTEGRATING BIODIVERSITY IN THE EXPLORATION STAGE*

IMPLEMENTATION GUIDANCE:

- Biodiversity values must be considered early and throughout the mine cycle from exploration, operation, rehabilitation and closure.
- Companies should undertake a review of relevant legislation pertaining to biodiversity early in the site selection process.
- Companies should determine the permissibility of mining operations in a selected site.
- Regardless of permissibility; in some cases, mining companies must acknowledge that exploration and mining development may be incompatible with biodiversity values, and the no-go option needs to be adopted.

Key

Site Selection

EXPLORATION

- It is vital to engage with stakeholders when assessing the biodiversity values of a site.
- Biodiversity management is relevant to all areas whether formally protected or not.
- A company must develop an exploration management plan to ensure biodiversity is conserved to the greatest practicable extent during the exploration.
- Biodiversity data should be obtained early and used as a benchmark for measuring change during mining operations.
- Use biodiversity screening criteria to determine which proposals need to be subject to ESIA or to what level any impact assessment is required to ensure biodiversity conservation through ESIA.
- Key important biodiversity management measures to include in the exploration management plan are:
  - Limit land clearing by using technologies and mining practices that minimise habitat disturbance;
  - Avoid road building wherever possible by using helicopters or existing tracks. If roads are to be constructed, use existing corridors and build away from steep slopes or waterways;
  - Use lighter and more efficient equipment to reduce impacts on biodiversity;
  - Drill holes and excavations should be positioned away from sensitive areas;
  - Remove and reclaim roads and tracks that are no longer needed; and
  - Use native vegetation to revegetate land cleared during exploration.

2.4.1 *Early Consideration of Biodiversity Values*

Key

Site Selection

EXPLORATION

Early consideration of biodiversity values is imperative for effective conservation and management. It is essential that in the very early stages of the mining cycle there is the establishment of a repeatable and rigorous description of the current biodiversity of the site and surrounding area. Obtaining data at an early stage will provide a benchmark (or baseline) for measuring change during the life of the project and beyond. In fact, early identification of critical biodiversity values for an exploration site may provide economic advantages to a project. For example, if a prospective area is deemed to have sensitive high biodiversity values which cannot be efficiently managed during operations, a project may be stopped earlier during the mine cycle rather than later when additional funds have already been expended.

The following case study demonstrates biodiversity considerations through low impact mining practices during exploration.

Case Study: Specialised low impact exploration practices. Deep Lead Flora and Fauna Reserve, Victoria Australia by Western Mining Corporation.

Western Mining Corporation developed specialised low impact exploration practices to satisfy regulatory requirements for access to the Deep Lead Flora and Fauna Reserve near Stawell, Victoria. This reserve contains 335 native vascular plant species of which eight are endangered in Victoria, four are described as vulnerable, five rare and five seriously depleted. During botanical surveys, two orchid species not known elsewhere were found. This work significantly upgraded the importance of the flora found in the reserve. In addition, the reserve is relatively weed free and discussions between the company, the Department of Conservation and Environment and a Public Advisory Group a set of working conditions were prepared for the company. The primary goal was to minimise activity on the ground by personnel and mechanical equipment.

The exploration methods used were geochemical soil sampling, a transient electromagnetic technique (TEM), induced polarised technique (IP), percussion and diamond drilling. The company used existing tracks, no clearance of vegetation and innovative procedures such as: surface boarding to support equipment; surface tarpaulins to capture all material exiting drill holes; oil absorbent materials spread out on plastic sheets beneath drill rigs as a precaution against fuel spills or leaks; water stored in portable tanks rather than sumps; additional dust suppression measures; and careful storage and restoration of surface soils, sods and litter to eliminate impacts. Vehicle movements were restricted and, during diamond drilling, water and sludge were pumped to tankers located on nearby tracks. Drilling was scheduled for summer thus minimising ground compaction and impact on lilies and orchids which are summer dormant.

These measures protected the biodiversity of the area and increased the overall knowledge of the area's flora and fauna due to work conducted by the company and its flora and fauna consultants.

Key

Site Selection

Resource Targeting

2.4.2 *Pre-Fieldwork Phase*

The earliest opportunity to consider biodiversity aspects in the exploration programme is before any fieldwork is considered. The process of selecting prospective areas in which to spend the exploration budget provides an excellent mechanism to incorporate an assessment of biodiversity values and plan fieldwork accordingly.

This process should consider available information at the global/regional/national and local levels before committing to more intensive exploration. At a regional or national level, it is possible to identify areas that are:

- Formally identified and usually internationally protected areas (e.g. World Heritage Areas and Ramsar Wetlands of Importance)
- Formally identified nationally or regionally protected (IUCN categories classified as I-IV)
- Areas considered of high or potentially high value by various groups eg:
    - WWF's hotspots;
    - Convention International biodiversity hotspots;
    - WRI's – critical ecosystems; and
    - Known or potential area for threatened or endangered species (e.g. Red Book).

Protected Areas

In evaluating which areas are prospective, there is the opportunity to identify areas described or designated as important for the protection of biodiversity values before any on the ground disturbance is conducted. This would immediately reduce the potential for conflict over exploration in high value locations that are clearly designated and protected as such. Whilst there are a number of lists of high value areas, the status of the lists varies from country to country and often within a country. At the global level, classifications such as the IUCN System of Management Categories for Protected Areas are a very strong starting point. Whilst there may be arguments about some of the specific designations made or the boundaries assigned to each area, it is clear that this is an increasingly recognised process for identifying areas of biodiversity value.

The ICMM member companies have made a commitment not to explore or expand operations in World Heritage Areas (see www.icmm.com) and through the ongoing IUCN-ICMM dialogue Categories I through IV should be considered 'off limits' for exploration.

This initial screening may also identify time-limited events that may limit exploration such as key times for migration of animals or climatic events such as monsoons.

Conservation International Biodiversity Hotspots

Two factors are considered for hotspot designation. Hotspots are regions that harbour a great diversity of endemic species and, at the same time, have been significantly impacted and altered by human activities. Plant diversity is the biological basis for hotspot designation; to quality as a hotspot, a region must support 1,500 endemic plant species, 0.5 per cent of the global total. Existing primary vegetation is the basis for assessing human impact in a region. To qualify as a hotspot, a region must have lost more than 70 per cent of its original habitat. Plants have been used as qualifiers because they are the basis for diversity in other taxonomic groups and are well known to researchers. Typically, the diversity of endemic vertebrates in hotspot regions is also extraordinarily high.

The hotspot concept targets regions where the threat is greatest to the greatest number of species and allows conservationists to focus cost-effective efforts there. The 25 biodiversity hotspots identified to date contain 44 per cent of all plant species and 35 per cent of all terrestrial vertebrate species in only 1.4 per cent of the planet's land area (see www.biodiversityhotspots.org).

While management is often associated with formal protected areas, it should not be the only concern of conservation planning. It is important to understand that biodiversity management is relevant to all areas and to acknowledge that biodiversity value, and therefore conservation, is required in parts of the world that do not fall within existing protected areas. Some examples of biodiversity high value areas that may not be within protected areas include sites containing threatened ecosystems or species and culturally sensitive sites. It is vital to engage with stakeholders when assessing the biodiversity values of a site.

The following case study demonstrates how stakeholder engagement can assist with identifying biodiversity value and the development of an integrated regional land-use planning process which benefits biodiversity conservation.

Case Study: Development of an alliance with stakeholders for an integrated regional land-use planning process. Iron Ore in Pic de Fon, Forest Guinea. Rio Tinto Mining and Exploration Limited

The Upper Guinea forest ecosystem, which includes portions of the West African country of Guinea, once covered an estimated 420,000 square kilometres. Centuries of human activity have resulted in the loss of nearly 70 percent of the original forest cover. The remaining Upper Guinea forest is restricted to a number of isolated patches that are refuges for the region's unique species, including the chimpanzee and pygmy hippopotamus. One of these isolated patches is the Pic de Fon classified forest in Guinea.

Rio Tinto Mining and Exploration Limited, a division of Rio Tinto, is currently prospecting for iron ore within the Pic de Fon. Given the potential for high biodiversity within the Pic de Fon, Rio Tinto entered into an agreement with Conservation International (CI) to assess the region's biodiversity, as well as the existing and potential socio-economic threats to and opportunities for conservation in the Pic de Fon. This partnership was formed in the spirit of providing significant gains for biodiversity conservation, the communities that rely on resources within the region, and the government of Guinea.

A terrestrial biological survey, conducted in partnership with CI's Rapid Assessment Program (RAP) and West Africa program, was completed in November and December 2002, to examine sites within Rio Tinto's concession in the Pic de Fon. During the RAP, nearly 800 species were recorded, including seven species new to science and 11 threatened species, such as the West African chimpanzee and Sierra Leone Prinia. These findings will feed into Rio Tinto's baseline studies for its Environmental Impact Assessment.

Also in November and December 2002, CI conducted a socio-economic threats and opportunities assessment on the region. Several threats were identified, including bushmeat hunting and unsustainable agricultural practices. Building from the findings of these assessments, an initial biodiversity action plan has been developed. From this, CI will launch a second phase of the project in spring 2004, in alliance with Rio Tinto and other local and regional partners. The aim of the alliance will be to develop an integrated regional land-use planning process in Forest Guinea, including the Pic de Fon and surrounding areas, benefiting biodiversity conservation, industry, the communities that rely on resources within the region and the government of Guinea.

2.4.3 *Potential Exploration Targets*

The identification of potential exploration targets provides the next opportunity where biodiversity conservation can be integrated into the process. This identification should be to a country, region or locality level depending on the level of information readily available. At this early stage, a 'high level' risk assessment should be prepared. Screening can be used to determine which proposals need to be subject to ESIA or to what level any impact assessment is required. It is important that screening criteria include biodiversity measures, to avoid any risk that biodiversity will not be properly managed.

There are a number of factors that contribute to that risk understanding. They include:

Key

Site Selection

Conceptual Study

- Commodity demand in the context of its value to meet sustainable societal needs;
- Country risk;
- Ecological and social sensitivity of the location;
- Inherent hazard of the operation (i.e. potential for impact, including age of operation); and
- Strength of regulatory process.

The result of screening can be that:

- An ESIA is required;
- A limited environmental assessment is required to satisfy any concerns or to determine whether a detailed assessment is required; or
- An ESIA is not required.

Screening Criteria

The following is a list of criteria that can be used when undertaking the screening process for a project:

- Determine if a country has a list of identified projects that require ESIA. This list is often found associated with the relevant planning legislation or policies within a country;
- If such a list is not defined, a limited environmental assessment may be required to ensure that the project will not impact the environment. Such an assessment should be undertaken by a team of professionals including those with biodiversity expertise;
- Determine what thresholds are relevant to the magnitude of the activity, area of influence and/or biophysical change; and
- Obtain and assess the relevance of maps indicating areas important for biodiversity or having special legal status (see below 'Protected Areas').

Protected Areas

When considering such new ventures, the biodiversity context of an area can be initially screened using some largely desk-based assessment steps. These include:

- Assessing whether the site or surrounding area is a Protected Area which is an area of land and/or sea that is designated for biodiversity protection either at a local, national, regional or international level;

Key

Site Selection

Exploration

- Assessing whether the site or surrounding area is not currently protected but has been identified by governments or other stakeholders as having a high biodiversity conservation priority;
- Assessing whether the site or surrounding area has particular species that may be under threat (although the area may not currently be officially protected); and
- Assessing whether the site or surrounding area has important traditional or cultural value.

Protected Areas are areas that have been identified as having high biodiversity values by governments or other stakeholders. There are many different systems under which Protected Areas are designated. The status of a Protected Area may affect its ability to be mined or it may have particular prohibitions or requirements that need to be implemented during mining. Such constraints are important to determine early during the site selection process.

Protected Areas Designated Under International Agreements

Protected Areas may be designated under international conventions such as UNESCO World Heritage Convention, Ramsar Convention on Wetlands of International importance or UNESCO's Biosphere Reserves. In addition, mining companies should recognise and be aware that Protected Areas designated under international agreements may result in national policies, regulations and guidelines that may place tighter restrictions on the Protected Area.

Protected Areas Designated Under Regional Agreements

Protected Areas may be designated under regional agreements, which have been developed to enhance biodiversity management at a regional level. An example is the European Union nature conservation sites known as Natura 2000.

Protected Areas Designated Under National Processes

Each country has its own processes and sets of designations for protected areas, with numerous ways of designating protected areas at a sub-national basis.

Some key on-line biodiversity information sources and International Conventions are described in *Appendix A*.

Key

Site Selection

Exploration

Areas with High Biodiversity Conservation Priority

Governments or other stakeholders as priorities for biodiversity conservation have identified some high biodiversity conservation areas. Some of these areas have been identified for Protected Area expansion. These areas may:

- Support endemic, rare, declining habitats / species / genotypes;
- Act as a buffer thereby maintaining environmental quality;
- Support habitats that take a long time to develop characteristic biodiversity; and
- Have important seasonal uses or are critical for migration areas or corridors.

It must be recognised that biodiversity does not always fall within existing protected areas. While it is recognised that protected areas are important with regards to biodiversity management, failure to implement biodiversity conservation in any area of biodiversity value can be problematic (Maze *et al,* 2004). Refer to the previous section for a more detailed description on identifying biodiversity value of an area.

2.4.4 Fieldwork Phases

Exploration Phase

On-site exploration usually results in some disturbance to ecosystems (soil, vegetation, aquatic systems etc.) to a greater extent than the initial exploration. For example:

- Drill pads sometimes need to be established within relatively undisturbed ecosystems; this will require intensive management to limit the associated disturbance and subsequent rehabilitation of that disturbance. Management measures implemented can include minimising the number of access roads, keeping tracks as small as possible and rehabilitating tracks as soon as practicable.

Key

Site Selection

Exploration

- Costeans can create large linear trenches of disturbance and these can create 'traps' for fauna. Associated soil disturbance and vegetation removal is often extensive. The usefulness of costeans as sampling methods must be evaluated accounting for the potential impact on local biodiversity and rehabilitation effort and effectiveness. Where costeans are used, specific management plans should be instituted to provide barriers to access (i.e. fencing or other guides to divert animals), easy egress for animals that do fall in and, most importantly, closure and rehabilitation as soon as possible.

- Seismic lines cleared for geophone assessments often create straight lines of cleared vegetation providing access to predators, potential weed invasion sites and isolating previously intact vegetation. With modern methods of positioning and surveying, it should be possible to avoid 'line of site' cuttings in the vast majority of cases, and low impact methods should be possible in all other cases. Techniques available include low-pressure terrain vehicles, using rubber tyred bulldozers in a 'blade-up' condition and helicopter access rather than cutting any lines.

It is important that a company develop an exploration management plan to ensure biodiversity is conserved to the greatest practicable extent during the exploration. It should include specific elements such as:

- Site specific objectives and targets;

- Specific legal requirements;

- Identification of communities potentially involved and the appropriate approaches to engagement;

- Preliminary site and local assessments of biodiversity issues;

- Design and location of camps and related facilities; and

- Rehabilitation plans.

The exploration phase requires its own formal biodiversity assessment and management plan particularly as exploration activities are both the first direct contact between the company and the community. Additionally, exploration activities can present the first opportunity for a company to demonstrate that it does understand how to manage biodiversity impacts.

Another reason justifying the importance of having a formal biodiversity assessment and management plan at this phase of the mine cycle is that exploration is usually omitted in the formal ESIA, process even though there are potential for significant biodiversity impacts.

Some recommended practices for improving biodiversity conservation during exploration activities include:

Key

Site Selection

Prefeasibility

- Limit land clearing by using technologies and mining practices that minimise habitat disturbance;
- Avoid road building wherever possible by using helicopters or existing tracks. If roads are to be constructed, use existing corridors and build away from steep slopes or waterways;
- Use lighter and more efficient equipment to reduce impacts on biodiversity;
- Drill holes and excavations should be positioned away from sensitive areas;
- Remove and reclaim roads and tracks that are no longer needed; and
- Use native vegetation to revegetate land cleared during exploration.

The following case studies demonstrate the forethought and planning required for biodiversity conservation during the exploration phase.

Case Study: Forethought and planning before the exploration activity. Development of an environmental protocol. Placer Exploration Limited.

In June 1994, Placer Exploration Limited implemented an Environmental Protocol to ensure its field teams followed their Environmental Management Plan (EMP) and Environmental Checklist (see Appendix A). The Protocol is an assessment tool that includes educational material, suggested delegations of responsibilities and two environmental performance indicators. The protocol gives responsibility and ownership of environmental outcomes to each member of the field team.

It was introduced at a seminar for field teams in January 1995, emphasising their responsibility for minimising environmental impacts and rehabilitating disturbed land. To ensure field teams meet their goals, areas affected by their exploration are assessed by the Environmental Technical Officer (ETO) who then reports back to the team on their environmental performance.

For successful environmental performance, all phases of the operation must be managed properly. For exploration this involves:

- forethought and planning before the exploration activity;
- minimising impacts during exploration;
- environmental cleanup immediately following the programmed exploration; and
- rehabilitation within six months of programmed exploration.

To assist field teams, the ETO developed the Environmental Hit list. It is a robust, laminated, A5-sized, dot-point summary sheet that fits in a vehicle glove box.

Two environmental performance indicators (EPIs) were developed that assign a numerical value to each project thus allowing comparison between projects. Data collected from each project is reported in a table showing each variable in the formula and the calculated EPIs.

Environmental Performance Indicator Formulas are:

- Drilling program that has undergone an Environmental Cleanup immediately after drilling completed.
- EPI = no. of open holes + no. of areas with excessive tracks + no. of hydrocarbon spills + no. of areas with significant litter / Total no. of holes drilled
- Drilling program that has undergone rehabilitation no later than six months after drilling completed.
- EPI = no. of drill sumps left open + no. of drill holes not buried + no. of areas left unscarified or unripped + no. of sample bags left / Total no. of holes drilled

Results of the assessments are circulated so that everyone in the company knows which projects teams are the best performers. This has lead to healthy competition among field teams. The assessment outlines clearly the areas needing improvement. The performance indicators also allow comparison of the field teams and indicate the company's performance over time. While visual assessment is somewhat subjective, this is minimised by using simple variables in the EPI and by using one officer to assess the projects.

As with most management systems, this process will be modified and improved over time to enable greater feedback and increase commitment to good environmental performance.

Case Study: **Forethought and planning during the exploration activity. Rehabilitation of a drill site. Cannington, Queensland Australia. BHP Minerals.**

BHP Minerals at its Cannington, north-west Queensland, silver and base metal deposit provides an example of comprehensive management of target drilling of more than 460 percussion and diamond drill holes. Inspection at any of the drill holes reveals minimal environmental disturbance.

The first stage in preparing the drill site is to remove and stockpile topsoil from around the sites for the drill collar and the drill sumps. 'A' horizon topsoil is carefully removed to a depth of 200 mm. This material contains viable seed, organic matter and nutrients. The next layer, the 'B' horizon, which can also be used for rehabilitation, is removed to a depth of 300 mm. Lower levels (that is, below 500 mm) of the sub-strata are also excavated and stockpiled according to their salinity or acid generating potential.

During drilling, the bentonite-based drilling mud, used to keep drill holes open, is recirculated through a series of pits rather than being allowed to run off into local drainage channels.

There are seven distinct stages in rehabilitating a drill site.

1. Capping the drill hole to ensure that no fauna are trapped in the hole.
2. Demobilising the rig.
3. A drying out period to allow water to evaporate from the drilling muds, which will then cake and crumble to a fine, non-toxic powder. Residue settles at the bottom of each pit and is subsequently buried under backfill. If oily residues appear on the water surface in the pits, mesh shade cloth is placed over the open pits to exclude birds. The shade cloth is not removed until the water has evaporated.
4. Backfilling commences with sequential replacement of the stockpiled material so that the layers go back in reverse order to their removal, with the 'A' horizon topsoil being replaced last.
5. The surface is then scarified.
6. Seed from species natural to the area is sown immediately before the wet season.
7. Regrowth of natural vegetation is visible within a few weeks of the wet season commencing, and the drill sites are generally well covered within six months.

Pre-feasibility Phase

Different companies will have different terminology for the various stages of project assessment, and this stage is typically that which is conducted following promising initial results from the exploration phase. It often overlaps with the later exploration work so the boundaries between stages may be blurred.

From a biodiversity perspective, the key opportunities in this stage are:

- The identification of critical areas, whether protected or not;
- Outline of mining options, underground versus open-cut etc.; processing options and likely waste products, water demands and so on;
- Possible timeframes for development; and
- Likely size and physical location of plant, dams and infrastructure.

The identification of potential impacts is important, and mitigation measures should be included in the design parameters. There are a number of generic lists of possible impacts associated with the various stages and types of development. Tables such as that presented in MMSD Southern Africa Research Topic 4: *Impacts of Mining and Minerals Processing on the Biophysical Environment in Southern Africa* provides a good starting point for discussions and analysis. That table is reproduced in *Appendix B.*

Key

Site Selection

Feasibility

Feasibility Phase

This level of study and analysis follows on from a pre-feasibility level evaluation and would commonly improve the confidence level for proceeding with mining to about 10% to 15%. This stage requires more detailed studies and generally is the stage at which design parameters begin to be locked in and subsequent changes become more difficult to effect. This work should be conducted towards the end of an ESIA or after it has been conducted so that its findings and outcomes can be incorporated into the design.

The steps outlined in the previous section should be reviewed and updated with the more detailed design data and the likely impacts reviewed and management plans prepared. Design criteria that address the biodiversity management objectives should be set so that the detailed design can be conducted in accordance with those objectives. Including a biodiversity specialist on the design team would be very valuable.

A key step in improving this stage of the planning process is the opportunity to develop biodiversity specific management plans or biodiversity action plans (BAP). BAPs have been developed as an outcome of the Biodiversity and Industry initiatives in the UK. The Earthwatch site http://www.earthwatch.org/europe/ has a number of documents that include examples of BAPs.

2.4.5 *Review of Legislation Provisions Relating to Biodiversity*

It is important to undertake a review of relevant legislation pertaining to biodiversity early in the site selection process. A site may be affected by legal framework at international, national level, or other levels.

National or sub-national legislation will vary from country to country. Provisions may relate to the protection of specific plant and animal species to restrictions for indigenous or traditional lands. This information may be readily sourced through the national authorities with responsibility for biodiversity.

Key

Site Selection

DESIGN

2.4.6 *Permissibility of Mining*

It is important for mining companies to determine the permissibility of mining operations in a selected site.

Irrespective of the permissibility of mining operations for a site, most governments have a formal process where exploration permits are issued subject to consideration being given to environmental, social and economic trade-offs of the development.

However, this does not always preclude the dilemma of whether or not to mine a biodiversity sensitive area. Decisions over whether or not to mine in or around sensitive areas should acknowledge some of the following:

- The extraction of different minerals can have widely differing types and degrees of impact;
- Some sensitive areas are of much greater value from a local of global perspective;
- Some impacts can cause irreversible changes that lead to extinction, while some environments are more resilient and changes can be reversed; and
- If the appropriate mining agreements are developed with host governments, mining companies can deliver conservation management.

Guidance for such areas is proposed as a two stage approach:

1. undertake a strategic assessment using existing information to determine the suitability of the site from a biodiversity perspective; and
2. undertake an ESIA to ascertain the sustainability of mining from a social and environmental perspective.

It should be recognised that, in some cases, exploration and mining development may be incompatible with the objectives for which areas are designated for protection (WWF, 2003).

2.4.7 *Importance of Integrating Biodiversity into the Site Selection Process*

Addressing biodiversity conservation during the site selection process has significant advantages to the company. Advantages may include:

- obtaining an easier path for licence acquisition and maintenance;
- lower capital and operational costs;
- improved reputation management; and
- not wasting time with untenable options.

Key

Site Selection

DESIGN

In addition, undertaking this assessment early during the mine development phase enables the company to adapt its planning and operations to the specific biodiversity requirements of the site and its surrounds as defined by international, regional and national legislation. This will help ensure that the company operates within the laws governing the site (EBI, 2004).

Equally, if the biodiversity is important or unique, then the no-go option needs to be seriously considered. It is not appropriate to assume that all types of impacts can be mitigated. Rigorous assessment at this stage can save time and effort in trying to obtain approval for sites that should be clearly 'no-go'. The following case study demonstrates how such rigorous assessment can be used to determine 'no-go' areas. It provides an excellent example of a situation where an area is not formally designated for protection but clearly has significant biodiversity values.

Case Study. EIA leads to mining refusal in South Africa. Richard Bay Minerals.

The eastern shores of St. Lucia Lake in South Africa contain valuable reserves of titanium, and in the 1970s and 1980s the government granted mining rights to Richards Bay Minerals. This area of forested dunes is also a valuable source of biological diversity. In 1986 it was designated as a wetland area of international importance within the International Convention of Wetlands.

Between 1989 and 1993 the post-apartheid government in South Africa undertook an environmental impact assessment. The research was entrusted to over 50 scientists and other experts and was presented in the form of individual reports that were commented on by the various stakeholders. A review Panel was charged with using this information to determine whether mining would be compatible with nature conservation and tourism. As a result of this rigorous exercise, mining permission was refused and in 1999 the area was declared a World Heritage site.

Key

Site Selection

Conceptual Design

2.5 SCOPING AND STAKEHOLDER ENGAGEMENT: INTEGRATING BIODIVERSITY IN THE CONCEPTUAL DESIGN STAGE

IMPLEMENTATION GUIDANCE:

- Scoping will provide a basic understanding of a project's context in relation to its biodiversity setting. Scoping should include:
  - desktop assessment;
  - preliminary stakeholder consultation;
  - gap analysis; and
  - preliminary field investigation consisting of a site walkover.
- For effective stakeholder engagement:
  - Go beyond compliance:
  - Build long term and sustainable relationships;
  - Recognise and respect cultural differences;
  - Develop trust; and
  - Support training of community relations staff.

2.5.1 *Scoping*

Scoping allows for the identification of key issues of importance during the ESIA process. When identifying the key issues of importance during the scoping stage, the impact assessment process focuses only on assessing significance and the relative importance of different biodiversity elements in relation to the proposed project. The stages that should be undertaken during the scoping assessment include:

Desktop Assessment

Undertake a desktop assessment including collation and review of available references and data on the biodiversity of the site will be of value. This can include databases established by government, community groups and educational institutions. Research aerial photos, satellite imagery and other mapping, planning documents and any information regarding protected areas, and threatened or protected habitats and species. This assessment should identify the basis for scoping, which in turn will identify the key impacts to be studied and establishes the terms of reference for the ESIA.

Key

Site Selection

Conceptual Design

Gap Analysis

Having established the biodiversity context of the site and surrounding areas and determined key issues of concern for the proposed project, it is important to undertake a gap analysis to determine if any additional information on biodiversity is required. A site-specific resource document summarising the desktop review and identifying the gaps in the data and technical knowledge should be prepared at this stage.

Identification of Key Issues of Importance

Key biodiversity issues of importance can be identified by overlapping the proposed project footprint with the biodiversity context of the area identified in the preliminary assessments described above. GIS can be a very efficient means of comparing different project options and environmental values. Key biodiversity issues of importance will be identified by the overlaps or intersections of the proposed project with biodiversity. Such areas should be flagged for detailed field assessment.

Field Assessment

Once information on biodiversity has been obtained through desktop assessment and preliminary stakeholder consultation, and the scoping study has not identified gaps, a preliminary field investigation consisting of a site walkover should be undertaken to confirm the information that was obtained for the site.

Should the scoping study identify gaps in biodiversity data, a targeted field assessment of the biological assets and features of the site should be conducted if key issues of importance for biodiversity are identified in the gap analysis. The assessment will need to be tailored to the type and stage of the mining project, the complexity of the ecosystems within and around the site and the issues identified by the stakeholder consultation. The assessment should be aimed at gathering the correct information to make an informed decision on whether the biodiversity will be impacted negatively. Where there is limited information, rapid assessment techniques such as those used by Rio Tinto and Conservation International for the Upper Guinea prospect in West Africa can be very useful (see case study Section 2.4.2) (www.africaconservation.org /dcforum/DCForumID5/238.html).

Key

Stakeholder Consultation

Conceptual Design

An important component of field investigation is to gain insight into the ecological processes currently and historically operating at the site, e.g. fire, flooding, seasonal influences, plant succession, emigration and immigration etc. This knowledge will be a major component of developing an ecosystem management approach to identify and manage any biodiversity changes that occur due to the mining project.

The Benefits of Scoping

Scoping will allow identification of issues of importance and the assessment undertaken through the ESIA process to be focused on key issues of biological diversity. In so doing, scoping will also eliminate issues that are not of concern. Scoping, therefore, will result in a more cost-efficient assessment that is targeted and useful to the decision-maker and is addressing concerns.

Scoping also provides for a basic understanding of the project's context in relation to its ecological and social setting.

2.5.2 *Stakeholder engagement*

Early engagement with relevant stakeholders or their representatives, in particular indigenous and local communities can be of great assistance in making a preliminary assessment of the potential viability of a proposed mining activity. It can also assist in ensuring the ESIA is focused on those matters which will add value to the decision-making process.

Once the preliminary information has been gathered, it is important to consult with stakeholders to improve understanding of the site, its biodiversity and the values the stakeholders place on the biodiversity. Therefore, stakeholder engagement on biodiversity issues is central to the integration of biodiversity into the ESIA process and will be an activity that runs throughout the process. As an initial task, preliminary stakeholder consultation will be undertaken to gather additional information on the biodiversity of the region and opinion about potential exploration and extraction including the potential impact mining will have on the biodiversity of the site and surrounds. Stakeholder consultation will help identify additional, undocumented biodiversity issues particularly those that may have both functional and cultural significance to the indigenous community.

Key

Stakeholder Consultation

Conceptual Design

Effective stakeholder engagement should enable mining companies to:

- clarify the objectives of the proposed mining activity in terms of community needs and concerns;
- clarify the objectives of the proposed mining activity in terms of government policy directions, strategic plans and statutory or planning constraints; and
- identify feasible alternatives and clarify their merits in terms of biodiversity values.

It is recognised that at this early stage companies may be unwilling to flag what commodities or specific areas they are targeting for commercial reasons. However, it is equally important that this stage is used to build trust and credibility. Therefore, it is valuable to ensure that reputable agencies or individuals conduct biodiversity assessments and reports are peer reviewed to the extent practicable at this early stage (see box on Credibility).

Credibility of Biodiversity Studies

The field of biodiversity studies and assessments is subject to diverse and often divergent views within the mining industry let alone the wider community. This means that it is very important that the studies or assessments conducted are rigorous, consider scientific and cultural requirements, and are adequately validated. Within the traditional scientific practice areas, the use of peer review processes from establishment of the initial study parameters through to evaluation, is commonplace and should be adopted especially if areas of high biodiversity value have been identified at the screening phase. In incorporating traditional or indigenous knowledge, it is more difficult (and controversial) to establish appropriate review and validation mechanisms; however it is equally important that the local communities validate the initial biodiversity assessments.

Because stakeholder engagement in the minerals sector has been undertaken for many years, engagement has occurred in a variety of ways and lessons have been learnt over time. The following strategic approach for effective stakeholder engagement is recommended:

- Go beyond compliance. Environmental legislation often contains requirements to have stakeholder consultation. While this requirement must be met, it is important that mining companies use this opportunity to build relationships with stakeholders rather than undertake the activity purely for the sake of compliance.

- Build long-term, continuing and sustainable relationships. Relationships with stakeholders should be considered as long-term investments and therefore it is important to allow the time for such relationships to develop.

- Ensure cultural differences are recognised particularly within indigenous communities. Engaging dialogue can only occur if each party understands each other's perspective. Cross cultural training is important to build levels of respect.
- Develop trust. Effective engagement occurs with trust.
- Ensure stakeholders are listened to and promises are fulfilled.

Key

Stakeholder Consultation

Conceptual Design

The following case study demonstrates a method of obtaining cross sectoral dialogue and collaborations between stakeholders.

Case Study. A community and business forum in Krygyzstan. Kumtor Operating Company.

Background

In May 1998 a truck on the way to the Kumtor gold mine crashed and spilled sodium cyanide into Barskoon River. The strength of the local reaction resulting from this accident focused national and international attention on the need for increased dialogue between businesses and local communities.

As a result, the Community and Business Forum (CBF) was established as a mechanism for facilitating dialogue between local communities and other stakeholders within the watershed of the Kumtor Gold Project. Funding was provided by the UK Department for International Development through the International Finance corporation and European Bank for Reconstruction and Development. Fauna and Flora International, a conservation NGO with considerable experience in the region, was selected to help set up the forum.

The CBF highlighted some pressing problems in the region, including poor access to credible information and a lack of accountability within the trust between different stakeholder groups.

Pressures on Biodiversity

The inland location of Kyrgyzstan, combined with its terrain, gives the country an arid, continental climate. This small mountainous country has some of the tallest mountains in the world. The combination of landscape and extreme climate has resulted in an interesting and diverse range of plants and animals.

A range of endemic plant species has been recorded in Kyrgyzstan, including many bulbous plants such as tulips and Alliums. The southern forests support a range of wild relatives of species that have since been propagated – including apples, walnuts, apricots, tulips and onions. Animal life is equally diverse. The alpine lakes, visited by vast number of water fowl during migration, are particularly important. Three species of marmot are recorded in Kyrgyzstan including the threatened and regionally endemic Menzbier's marmot. Other herbivores using the high mountain pastures include ibex and the rare Marco Polo sheep, with its distinctive curving hornes.

A number of problems threatened the unique and fragile environment of this country. Many are legacies of the Soviet era: extensive overgrazing and degradation of the fragile mountain pastures, use of forests as fuel for industry and pollution from both heavy metals and pesticides. In addition, a number of uranium mines remain unsealed, and radioactive tailings potentially threaten important watercourses. The Soviet system did institute a strong system of protected areas. Since 1991, however, the loss of government income has reduced expenditure on environmental protection, and many protected areas now lack the resources to provide effective protection and enforcement against illegal activities.

Case Study. A community and business forum in Krygyzstan. Kumtor Operating Company, cont.

Lessons Learned

- A participatory approach to project development and implementation meant that the CBF acted to meet expressed local needs and achieved local ownership.
- The CBF was adaptable and used a wide range of different approaches to achieve results that exceeded expectations.
- Facilitation by a neutral but active third party provided an effective mechanism to engage all key stakeholders.
- The involvement of a wide range of actors was important for increasing the project's scope and effectiveness.
- Site visits and meetings that involved community representatives and credible local NGOs allowed more effective and accepted monitoring and review of environmental performance.

Partnership and dialogue are highly complex and slow. Yet the benefits of incorporating differing and even conflicting perspectives are clear. The lessons learned in the CBF include that it is important to build on existing initiatives, to provide appropriate information, to create space for discussion, to build trust through action on the ground, to embrace both positive and negative unexpected outcomes and to take a holistic approach – understanding both biodiversity and mining in terms of wider issues, context and history.

- Support training of community relations staff. Ensure community relations staff are given adequate status and support.

The case study below shows that building long-term relationships and obtaining trust requires time with stakeholders but ultimately will achieve effective engagement.

Case Study. The Bushmanland Conservation Initiative. Anglo American/National Biodiversity Institute.

Background

In 1999, Anglo American proposed opening the Gamsberg Zinc Project in Bushmanland, a large open pit mine on a quartzite inselberg (an island mountain) in the heart of a pristine biodiversity hotspot. The proposed 5.5 billion rand mine would create a hole some 2 by 3 kilometres wide and 600 metres deep – 200 metres deeper than the Kimberly hole. The mine would also create approximately one thousand jobs in an area with minimal economic resources. Unfortunately, the often-conflicting imperatives of development and conservation collided head-on soon after the company announced its intentions.

Assessing Biodiversity Impact

The involvement of the environmental lobby and biodiversity groups in the Gamsberg Zinc Project began in 1999 during the environmental impact assessment done for the mine and associated infrastructure. The assessments undertaken for biodiversity were adequately detailed and even included an assessment of the 14 surrounding quartzite inselbergs in order to place the impacts of the proposed Gamsberg mine in a regional context. This analysis showed the Gamsberg was going to be the single most important site for biodiversity conservation in the region, since it contained 70 per cent of the unique fine quartz patch habitat as well as three new plant species and the largest populations of several threatened plant species.

While the biodiversity specialist studies were thorough, there was concern from the biodiversity sector that the global and national significance of the area had not been adequately recognised in the overall environmental assessment and that the proposed mitigation measures were inadequate. A conservation agency commissioned a fine-scale conservation plan to identify options for achieving conservation targets. This study was supposed to lay the basis for negotiation on mitigation measures to offset the impacts of the open pit, but a lack of trust between parties and the lack of precedent for such an initiative eventually led to a stalemate between Anglo and many of the conservation NGOs involved.

What Anglo was offering as compensation did not have the support of the majority of NGOs and biodiversity specialists in the region. Shortly after this unsatisfactory process, the mine project was placed on hold due to low zinc prices.

Having the project on hold was a blessing in disguise. It provided some breathing space between opposing parties, and two important developments during this time facilitated constructive engagement between the conservation and mining sectors in the region.

A New Partnership

During the SKEP planning process, the dialogue between biodiversity groups and Anglo continued, and an agreement was reached to establish a partnership project: the Bushmanland Conservation Initiative (BCI). This partnership between conservation NGOs, the mining company and local communities aims to establish a multi-owned protected area through a variety of innovative interventions and mechanisms that draw in local landowners. The protected area will achieve conservation targets for biodiversity features in this priority area through a multi-use approach. The BCI will develop local conservation management capacity through training local community members as conservators within the project management team.

Case Study. The Bushmanland Conservation Initiative. Anglo American/National Biodiversity Institute, cont.

The initiative aims to demonstrate best-practice lessons for the engagement between mining and conservation. Central to this is creating a culture in which mining not only minimised adverse environmental impacts within its operations, but also works to positively enhance in situ biodiversity conservation. Anglo has made in in-principle commitment to make a substantial contribution to the BCI. This will include setting aside the land surrounding the Gamsberg mine for conservation within the BCI.

Conclusion

What began as a confrontation between mining and conservation gradually changed into a collaborative approach that included systematic conservation planning. This catalysed Anglo Base Metals' direct involvement in implementing conservation action that meets conservation targets. Without systematic conservation planning, it would not have been possible to determine the impacts of the Gamsberg mine, suggest meaningful mitigating measures, build credibility of biodiversity goals or provide a way for the mining sector to contribute that adds directly to efforts to meet biodiversity conservation targets.

Using the above approach, the following consultation procedures are recommended:

- Consultation with relevant government agencies is recommended to help identify alternatives and to provide a preliminary view on their acceptability of a proposed project within the strategic context.
- To maximise the benefit of consultation with government authorities, it is recommended that the company provides adequate information about the proposal and the proposed site locations.
- Occasionally, it may be necessary to hold a meeting with the attendance of all relevant government agencies, particularly on controversial projects. Such meetings should include the government authority with the approval role, other agencies that may have a role in catchment management or management of a specific environmental area etc.
- In addition to government agencies, it is recommended to include relevant non-government agencies and community groups that are directly or indirectly affected by the proposed project.
- Consultation should also include affected individuals or groups such as local indigenous groups or members of the public that are directly or indirectly affected by the proposed project.

- Occasionally, it may be necessary to undertake a program of stakeholder consultation, which should include two phases; one seeking to inform the community (through public displays and newsletters) and another seeking to gain input on issues of community concerns (through community workshops of surveys).

The following case study demonstrates going beyond compliance during stakeholder consultation.

Key

Stakeholder Consultation

Conceptual Design

Case Study. Awareness and capacity building. Tampakan Copper Project, previously owned by WMC Resources (WMC), Philippines. WMC had been working with the indigenous Bla'an communities near its Tampakan Copper Project, in south Mindanao, the Philippines, to ensure that they get legal title to their traditional lands. According to the Philippines Mining Act of 1995, mining is forbidden on officially recognised lands without the 'informed consent' of the relevant indigenous groups. However, the reality is that few of these groups possess legal titles to their land, and all unclaimed land, according to national law, is property of the state. However, recognising their responsibilities to local communities, WMC worked with local people to research historical land claims and demarcate the lands, through ethnographic, archaeological, social and customary law data collection, mapping of territories and a baseline assessment of local resource use. This information will help the communities to register their official Ancestral Domain Claims and provide a long-term foundation for development. WMC Resources sold this project in 2002.

2.6 *BASELINE CONDITIONS: INTEGRATING BIODIVERSITY AT THE MINE DESIGN STAGE*

IMPLEMENTATION GUIDANCE:

The following steps are required when assessing biodiversity:

- Identify the components of biodiversity that are considered most important by stakeholders.
- Undertake a database and literature review of all aspects of biodiversity relating to the site including:
  - The presence of significant species and communities potentially occurring on or in the vicinity of the site;
  - Quality of wetlands and riparian zones;
  - Presence of threatening processes;

Key

Baseline

Conceptual Design

- Proximity of the site to 'protected' areas;
- Land capability information and;
- Biodiversity –rich habitats/areas.

Where feasible, consult:

- Relevant Government departments and local councils, academic institutions, local communities for relevant legislation, policies and strategies pertaining to the biodiversity of the site and surrounds.
- Local environmental groups.
- Herbariums, botanic gardens and museums for records of rare and unusual plants found in the vicinity of the site.

Use biodiversity context and values to develop biodiversity objectives for the project.

2.6.1 *Design*

The design stage should, in most cases, be the stage where the designs prepared in the feasibility stage are taken to the point at which construction can begin. The design criteria set at the earlier stage should be revisited on a regular basis to ensure that the design is not compromising biodiversity objectives. Issues that can arise at this stage include:

- Changes to plant layout (either increase in footprint, or changes to location of equipment) which may have biodiversity impacts through increasing disturbance or encroaching on sensitive areas;
- Modifications to processing plant design, perhaps reagent types or quantities, that could have impacts on aquatic biota;
- Changes to the power source altering impacts on air or water quality;
- Changes to drainage routes that could lead to discharge of runoff to different drainage catchments than those planned;
- Alterations to the alignment of dams, roads and powerlines that could increase fragmentation of vegetation areas;
- Changes to mine and waste dump designs that could increase the potential for acid drainage;
- Alterations to the tailings disposal methods; and
- Changes to the mining operations plan enabling backfilling of mine waste into mined out pits, thereby reducing the mine footprint.

Key

Baseline

Conceptual Design

2.6.2 *Confirming the Biodiversity Context of a Site*

Once a site has been selected, preliminary assessments need to be made and management controls developed and implemented. The preliminary assessment is required to confirm the biodiversity context of the site. As sites are not homogenous, preliminary assessment can identify areas of sensitivity, or lack thereof, so that potential mine plans may be adjusted accordingly.

Preliminary assessment can also assist identifying whether some land systems may contain significant species or communities that are potentially vulnerable to even the minor disturbance associated with the initial low impact exploration such as walking transects and sample collection. For instance, some susceptible species may be particularly vulnerable to predators or other forms of disturbance that will follow human tracks. This stage provides an opportunity to engage with local communities to begin to understand what their priorities and concerns are. Specifically, it is an opportunity to gain background, and often very specific, information on traditional knowledge of biodiversity that are not often recorded in written formats.

The following steps are required when assessing biodiversity context:

- Identify the components of biodiversity that are considered most important by stakeholders.
- Undertake a database and literature review of all aspects of biodiversity relating to the site. This may be undertaken through a thorough literature search and by interrogating relevant Government databases for information regarding (for example):
    - The species of flora and fauna recorded on or in the vicinity of the site;
    - The presence of significant species and communities potentially occurring on the site;
    - Quality of wetlands and riparian zones;
    - Presence of threatening processes;
    - Proximity of the site to 'protected' areas;
    - Land capability information and;
    - Biodiversity –rich habitats/areas.

Where feasible, consult:

Key

Baseline

Conceptual Design

- Relevant Government departments and local councils, academic institutions, local communities for relevant legislation, policies and strategies pertaining to the biodiversity of the site and surrounds.
- Local environmental groups.
- Herbariums, botanic gardens and museums for records of rare and unusual plants found in the vicinity of the site.

Determination of biodiversity context and values will assist in developing biodiversity objectives for the project. These objectives will form the basis of the benchmarks against which biodiversity management measures are to be evaluated.

The following case study shows how one company developed a partnership strategy with stakeholders to successfully determine stakeholder biodiversity values.

Case Study: A strategic response to biodiversity conservation. A Biodiversity Strategy. Rio Tinto.

Rio Tinto has developed a strategic response to biodiversity conservation, designed to enable the company to meet a wide range of expectations held in many different constituencies with interests in the company and its activities. As a first step, partnerships were formed with leading conservation organisations such as Earthwatch Institute to provide perspectives on the opportunities and challenges raised by the mining process. A detailed survey of the level of awareness and management of biodiversity issues at all operations was carried out. A strong business case for developing a biodiversity strategy has been put to senior management. A strategy is under development with inputs from many of the Group's operations and from conservation partners and other NGOs. The aims are to raise performance in biodiversity management across the company and to improve the company's reputation with key audiences including regulators, communities and environmental NGOs.

Rio Tinto's approach to the development of a strategy has four steps:

Establish a representative internal consultation group to capture existing expertise and promote the interchange of ideas and their timely review across the Group.

Document existing knowledge through a survey of flora and fauna inventories at individual businesses, rehabilitation and monitoring programmes, conservation projects and partnerships. Produce case histories where nature conservation has benefited from actions taken by operations, or where difficult trade-offs between conservation and development have been agreed.

Consult widely to learn from experts in biodiversity assessment, conservation and management. These may be found within existing partners and other organisations.

Develop the business case for Rio Tinto adopting a Biodiversity Strategy, identifying the costs of implementation of biodiversity management plans as well as the value of reputation benefits associated with the company having a declared strategy.

This strategy is leading to the development of tools to guide future activities with respect to management of biodiversity. These tools will be used in assessing exploration areas, new project assessment and approval procedures, developing biodiversity indicators, ongoing rehabilitation management, and community development programmes.

2.6.3 *Establishing Baseline and Reference Areas*

Key

Baseline

Conceptual Design

Reference areas need to be established as a benchmark against which a comparison of change in biodiversity over time can be made. Reference areas must include examples of the ranges of vegetation types, and degrees of disturbance, of the areas to be impacted. Monitoring of these sites need to cover the biodiversity (ecosystems and species, in particular) that exists in the environment. In summary, establishing a baseline will provide the necessary information on the site-specific environmental setting of the project from which changes to biodiversity can be compared as operations progress over time.

Baseline

Often the most difficult variables to incorporate with assessment of biodiversity baselines are spatial and seasonal variations, as insufficient time is allocated to develop an accurate assessment. This highlights the importance of starting assessments early in the mine cycle to establish pre-project trends from which change can be measured.

The results of the baseline assessment can be shared with stakeholders through the engagement process (EBI, 2004). This will ensure that the setting of the project is in line with the stakeholders' expectations of the environment. Additionally, it demonstrates transparency and encourages cooperative relationships among interested parties.

The collection of baseline data may also reveal additional biodiversity values of the mine site that were not previously recognised during the initial assessment of values (Section 2.4). Therefore, biodiversity objectives and subsequent selection of biodiversity indicators should be re-assessed in consultation with stakeholders, following an evaluation of the baseline dataset.

Reference Areas

The ecology of each project site is unique and no two sites will be the same. Reference sites should preferably be selected before project commencement and have similar ecology, degree of disturbance and landform to the project site. Close physical proximity of the reference site to the project site is desirable.

As these reference sites may be very important in judging whether the site rehabilitation programs have been successful, particular care needs to be paid to selecting these sites. The credibility of the selection process is best achieved through a targeted stakeholder exercise aimed at key members of the local and regional communities. Community and social values also need to be considered in selecting reference sites.

Key

Impact Identification

Conceptual Design

Where operations have already commenced and baseline information is not available on the pre-mining condition, an estimation of the pre-mine condition will need to be made in order to select comparative reference sites. This should be undertaken by reviewing historical information on the nature of the landscape, disturbances, land-use and biodiversity condition prior to the existence of the operations. Tools for undertaking such a review include:

- An historic review of aerial photography of the site;
- Comparison of soil types found on the site with those found on potential unmined reference sites;
- Consultation with local communities and government authorities;
- Accessing database information on the flora and fauna recorded on and in close proximity to the site prior to mining;
- Reviewing topographic and geological mapping for the area; and
- Using the Beyond-BACI (Before-After-Control-Impact) design for selection of reference sites (Underwood, 1994).

2.6.4 *Measuring and Interpreting Change in Biodiversity*

Establishing the framework for the evaluation of changes in biodiversity that may occur as a result of the project and related activities is a key objective of biodiversity conservation. This will require extensive consultation with stakeholders and rigorous, statistically sound methods of data collection and analysis.

As the biodiversity at a particular site consists of numerous components, each interacting with each other over varying periods of time, seasons and space, the framework selected will necessarily need to be varied to provide an adequate measuring approach. At some sites, groups or associations of species of plants and animals may better reflect change than intensive assessment of individual species. Selecting indicator species or groups of species may be appropriate at other sites. A species that occupies a particular development stage of an ecosystem may be monitored to provide an indication of change either positive or negative. Given that development stages are dynamic, the challenge is to determine positive and negative changes. Invertebrates are often used for this purpose. It is sometimes difficult to measure impacts on a single species, particularly if that species is already threatened/vulnerable or otherwise difficult to monitor.

Key

Impact Identification

Conceptual Design

Each mining company should, in conjunction with its government regulators and stakeholders, determine what set of indicators will be required to measure and manage impacts on biodiversity. Site indicators are to be determined based on the biodiversity context and values already identified.

Desirable characteristics of the suite of indicators include:

- Based on SMART (specific, measurable, achievable, relevant, timely) principles;
- Reflect pressures (threats) to biodiversity values, the condition of biodiversity and management responses to impacts on biodiversity;
- Include species-based, ecosystem structure-based and ecosystem function-based indicators of biodiversity; and
- Fulfil legislative and policy requirements.

Indicators are divided into:

- Condition indicators, e.g. species richness, species composition.
- Pressure indicators, e.g. extent of native vegetation clearance.
- Response indicators, e.g. area of weeds control, area revegetated.

Expert assistance may be required in selecting and reviewing the most appropriate indicators of biodiversity to be measured, particularly regarding the measurability of the indicators. In addition, the initial suite of site-specific biodiversity indicators selected for the site is likely to alter during the life of the project.

Before final selection of measurable indicators, consultation with stakeholders should be undertaken to ensure the suite of indicators selected is socially acceptable.

Appendix C provides a suite of biodiversity indicators and potential measures. In identifying and measuring change, it will be necessary to take into account the:

- Ability of an ecosystem/habitat or species to recover;
- Local value and role of biodiversity;
- Interactions with natural processes; and
- Global, national or local significance of the biodiversity (EBI, 2004).

Furthermore, any biodiversity assessment that occurs in traditional areas will benefit from obtaining knowledge from indigenous people on biodiversity, land-use and in particular knowledge of plants and animals and their uses, including harvesting, breeding and cultivation techniques (Rio Tinto, 2004).

Key

Impact Identification

Conceptual Design

2.6.5 *Establishing a Monitoring Program*

Sites are to be routinely monitored and performance evaluated against predicted biodiversity objectives. Monitoring will measure change in selected indicators over time. The monitoring program should be directly linked to the collection of baseline data, as baseline data collection is technically the first monitoring event to take place.

The first step in establishing the monitoring program will be to set up an appropriate 'experimental design'. This involves:

- Defining the hypotheses (predictions or questions to be answered) for each indicator of biodiversity to be measured and monitored. The development of these hypotheses will be drawn from information gained in previous sections;
- Defining the statistical tests / method of results analysis best suited to testing the hypotheses;
- Developing appropriate techniques to measure selected site-specific indicators; and
- Designing an appropriate sampling procedure, incorporating aspects of randomisation and replication of sampling units. The sampling process will need to be consistent with the type of variable being measured. For example, if trying to assess the change in vegetation quality, a suitable process might include regular floristic surveys of species richness and cover abundance.

It is important to establish a time frame for monitoring frequency Some expert advice from the scientific community may be useful in assisting with the development of the experimental design program.

Once the monitoring program has been established, regular monitoring should commence and continue throughout the life of the project.

2.7 BIODIVERSITY IMPACT PREDICTION AND ASSESSMENT: INTEGRATING BIODIVERSITY AT THE MINE DESIGN STAGE

IMPLEMENTATION GUIDANCE:

- ESIA should be an iterative process of assessing impacts, redesigning alternatives and comparing predicted impacts to the established baseline.

Impact assessment must include:

- An assessment of the impact level, i.e. ecosystem, species and/or genetic;
- An assessment of the nature of the impact (primary, secondary, long term, short term, cumulative etc.);
- An assessment of whether the impact is positive, negative or has no effect; and
- An assessment of the magnitude of the impact in relation to species/habitat richness, population sizes, habitat sizes, sensitivity of the ecosystem, recurrent natural disturbances etc.

Key

Impact Identification

Conceptual Design

2.7.1 *Nature and Level of Impacts*

Mining development and operation will have a range of potential risks or impacts on the biodiversity of a site. Some impacts can be minor, while others can be devastatingly negative such as historical mining operations that occurred in areas of high biodiversity without adequate implementation of mitigation measures. Equally, mining can take place in areas previously cleared or severely degraded creating opportunities for biodiversity enhancement to occur during and when mining ceases.

The following text provides guidance to identifying impacts.

Direct Impacts

A direct impact occurs where a proposed activity is directly responsible for that impact.

Secondary Impacts

A secondary impact occurs where the impact is a consequence of the direct impact.

Cumulative Impacts

Evaluation of biodiversity impacts arising from the development of a project needs to include those impacts that are a potential result of the total developments in an area such as multiple coal mines in a coal basin, together with the associated infrastructure.

When considering cumulative impacts, attention should be given to:

- The relationship of the proposed mining operations and the likely effect of that activity on other activities in the area;
- Any existing or proposed activities in the area and the likely effect on biodiversity of those proposals in conjunction with the proposed mining activity;
- Any synergistic effects of the individual project impacts when considered in combination; and
- Any known biodiversity stresses in the area and the likely contribution of the proposed mining activity to increasing or decreasing those stresses.

Key

Impact Identification

Conceptual Design

Impacts at Ecosystem Level

An ecosystem or habitat can be impacted if a potential project or activity changes the size, diversity or spatial variation of the ecosystem. In addition, an impact to an ecosystem can occur if its ability to provide long-term function or services is changed.

Impacts at Species Level

In predicting biodiversity impacts, it is also important to assess the impacts at a species level. Potential impacts to species can be assessed according to population numbers and the internal, national or local significance a species may have to stakeholders.

Impacts at Genetic Level

Diversity within an ecosystem is also associated with genetic diversity of populations. Genetic diversity is extremely difficult to measure. For these reasons the assessment of biodiversity is usually carried out at the ecosystem or species level.

Loss of Ecosystem

Mining may require the removal of ecosystems or habitats. This may be a permanent or temporary impact to biodiversity. Permanent habitat loss may occur due to clearing for the mine location, while temporary habitat loss may occur due to clearing for construction equipment.

Key

Impact Assessment

Conceptual Design

Habitat Fragmentation Impacts

The isolation or fragmentation of ecological habitats can have significant impact on the biodiversity of the site. Interruption to the natural linkages between populations of plants and animals can create significant, sometimes irreversible, changes to the dynamics and the genetic integrity of those populations.

Fragmentation also increases the 'edge effects' of the habitats. The separated, smaller areas are less resilient to change. Long convoluted edges provide greater potential for pest plants and animals to occupy the site. The remaining isolated patches may not provide adequate habitat quality or quantity for some species. Fragmentation may disrupt ecological processes critical to the maintenance of biodiversity. Time is also a factor; the longer isolation or fragmentation exists, the greater the impacts may be. This has important implications for rehabilitation and is one of the drivers for rehabilitating areas as soon as possible and also maintaining ecological corridors wherever possible.

Alteration of Ecological Processes

The alteration of ecological processes will impact on the sustainability of the site's biodiversity, e.g.

- The interruption of hydrological regimes may have significant impact on wetland and groundwater systems. Changes to stream and river flows may impact on the biota dependent on such an ecosystem including downstream human communities.
- The removal of a structural layer or zone will decrease the structural diversity of the site potentially causing disruption to predator prey relationships.
- The disruption of soil structure may cause surface crusting and erosion problems.

Pollution Impacts

Pollution can occur to the air, water and soils at or around a mine site, e.g.

- Airborne pollutants such as dust and sulphur dioxide may affect biodiversity directly by suffocation or smothering or via secondary impacts such as soil and water pollution.
- Water pollution from spillages may be toxic.
- Mobile sediments from soil erosion may grossly alter in-stream habitats such as filling deep pools. Suspended colloidal material will create turbid conditions that may adversely affect aquatic vegetation. In aquatic systems, mobile sediments, organic matter and runoff of nutrients may cause localised algal blooms and areas of deoxygenation.

Disturbance Impacts

Key

Impact Assessment

Conceptual Design

Soil disturbance frequently provides a competitive advantage to species of plants and animals adapted to occupying a range of habitat types. Some pest plants and animals thrive in the inherently disturbed environment of mine sites.

Noise, artificial lighting and vibration may also disturb wildlife creating changes to population dynamics.

2.7.2 *Assessment of Impacts*

ESIA should be an iterative process of assessing impacts, redesigning alternatives and comparing predicted impacts to the established baseline. As well as assessing impacts of alternatives, it is most important to assess the impacts of doing nothing as, in some cases, doing nothing may sometimes have even worse impacts than the proposed activity. The main components of this stage of the impact assessment are:

- Refinement of the understanding of the impacts identified in the screening and scoping stages and an assessment of these impacts against any relevant criteria or guidelines for decision making;

- Reviewing and redesigning alternatives, comparing alternatives and developing and considering appropriate impact mitigation measures; and

- Reporting the assessment results in the ESIA statement.

The assessment needs to take into consideration impacts of the proposed project on the established baseline. At a minimum, the following assessments should be made in and around the proposed project area:

- An assessment of the impact level, i.e. ecosystem, species and/or genetic;
- An assessment of the nature of the impact (primary, secondary, long term, short term, cumulative etc.);
- An assessment of whether the impact is positive, negative or has no effect; and
- An assessment of the magnitude of the impact in relation to species/habitat richness, population sizes, habitat sizes, sensitivity of the ecosystem, recurrent natural disturbances etc.

When assessing biodiversity impacts, it should be recognised that the intensity of impacts varies over the life of a project, being typically low at the start, increasing markedly through the construction and operation phase and diminishing as planned closure occurs. *Appendix B* presents a table that summarises a number of potential impacts (after MMSD report).

Additionally, when assessing biodiversity impacts, a clear distinction must be made between those impacts which can be assessed quantitatively, and those for which only a qualitative assessment can be made. Whenever conclusions and recommendations have been made substantially on qualitative assessments, the basis of the judgements should be well defined. A precautionary approach should be adopted in such cases where limited scientific knowledge exists (see Section 1.4.2).

Key

Impact Management

Detail Design

2.8 MITIGATION AND ENHANCEMENT: INTEGRATING BIODIVERSITY AT THE MINE DESIGN STAGE

IMPLEMENTATION GUIDANCE:

- The hierarchy of biodiversity risk management, that is *avoid – reduce – remedy – compensate.*
- Potential impacts on biodiversity significant sites may be avoided by selecting an alternative location for the development and infrastructure.
- Reduce the biodiversity impact of the operation by modifying the project design or layout to reduce the area of influence (footprint).
- Biodiversity impacted areas may be restored by way of replanting using species that are compatible with the local environment.
- Offsets are activities undertaken to compensate the impact of an action where biodiversity impacts are unavoidable (see ICMM, 2005).

2.8.1 Options for Management of Biodiversity Impacts

This section presents an overview of a range of options for the management of biodiversity impacts in mining situations. The aim of impact management options described is to provide a level of ecosystem service that is the same after mining as before mining even if there is an acceptable change in biodiversity.

The hierarchy of biodiversity risk management, that is *avoid – reduce – remedy – compensate*, is typically that adopted in most ESIA planning processes. Management of impacts involves the identification of measures that safeguard the biodiversity impacts that might otherwise occur due to the proposed project. The mitigation measures, identified during ESIA, should be implemented during project commencement by way of a written plan often termed an Environmental Management Plan.

Avoid Impacts

Key

Impact Management

Detail Design

Potential impacts on significant sites may be avoided by selecting an alternative location for the development and infrastructure. For instance, locating processing works within a nil discharge catchment may be acceptable so as to avoid the potential for pollution of streams. Choosing underground extraction in place of open cut to minimise disturbance to above ground vegetation and habitats may also be possible.

Alternative treatment or processing routes such as cyanide recovery or destruction technologies may be used to avoid the potential for cyanide concentrations in dams exceeding the acute toxicity thresholds. An example of avoiding impacts is shown in the Huntly Mine case study below:

Case Study: Preventing contamination from mining equipment. Huntly Mine, Alcoa World. Alumina Australia.

Alcoa's Huntly Mine near Perth, Australia, is located inside a State Forest area and uses heavy machinery for land clearing and bauxite mining. A major environmental concern for the operation is the potential spillage of fuel and oils from the machinery. At the beginning of operations, the company focused its efforts on wastewater technology, aiming to clean water sufficiently to comply with strict water quality discharge standards in the area. However, because of the high costs of this strategy, the company has shifted its focus to controlling water pollution as close to the source as possible, thereby reducing the need for expensive treatment systems. Now "clean and dirty" water are separated early in the operation to reduce the quantity of water being treated. To reduce the amount of contaminated water generated during the processing stages, spills are picked up by a suction cleaning machine instead of washed away with water. Parking areas are hard surfaced, and draining from these areas is directed into designated sumps. In case of a spill or leak, the sump collects the extra oils, preventing direct discharge into the environment. With an overall goal for achieving "zero discharge", the company has already benefited economically and has bolstered employee morale with a safer working environment and fewer negative impacts on the environment.

Reduce Impacts

Where the impact of mining operations cannot be avoided, it may be possible to minimise the impact of the operation by modifying project design or layout to reduce the area of influence (footprint). Impact minimisation can also be achieved by adopting high standards of quality control and resource monitoring.

Remedy Impacts

Impacted areas may be restored by way of replanting using species that are compatible with the local environment.

Key

Monitor & Audit

MINE DEVELOPMENT

Compensate Impacts

Offsets are activities undertaken to compensate the impact of an action where impacts are unavoidable (refer ICMM, 2005). Offsets can be used to create habitat for unavoidably impacted areas. Offsets should preferably be established on or near the site where the impact occurs. For instance, offsets could be used to target rehabilitation works in strategic unmined sites such as improving connectivity between isolated patches of vegetation.

The determination of acceptable offsets requires consultation with stakeholders. The offsets will of necessity be site and project specific.

2.9 MONITORING, EMP AND AUDITING: INTEGRATING BIODIVERSITY INTO THE MINE DEVELOPMENT STAGE

IMPLEMENTATION GUIDANCE:

- Monitoring should begin prior to the start of an exploration programme, last throughout the construction and operation of the mine, and continue for years after closure and reclamation.
- Monitoring is important for verifying the predicted effects of an ESIA, and ultimately, should be part of a company's overall environmental management system (see Module 2).
- Auditing should be used to assess, confirm and modify operations to ensure biodiversity conservation occurs throughout the mine lifecycle.

2.9.1 Introduction

Mine development can result in many problems if not well managed from a biodiversity perspective. There is extensive disturbance to the site with clearing for the mine, processing plant and related infrastructure. Increasingly, strict obligations are placed on construction companies to implement their own Environmental Management System (EMS) to deliver to the mine owner's standards, including those for the protection of vegetation (no clearing outside designated areas), the control of pests (no pets, wash down of all vehicles), disruption of wildlife (e.g. no hunting allowed), and waste management. See Module 2 for more information on EMS.

Mining companies should only let construction contracts on the basis of the contractor's past performance and audits of the contractor's environmental management programmes, systems and performance.

2.9.2 *Monitoring, Evaluation and Auditing of Mitigation Measures*

Key

Monitor & Audit

MINE DEVELOPMENT

As discussed in Section 2.6.4, monitoring should begin prior to the start of an exploration programme, last throughout the construction and operation of the mine, and continue for years after closure and rehabilitation. Monitoring is essential to understanding the effects of a proposed project on biodiversity. Monitoring is also important for verifying the predicted effects of an ESIA, and ultimately, should be part of a company's overall environmental management system (see Module 2). Monitoring evaluates the degree of implementation of mitigation measures and assesses the degree of success obtained in managing biodiversity.

By systematically comparing changes against the baseline data, mining companies can not only evaluate the effectiveness of the mitigation that has been implemented but also identify unforeseen negative effects and adjust their operations to further mitigate these effects.

As monitoring should be used to assess, confirm and modify operations, it is important to use accepted, statistically sound techniques and methods for monitoring which ensure reproducibility and quality control is maintained through the process.

An agreed process for conducting an environmental audit should be established. This can be undertaken as an independent examination and assessment of a company's or project's performance. The audit will assess the project's performance in relation to management measures outlined in the environmental or biodiversity management plan and ensure the conditions for project approval are being met. A major problem with assessing performance is credibility. A third party auditor should be used under such circumstances.

Some case studies showing implementation of various monitoring programmes follow.

Case Study: Verifying the efficiency of monitoring programmes. Rio Tinto, Madagascar.

QIT Madagascar Minerals is planning to mine titanium-rich sands in the coastal plains of south-eastern Madagascar. Based on clearly defined and agreed upon objectives, conservation programs have been put in place and monitoring programs have been established to verify the efficiency of the conservation measures on the genetic, population, ecosystem and socio-economic levels. The human population is included at all levels and at all stages of the project, ranging from the villages affected by the pending mining operation to the company's participation in the regional development plan and in fund raising for socio-economic development outside and beyond the actual mining operation.

Case Study: How local monitoring can help develop regional knowledge. Freeport McMoRan/Royal Botanic Gardens, Kew. Indonesia.

New Guinea is botanically the most diverse region in the Asian tropics. Of particular significance are the high levels of endemism on the island – the occurrence of species found nowhere else. Studies of the wealth of biodiversity in the Lorentz World Heritage Area (the largest reserve in South – east Asia) have been constrained by its remote location and difficult logistics within the park. But botanical surveys of nearby areas within the PT Freeport Indonesia project area are supplying valuable information concerning the diversity within the Lorentz. These studies also provide information that Freeport uses during reclamation of overburden and tailings areas.

Case Study: Biodiversity data generation and sharing adds to credibility and transparency of operations . BHP Billiton, Chile.

In 1990, Minera Escondida Ltda. began operations in Chile at the world's largest copper mine. Parts of the company's industrial installations are located next to the sea, so a program to monitor the marine ecosystems was established when the facility was opened. Fourteen years of monitoring of a key abundant species, the ascidian *Pyura praeputialis*, that is unique to the Bay of Antofagasta indicated that species diversity is higher inside the rocky shore of the bay than outside it. The ascidian harbours 116 species of macro-invertebrates and algae. In contrast, in sites outside the Bay at the same tidal level, the number of macroinvertebrates and algae reaches only 66 species. Thus the monitoring programme led researchers to conclude the matrices of this ascidian increased species richness at intertidal local and seascape scales by providing novel habitats that are used by mobile macro invertebrates. A key aspect of the company's approach to its research on marine coastal systems in Chile has been publication of the results the company has obtained, which adds credibility and transparency to industrial operations.

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Appendix A

Key Source of Information on Biodiversity

Table A.1 Key Sources of Information on Biodiversity, (From Rio Tinto, 2004)

Designation	Conventions / Programme / Organisation	Information Sources	Implications for Development
		Globally Protected Areas	
General	United Nations Environment Programme – World Conservation Monitoring Centre	Website is key source. Includes world database on protected areas, which includes internationally, nationally and sometimes regionally protected sites. http://www.unep-wcmc.org	
World Heritage Sites	The World Heritage convention (1972)	These sites are considered to be of outstanding global value, and are usually protected under national legislation http://whc.unesco.org/heritage.htm	Although legislation or rules governing development in or around World Heritage sites differs, most Industrial activities are incompatible with this status. Such sites are considered as of outstanding global value and any impact presents a very high risk. ICMM has recently agreed to treat such sites as 'no-go' areas for exploration or mining.

Designation	Conventions / Programme / Organisation	Information Sources	Implications for Development
Ramsar Sites	Convention on Wetlands of International Importance for Wildfowl (Ramsar, Iran, 1971)	The Ramsar List of Wetlands of International Importance. http://www.ramsar.org	These sites are of international importance and many are protected under National legislation. The Ramsar Convention (Article 3.1) does allow for "the wise use" of wetlands, however development should not affect the site's ability to maintain its ecological character. Detailed assessment would be needed here. Adopt precautionary approach as adverse effects on the site pose a high reputational risk.
Biosphere Reserves	UNESCO Man and Biosphere Programme (Biosphere)	These reserves promote the conservation of biodiversity as well as fostering economic and human development that is socio-culturally and ecologically sustainable. http://www.unesco.org/mab	By definition, MAB reserves look to reconcile conservation with development, with the caveat that the development is socio-culturally and ecologically sustainable. So for mining to proceed in or adjacent to MAB reserves, these broad acceptability criteria need to be satisfied.
		Regionally Protected Areas	
Natura 2000 **Special Protection Areas (SPA) and Special Areas of Conservation (SAC)**	EC habitats Directive (92/43/EEC) EC Wild Birds Directive (79/409/EEC)	European Union wide network of nature conservation sites containing habitats or species that are endangered within Europe. Sites established under the Habitats Directive are known as Special Areas of Conservation. Sites established under the Wild Birds Directive are known as Special Protection Areas.	**Article 6(3)** Member states must review any plans or projects that may affect the conservation status of these sites and to permit them to proceed only if they are not likely to damage site integrity. **Article 6(4)** requires that where, 'for imperative reasons of overriding public interest including those of a social or economic nature' plans or projects that

Designation	Conventions / Programme / Organisation	Information Sources	Implications for Development
			damage the integrity of the sites are implemented, member states must take compensatory measures such as designating additional areas.
	Nationally Protected Areas		
IUCN Protected Areas I-IV	The IUCN Programme on Protected Areas (PPA) is the focal point within the IUCN Secretariat for Protected Areas and serves as the Secretariat for World Commission on Protected Areas.	IUCN categorises protected areas by management objective and has identified six distinct categories of protected areas, I-VI. http://sea.unep-wcmc.org/wdbpa/	.Rio Tinto's current policy is that operations should look at each case on an individual basis, as sites may have been degraded and mining revenues could positively contribute to conservation in the region. Approach with caution-high reputation risk despite quality of reserve. IUCN's view (Amman 2000 Recommendation 2.82) is that companies should refrain from developing in sites classified I-IV. ICMM has committed to work with IUCN to reform the system to provide greater clarity on 'no-go' and mixed use areas..
Other Nationally Protected Sites	Convention on Biological Diversity (CBD) Clearing House Mechanism	Countries have set up a wide array of protected areas (not just those that correspond to IUCN list both publically and privately owned. In addition to the information sources identified above 61 countries have set up Biodiversity Clearing House Mechanism websites some of which contain a lot of relevant information on biodiversity pertinent to that country http://www.biodiv.org/chm/stats.asp However, the CBD does not designate any new sites as proteced areas.	

Designation	Conventions / Programme / Organisation	Information Sources	Implications for Development
		Priority Areas for Conservation	
Important Bird Areas (IBA)	Birdlife International	Important Bird Areas are key sites for conservation.They either have: significant numbers of one or more globally threatened species or; are one of a set of sites that together hold a suite of restricted-range species or biome-restricted species or: very large numbers of migratory or congregatory species. http://www.birdlife.org/action/science/sites/index.html	IBA does not afford legal protection for a site, but BirdLife International aims to get all IBAs protected under national and/or international law. The current level of protection is higher in some countries than in others. IBAs are selected on the basis of internationally agreed standard criteria. In Europe, the criteria takes into account the requirements of regional conservation treaties such as the Emerald Network under the Bern Convention, the Helsinki Convention, the Barcelona Convention, as well as, the Wild Birds Directive of the European Union. Hence, these sites may be protected by other conservation instruments.
Critical Natural Habitats	World Bank/IFC/MIGA Natural Habitats Policy OP4.04	Critical natural habitats are: (i) protected areas and areas officially proposed by governments as protected areas, areas initially recognized as protected by traditional local communities (e.g., sacred groves), and sites that maintain conditions vital for the viability of these protected areas (as determined by EA); or (ii) sites identified on supplementary lists prepared by the World Bank or an authoritative source. http://www.ifc.org/enviro/EnvSoc/Safeguard/Habitats/habitats.htm	If financing or a political risk guarantee is being provided by the World Bank/IFC or MIGA, or any commercial Bank listed on the Equator Principles list, the Natural Habitats policy will apply. The Bank does not support projects involving the significant conversion of natural habitats unless there are no feasible alternatives for the project and its siting, and comprehensive analysis demonstrates that overall benefits

Designation	Conventions / Programme / Organisation	Information Sources	Implications for Development
			substantially outweighs the environmental costs. Listings are based on systematic evaluations of factors such as species richness; degree of endemism, rarity, and vulnerability of component species; representativeness; and integrity of ecosystem.
Global 200 Ecoregions	WWF	The Global 200 ecoregions were chosen from outstanding examples of each terrestrial, freshwater, and marine major habitat type. http://www.panda.org/about_wwf/where_we_work/ecoregions/global200/pages/home.htm	The Global 200 ecoregions cover large areas, some of which may be partially protected, but which are in any case of outstanding value for biodiversity. Irrespective of the protective status of such areas, developing a mining operation is likely to be controversial and has the potential to attract significant criticism from the conservation community.
Conservation International Hotspots	Conservation International	Hotspots are 25 areas that harbour a great diversity of endemic species (and 60 percent of all known species), yet are under significant threat of destruction. http://www.biodiversityhotspots.org/xp/Hotspots	The hotspots cover large areas, some of which may be partially protected, but which are in any case of outstanding value for biodiversity. Irrespective of the protective status of such areas, developing a mining operation is likely to be controversial and has the potential to attract significant criticism from the conservation community.

Designation	Conventions / Programme / Organisation	Information Sources	Implications for Development
		Protected Species or Species Under Threat	
IUCN Red List of Threatened Species	IUCN	IUCN Red list website. http://www.redlist.org/ contains a list of all threatened species	Depending on the categories of threat pertaining to species present in or around an existing or proposed mine site, this may have implications for how mining is undertaken or whether it can proceed.
Protected Species Databases	WCMC	Includes a Species database where one can search by species or by country. The data base also includes other interesting lists such as CITES–listed species and EU Wildlife Trade Regulation listed species. http://www.wcmc.org.uk/	As above for IUCN Red List.

Appendix B

Table of Potential Biodiversity Impacts

Table B.1 ***Overview of the potential environmental impacts associated with different phases of mining activities. [Information adapted from Environment Canada (1969) and Australian Environmental Protection Agency (1995-1996)]. From MMSD Southern Africa Research Topic 4***

Mining Phase	Activities	Potential Environmental Impacts
Exploration and surveying	• Geochemical, geophysical and airborne surveys • Drilling and trenching • Blasting of exploration adits • Exploration camp housing • Vehicle and machinery parks, fuel points and service bays • Access road construction • Waste disposal (garbage) • Camp sanitation systems	• Vegetation removal, damage and destruction • Habitat disturbance due to noise / vibration • Disturbance to wildlife and local residents • Soil erosion along trenches and transects • Demand on local water resources • Discharge or spillage of contaminants • Contamination of local ground waters by drilling muds and exposed ores
Mine development start-up; sourcing and stockpiling of raw materials	Mine construction Stripping / storing of soil "overburden" Installation of power lines Surveying and levelling of sites for buildings and plant Installation of mine and surface water treatment plants Construction of mine facilities, offices and roads Construction of processing plant, smelter and refinery Construction of storage facilities Landscaping of site Construction of staff housing, infrastructure and recreational facilities Construction of railway lines and sidings	• Fauna and flora habitat loss and disturbance • Reduction in biodiversity on site • Potential loss of heritage sites • Decreased aesthetic appeal of site • Altered landforms due to construction • Altered drainage patterns and runoff flows • Increased erosion of site area • Increased siltation of surface waters • Contamination of surface and ground waters by seepage and effluent discharges • Discharge of contaminants via mine de-watering activities • Increased demand on local water resources • Seepage / discharge of acid rock drainage • Ground and surface water contamination from seepage and radionuclides • Contamination from fuel spills and leakages
Removal and storage of ores and waste materials	• Stripping / storing of soil "overburden" • Waste rock stockpiles • Low grade ore stockpiles • High grade ore stockpiles	• Land alienation from waste rock stockpiles and disposal areas • Disturbance from vehicle and machinery noise and site illumination disrupting migration, nesting etc • Increased erosion and siltation of nearby surface waterbodies (rivers and lakes) • Contamination of local ground

Mining Phase	Activities	Potential Environmental Impacts
		waters
Blasting, milling and grinding	• Blasting of rock to release ores • Transport of ore to crusher • Extraction and preliminary crushing of ore • Milling and grinding of ore • Flotation and chemical concentration / leaching of ore and final product • Transport of ores to smelter	• Disturbance due to noise and vibrations • Contamination from explosive residues • Discharge of contaminated water • Windborne dust and radionuclides • Sulphur dioxide emissions from roasters and acid plants • Metal vapour emissions from smelters
Smelting, refining and beneficiation	• Mineral processing through smelting, roasting and other methods for refining ore • Replenishment of refinery plant processes /solutions • Stockpiling of final product	• Discharge of contaminants to air, including heavy metals, organics and SO_2 • Leakages from electrolytic plant leading to site contamination • Spillage of corrosive liquids
Transport of final product to markets	• Packaging / loading of final product into transportation • Transport of final product via rail link	• Disturbance due to noise, vibration and site illumination • Dust and fumes from exposed product stockpiles
Mine closure and post-operational waste management	• Decommissioning of roads • Dismantling buildings • Reseeding/planting of disturbed areas • Re-contouring pit walls/waste dumps • Water quality treatment • Fencing dangerous areas • Monitoring of seepage	• Subsidence, slumping and flooding of previously mined areas • Underground fires in abandoned coal mines • Acid rock drainage from exposed ores • Continuing discharge of contaminants to ground and surface water via seepage • Fauna and flora habitat loss and disturbance • Windborne dust, including radionuclides • Dangerous areas that pose health risks and possible loss of life (e.g. shafts, pits, etc.)

Appendix C

Examples of Biodiversity Indicators

Table C.1 Example Suite of Biodiversity Indicators and Potential Measures

Biodiversity Indicator Examples	Potential Measure	Comments
Native vegetation clearance		
	• Rate of vegetation clearance (e.g. hectares per annum; percentage of total vegetation community type cleared)	• Direct indicator of pressure.
Aquatic habitat destruction		
	• Area (ha) cleared for operations	• Indirect indicator of pressure
Introduced species		
	• Species richness	• Species-based indirect indicator of pressure
	• Species composition	• Species-based indirect indicator of pressure
	• Cover abundance	• Species-based indirect indicator of pressure
	• Distribution	• Species-based indirect indicator of pressure
Human inhabitancy		
	• Number of employees occupying site	• Indirect indicator of pressure
	• Area occupied by infrastructure	• Indirect indicator of pressure
Fragmentation		
	• Vegetation patch size	• Structure-based indirect indicator of pressure
	• Vegetation spatial pattern	• Structure-based indirect indicator of pressure
	• Distance to 'core' area	• Structure-based indirect indicator of pressure
	• Total area occupied by roads and tracks	• Structure-based indirect indicator of pressure
Extent and condition of native vegetation		
	• Species richness	• Easily measurable • Species-based indicator of condition
	• Species composition	• Easily measurable • Species-based indicator of condition
	• Cover abundance	• Easily measurable • Structure / species-based indicator of condition
	• Distribution of species	• Species-based indicator of condition
	• Distribution of vegetation types	• Species-based indicator of condition
	• Number of vegetation types	• Species-based indicator of condition
	• Stand-age distribution	• Structure-based indicator of condition

Biodiversity Indicator Examples	Potential Measure	Comments
	• Depth of litter layer	• Structure-based indicator of condition
Extent and condition of terrestrial fauna habitat		
	• Density of logs (e.g. meters per $10m^2$)	• Structure-based indicator of condition
	• Tree size (DBH) and density	• Easily measurable • Structure-based measure of condition
	• Vegetation height structure	• Easily measurable • Indirect structure-based measure of ecosystem condition
	• Number of tree hollows	• Structure-based indicator of condition
	• Plant species diversity	• Several scientific methods available for analysis • Species-based indicator of condition
Extent and condition of aquatic habitats		
	• Water depth	• Indirect measure of zonation i.e. different species have different tolerances to water depth. Structure-based indicator of condition.
	• Vegetation cover abundance	• Several scientifically accepted measures available. • Structure / Species-based indicator of condition
	• Plant species composition	• Easy to record. Several scientific methods available for analysis • Species-based indicator of condition
	• Turbidity	• Easy to measure • Structure-based indicator of condition
	• Dissolved oxygen	• Easy to measure • Structure-based indicator of condition
	• Water temperature	• Easy to measure • Structure-based indicator of condition
	• Electrical conductivity	• Easy to measure • Structure-based indicator of condition
	• pH and alkalinity	• Easy to measure • Structure-based indicator of condition
	• Invertebrate taxa composition	• Indirect species-based indicator of condition
	• Invertebrate taxa abundance	• Indirect species-based indicator of condition

Biodiversity Indicator Examples	Potential Measure	Comments
Soil condition and nutrient cycling		
	• Nutrient analysis – e.g. total nitrogen, ammonium, nitrates available phosphorus, organic matters	• Indirect structure / function-based indicator of condition
	• Soil infiltration rate	• Easily measurable • Indirect structure / function-based indicator of condition
	• Soil penetration resistance	• Easily measurable • Indirect structure / function-based indicator of condition
	• Soil texture	• Easily measurable • Indirect structure / function-based indicator of condition
	• Ecosystem Function Analysis	• Easily measured • Indirect function-based indicator of condition
	• Depth of litter layer	• Easily measured • Indirect function-based indicator of condition
Nutrient condition of aquatic habitats		
	• Total nitrogen	• Easily measurable • Indirect structure / function-based indicator of condition
	• Oxidised nitrogen	• Easily measurable • Indirect structure / function-based indicator of condition
	• Total phosphorus	• Easily measurable • Indirect structure / function-based indicator of condition
Significant (extinct, endangered, vulnerable or otherwise threatened) species and communities (flora and fauna)		
	• Number of significant species present	• Species-based indicator of condition
	• Area of significant communities	• Species-based indicator of condition
Microclimate		
	• Temperature (air, soil, water)	• Indirect structure / function based indicator of condition
	• Wind speed	• Indirect structure / function based indicator of condition
	• Humidity	• Indirect structure / function based indicator of condition
	• Light	• Indirect structure / function based indicator of condition
Terrestrial, marine, estuarine and wetland protected areas		
	• Number of hectares formally protected on the site.	• Indicator of response

Biodiversity Indicator Examples	Potential Measure	Comments
	• Dollars committed to managing protected areas	• Indicator of the effort being made to conserve and enhance protected areas on the site (response_
Recovery plans		
	• Ratio of number of recovery plans for significant species written to number of significant species occupying the site	• Indicator of response
	• Ratio of number of recovery plans for significant species implemented to number of significant species occupying site	• Indicator of response
	• Fecundity	• Indirect measure of breeding success
	• Ratio of females to males present	• Indirect measure of breeding success
Pest plant and animal plans		
	• Successful completion of contracts to implement pest plant and animal management plans	• Indicator of response
	• Area of weeds controlled	• Indicator of response
	• Species successfully controlled	• Indicator of response
Rehabilitation plans		
	• Area revegetated	• Indicator of response
	• Number of new species recorded since implementation of plan	• Indicator of response

Key

Policy

Operation

3 MODULE 2: INTEGRATING BIODIVERSITY INTO OPERATIONS THROUGH ENVIRONMENTAL MANAGEMENT SYSTEMS AND COMMUNITY DEVELOPMENT PROGRAMMES

3.1 INTRODUCTION

Two key tools used by mining companies to improve their environmental and social performance are Environmental Management Systems (EMS) and Community Development Programmes (CDP). Environmental Management Systems (EMS) provide a suitable tool to ensure biodiversity management measures are developed, integrated and monitored into a company's work practices. Furthermore, given the interactions between mining operations and local communities, development of Community Development Programmes (CDP) can provide a process by which companies can work in partnership with government, communities and other stakeholders to ensure biodiversity risks are understood, evaluated and communicated throughout the life cycle of a mine.

This Module builds on the identification of biodiversity elements in consultation with local and indigenous communities, and the potential impacts of mining outlined in Module 1. It provides for the integration of biodiversity management into the mining operation through EMS and CDP with the objective of 'operationalising' biodiversity management principles at the site level and making biodiversity management part of day-to-day operations(refer Figure 2.1).

In the operational phase, the key objectives are to:

1. *Minimise all mining-related disturbance to the greatest extent possible so that the existing ecological process can be protected to prevent damage beyond that which is absolutely necessary for construction and operation. In so doing, the potential to integrate rehabilitation or revegetation activities with existing ecosystems is greatly enhanced. As a minimum this reduces the long-term rehabilitation costs.*

Key

Policy

Operation

2. *Monitor and evaluate the success of implementing the plans developed during the ESIA and design/construct phases. (Monitoring is discussed in detail in Module 1, section 2.6).*

3. *Modify the management process to achieve improved outcomes that reduce impacts on biodiversity values and promote the re-establishment of biodiversity following disturbance in specific areas of the mine.*

4. *Set up the processes and activities essential for successful long-term rehabilitation and mine closure, as described in Module 3. From a biodiversity viewpoint, these key processes will include selective materials handling, implementation of topsoil management plans, identification of plant propagation sources, and the establishment of landforms suitable for rehabilitation that will prevent long-term off-site impacts, such as pollution of water bodies.*

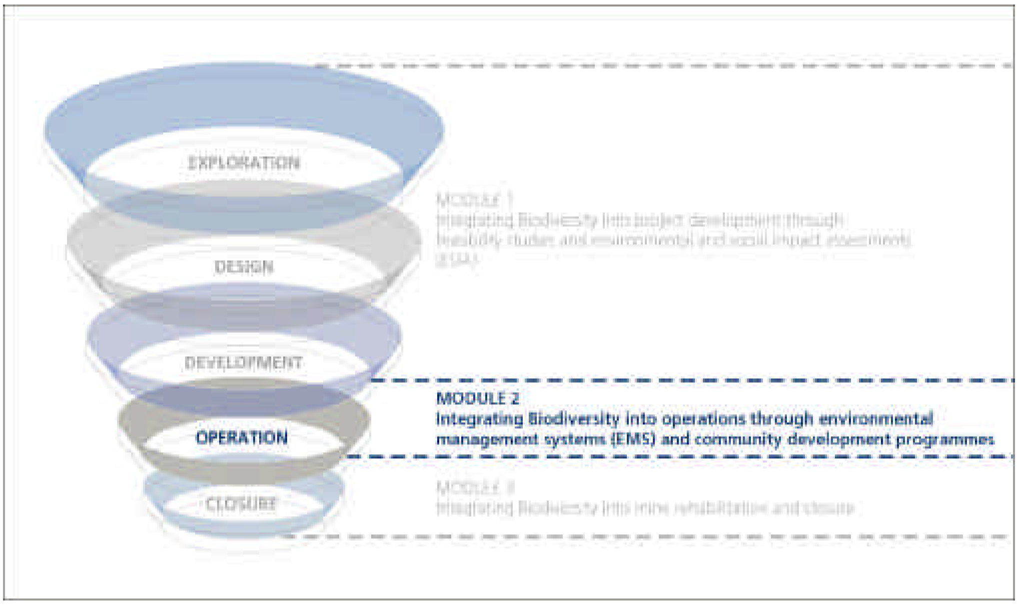

Figure 3.1 Integrating Biodiversity into the Mine Cycle using EMS and Community Development Programmes

3.2 BACKGROUND

IMPLEMENTATION GUIDANCE:

A biodiversity integrated EMS will achieve a number of objectives including:

- Assistance with compliance with regulatory requirements;
- Assisting the company to meet its biodiversity targets;
- Improve the company's stakeholder image;

Key

Policy

Operation

- Make licences and permits easier to obtain;
- Better understanding of the biodiversity of the area through accumulation of biodiversity data from monitoring;
- Comprehensive identification of impacts allowing for better control of actual or potential biodiversity impacts;
- Better preventative management techniques of biodiversity impacts demonstrating due diligence;
- Improve access to capital; and
- Allow greater control of operations and costs through reporting, reviewing and continually improving biodiversity management measures.

The operational stage of a mine is central to the long-term success of managing impacts to biodiversity. It is the stage of a mine lifecycle where the greatest impacts occur. For larger mines, this stage can last for many decades, and even smaller operations are likely to operate for five to ten years. The construction of infrastructure such as ports, railways, towns and the associated increases in population can substantially increase the area and severity of impacts.

Typically, large, long-life, mines undergo many expansions in area and capacity, generating a sequence of events that can be the equivalent of new mines being started, so there may also be a requirement to conduct new Environmental and Social Impact Assessment (ESIA) or update the initial ESIA.

Impacts on biodiversity through this stage can be obvious and dramatic, such as clearing overburden for new pits, but are often subtle and overlooked until too late to remedy. Gradual clearing of vegetation to make way for mine facilities and access roads is an example where many small impacts can eventually leave areas isolated and subcritical in size. Introduction of weeds and feral fauna can result in secondary impacts that extend well beyond the mine. Biodiversity action plans need to take account of both scales of impact.

This module is built around the ISO14001 model, as many sites have implemented this or are very familiar with it. If well implemented, the ISO14001 approach provides an excellent framework to integrate biodiversity management into the day-to-day processes of a site giving the best chance to ensure that all personnel are aware of, and contribute to, biodiversity management and protection. This Module provides guidance for each of the operating principles developed by the IUCN/ICMM July 2003 workshop in aiming to integrate operational biodiversity principles into an Environmental Management Systems/Community Development Programmes (EMS/CDP).

The objective of this module is to provide guidance such that mining operators and companies can effectively manage biodiversity to achieve the objectives established during the ESIA In aiming to integrate biodiversity considerations into an EMS/CDP, a mining company should:

Key

Policy

Operation

- **Continue to document and assess local biodiversity in consultation with appropriate partners, including local, indigenous and traditional communities;**

  A detailed reassessment of the biodiversity attributes that builds on the ESIA baseline studies is required. This provides the additional detail against which impacts can be assessed, and the effectiveness of subsequent management plans and actions evaluated. The assessment should be conducted in consultation with local, indigenous and traditional stakeholders. This process provides the basis for continuous improvement, or adaptive management.

- **Undertake comprehensive identification of actual and potential biodiversity impacts;**

  Moving from design and construction to operation introduces new activities and modifies many others such that detailed revision of potential and actual impacts is required. As operations progress, modifications to processes are common in response to changing ore characteristics, new technologies or experience in operating the plant and equipment. For each change, the potential biodiversity impacts need to be evaluated.

- **Plan, design and implement preventative and mitigative responses to identified biodiversity impacts, including secondary and cumulative impacts;**

  Clear, unambiguous plans are required if biodiversity impacts are to be managed. Companies should assign accountability to senior managers such that biodiversity goals are considered in parallel with production goals. Integration of site-specific plans with local and regional plans can increase the likelihood of mitigating cumulative impacts and those that flow from the infrastructure development and population increases.

- **Monitor, measure and report performance on biodiversity management; and**

  Comprehensive monitoring of impacts, mitigation measures and revegetation efforts is a fundamental requirement. Monitoring needs to reflect the intensity and duration of events, and also be designed to take into account the characteristics of local ecosystems in terms of their structure, composition, successional processes and natural perturbations (e.g. fire). Critical review of the monitoring by external agencies or stakeholders should be conducted to provide independent comment and advice. Public reporting, including in peer reviewed publications is an important aspect of communicating progress.

- **Implement and support initiatives that promote and enhance biodiversity conservation objectives.**

  Whilst the mine will have site, or process, specific issues that need to be addressed through targeted initiatives, it is also common that many initiatives, such as increasing awareness of the value of biodiversity or researching pest species management will be of regional interest. Supporting these broad based initiatives can increase the effectiveness of the biodiversity management initiatives of all parties.

Key

Policy

Operation

3.3 INTEGRATING BIODIVERSITY INTO THE EMS FRAMEWORK

IMPLEMENTATION GUIDANCE:

To integrate biodiversity into EMS, a mining company should:

- Integrate biodiversity into the environmental policy;
- Document and assess local biodiversity in consultation with appropriate stakeholders;
- Undertake identification and assessment of biodiversity aspects/risks;
- Plan and develop preventative and mitigative measures for identified biodiversity aspects;
- Implement preventative and mitigative responses to identified biodiversity aspects;
- Monitor, measure and report performance on biodiversity management;
- Manage review of procedures and outcomes; and
- Adopt a continuous improvement approach.

3.3.1 *EMS – What is it?*

EMSs have been defined as:

'That part of the overall management system which includes organisational structure, planning, activities, responsibilities, practice, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy' (International Organisation of Standards, 14001:2004)

Key

Policy

Operation

The concept of a formal EMS has been adopted across much of the mining industry with the ISO14001 series the dominant model in use. Developed by the International Organisation for Standards (ISO), ISO14001 specifies the requirements for an EMS. Many companies require that their operations are either certified to ISO14001 or maintain systems that are compliant with ISO14001. This guidance utilises the framework of ISO14001 to describe steps and actions that should be undertaken to integrate biodiversity into the EMS.

There is a wealth of information on ISO14001 systems, implementation, outcomes, the pitfalls and successes. When well structured, developed and implemented, an EMS has the potential to lock the environmental objectives of a company into the day-to-day management and operation of a mine. An EMS is generally most effective when there are clear objectives established and a rigorous 'Aspects and Impacts Register' has been developed. However, as mentioned earlier, biodiversity has often been an implicit component of 'environment' that is addressed through the management system. The paper by Gardner and Mitchell (2004), *Integrating Biodiversity into Environmental Management Systems and Community Development Programmes*, provides a useful summary of the issues, and should be taken into account. Specifically identifying and managing biodiversity in the EMS has the potential to assist the mining company to provide a positive contribution to the environment and to provide greater opportunities to address impacts on biodiversity.

The framework of an EMS with respect to biodiversity integration requires that a mining company:

- Integrate biodiversity into the environmental policy;
- Document and assess local biodiversity in consultation with appropriate stakeholders;
- Undertake identification and assessment of biodiversity aspects/risks;
- Plan and develop preventative and mitigative measures for identified biodiversity aspects;
- Implement preventative and mitigative responses to identified biodiversity aspects;
- Monitor, measure and report performance on biodiversity management;
- Manage review of procedures and outcomes; and
- Adopt a continuous improvement approach.

Requirements for addressing biodiversity in each of these stages are described below.

Key

Policy

Operation

3.3.2 *Integrate Biodiversity into the Environmental Policy*

A strong component of the ISO approach to management of environment, quality or other fields is that there must be strong support from senior management and that it should start with a statement of corporate policy. Reference should also be made to the company's biodiversity strategy. The importance of biodiversity management to the industry now means that there should be a higher focus and explicit commitment to this topic. However, care should be taken to ensure that the overall policy is clear, concise and transparent, and not too specifically focussed on detail that belongs in the biodiversity strategy.

The recent survey of 20 major extractive industry companies undertaken by ISIS Assessment Management (2004) identified only 7 with published policies or position statements on biodiversity. All 20 had environment policies. An example of a biodiversity policy is in the following box.

> Comment: This policy signals a strong corporate commitment to biodiversity goals and provides a clear direction for activity by Rio Tinto operations.
>
> *Rio Tinto recognises the importance of the conservation and responsible management of biological diversity as a business and societal issue. We aim to have a net positive impact on biodiversity.*
>
> *We are committed to the integration of biodiversity conservation considerations into environmental and social decision making in the search for sustainable development outcomes. We recognise that this may mean we do not proceed in some cases.*
>
> *We want to be biodiversity leaders within the mining industry, for the competitive advantage and reputation benefit this provides. Our performance on biodiversity management issues will create benefits for our business. We are committed to:*
>
> - *The prevention, minimisation and mitigation of biodiversity risks throughout the business cycle;*
> - *Responsible stewardship of the land we manage;*
> - *The identification and pursuit of biodiversity conservation opportunities; and*
> - *The involvement of communities and other constituencies in our management of biodiversity issues.*

At a corporate level, biodiversity policy statements can play a key part of a company overall corporate social responsibility strategy. However, given the site-specific nature of biological diversity, a biodiversity policy statement may also be developed for individual project sites.

Such a policy would be specific to the biodiversity issues of the site. Statements may include discussion around management of all impacts including secondary impacts, management of site specific threatened ecological species or comminutes and compliance to the objectives outlined in the project ESIA.

Key

Policy

Operation

Some examples of how biodiversity can be addressed in policy statements include:

- Maintaining natural ecosystems and managing protected areas;
- To form partnerships with indigenous people, respect their values and develop management solutions for potential impacts to a collaborative fashion;
- Limit discharges to ecosystems below the critical level;
- Raise employee awareness to make a positive contribution to the environment;
- Conserve biodiversity by not destroying habitat;
- Comply with applicable legislation and regulation;
- Comply with the precautionary principle;
- Enhance wildlife corridors and habitats;
- Protect archaeological sites;
- Consult with relevant conservation organisations;
- Conduct biodiversity assessment in environmental assessments;
- Focus attention on internationally recognised 'hot-spots';
- Understand and manage direct and indirect impacts to biodiversity;
- Make a positive contribution to biodiversity research and development; and
- Restore used areas when activity is completed.

Key

Stakeholder Consultation

Operation

3.3.3 *Document and Assess Local Biodiversity in Consultation with Appropriate Stakeholders*

Sound management requires a very thorough knowledge of the biodiversity attributes of the site. Whilst the original ESIA and subsequent studies during design and construction will have focussed on core areas, in the operational stage, a detailed understanding of all attributes (both on site, in adjacent areas and some more remote locations) is required. This is to allow the management plans to be refined and specifically targeted to management of operational impacts. Gaps in knowledge will also be identified at this time, and research projects can be initiated.

The use of GIS tools is strongly recommended for larger sites to enable assessment of impacts on biodiversity values by providing a readily updated plan of the operations, overlain with areas managed for biodiversity objectives. GIS provides the capability to integrate all relevant information into site maps so that all geologists, mining engineers and others know exactly where 'hands-off' areas are located, as well as zones that require specific management, through to those that can be disturbed.

Consultation with stakeholders early in the process, including with local, indigenous and traditional communities, can provide valuable knowledge on biodiversity. If the exploration phases and subsequent ESIA were conducted rigorously, as described in Module 1, then much of this will have been done. However, it is important to update the information on a regular basis to reflect increased knowledge, time-based events that may not have been identified, or changes in species present that may have occurred through changed land management practices, species recovery programmes, or alterations to the areas impacted as a result of extended exploration work. For example, exclusion of grazing animals from the immediate exploration area is common practice for safety reasons, and as part of Green Offset strategies, the removal of grazing pressure may allow some plant species to be identified that were previously unseen or previously unrecorded fauna species to recolonise.

The rigour with which this and associated monitoring activities are conducted is central to developing the ongoing relationships with the local community and other stakeholders and, ultimately, the credibility of the 'baseline' information.

Key

Aspects and Risks

Operation

3.3.4 *Undertake Identification of Activities and Assessment of Biodiversity Aspects and Impacts*

Aspects and Impacts

A first step in developing an ISO compliant EMS is to identify the mining activities which have the potential to lead to aspects and impacts of the business or operation that can have significant potential or actual impacts on the biodiversity. This then drives the setting of objectives for the business/operation that are relevant to the specific operation. Much of this information should be available through the ESIA process (see Module 1).

Once the mining activities have been identified, a risk assessment should be undertaken to identify the aspects and biodiversity impacts which may occur from the identified mining activity.

The output of the risk assessment should be ranked using the risk assessment calculation adapted from the AS/NZ Standard 4360: 1999 as shown below. The output of this task will inform the priorities and focus objectives for the EMS.

LIKELIHOOD	**CONSEQUENCES**				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	**H**	**H**	**E**	**E**	**E**
Likely	**M**	**H**	**H**	**E**	**E**
Moderate	**L**	**M**	**H**	**E**	**E**
Unlikely	**L**	**L**	**M**	**H**	**E**
Rare	**L**	**L**	**M**	**H**	**H**
L=low, M=medium, H=high, E=extreme					

Regular reassessment and review of potential biodiversity aspects and impacts including primary, secondary and cumulative impacts should be undertaken throughout the mine cycle to ensure continued improvement. The following table gives examples of some broad mining activities that can occur through operation and the associated aspects and biodiversity impacts that need to be considered:

Table 3.1 Examples of mining activities, aspects and biodiversity impacts

Mining Activity	Examples of Aspects	Examples of Biodiversity Impact
Extraction	clearing	Loss of habitat, introduction of plant disease, siltation of watercourses
Blasting	dust, noise, vibration	Smothering stomata
Digging and Hauling	dust, noise, vibration, water pollution	Disruption to water courses, impacts on aquatic ecosystems due to changes in hydrology and water quality.
Waste Dumping	clearing, water and soil pollution	Loss of habitat, soil and water contamination, sedimentation, acid mine drainage.
Processing/ Chemical use	toxicity	reproductive impacts
Tailings Management	clearing, water pollution	Loss of habitat, toxicity, sedimentation, water quality and streamflow
Air emissions	air pollution	Loss of habitat
Building workshops and other structures	clearing, soil and water pollution	Loss of habitat, contamination from fuel, waste disposal
Waste disposal	soil and water pollution	Encourages pests, disease transfer, contamination of groundwater and soil
Building power lines	clearing	Loss of habitat.
Provision of accommodation	Clearing, soil and water pollution, waste generation	Loss of habitat, , sewage disposal and disease impacts, pets, harassment of wildlife
Roads and rail	clearing	Habitat destruction or fragmentation, waterlogging upslope and drainage shadows down slope
Population growth	clearing	Loss of habitat, stress on local and regional resources, pest introduction, clearing

Legal and other Requirements

Companies should prepare a legal register using existing permits, licences and relevant legal and non-legal documentation.

It should be noted that legislative and regulatory requirements vary markedly across countries and regions, and each operation needs to be vigilant in maintaining, understanding and using a register of obligations.

Voluntary obligations also need to be considered particularly as a number of developing areas such as biodiversity management tend to be addressed through voluntary company policies and industry initiatives well before they become incorporated into legislation. The ICMM principles are an example of such an initiative.

(See '*Integrating Biodiversity at the Exploration Stage*' Module 1).

Objectives, Actions and Targets

Clear goals for the outcomes of the biodiversity management projects need to be set and communicated to all involved. Those goals and objectives should be set in consultation with the various parties who will judge the success of the work. Local community groups, regulators, academics and so on should all be consulted. There are likely to be internal company goals related to efficiency and effectiveness, and these need to be compatible with the objectives set with external parties.

The objectives will depend on the biodiversity aspects identified and the requirements and opportunities to mitigate impacts. Objectives can be specific for a local issue such as a plant or animal species, or they may be general at the ecosystem level. In either case, objectives should be set in conjunction with the biodiversity values identified by the company and stakeholders, both of whom should seek opportunities to reduce negative impacts and increase positive impacts on biodiversity. Examples of goals and objectives may include:

- Successful reintroduction to mined areas of key flora or fauna species.
- Non-disruption to migration patterns.
- Protection (non-interference) of designated high value locations.
- Control of weeds and other pest species.

Actions to achieve the nominated objectives should be developed and then documented within the EMS.

Each company or operation should set targets that are specific to its operations and activities, that clearly describe what is to be achieved and by when, and that link into the overall rehabilitation and mine closure strategy described in Module 3. Each target should be realistic and take into account availability of resources, any technical limitations, engaging with landowners and the community, obtaining lease requirements, long-term land management requirements etc.

The objectives, actions and targets must be consistent with the policy and should include a commitment to 'no net loss of biodiversity'.

Biodiversity action plans

The biodiversity action plan (BAP) is a means by which the objectives and targets for biodiversity conservation can be achieved. BAPs can be incorporated into the EMS. Specific elements that may be covered in the plan include:

Key

Aspects and Risks

Operation

- Control of access to, and disturbance of, vegetated areas which do not need to be disturbed in the course of mine operations (i.e. to control inadvertent destruction of protected areas on-site);

  To maintain the maximum extent of existing biodiversity elements, rigorous control of disturbance caused by clearing is required. Corridors that allow safe movement of fauna must be protected and maintained, especially where larger animals may move through the area (eg migrating caribou in the Arctic, or large mammals in Africa). In many areas where mining occurs, extensive clearing for agricultural purposes has already occurred, resulting in the fragmentation and degradation of remnant habitat. In such cases it is essential that companies implement effective clearing controls to prevent further fragmentation and isolation of fauna populations, and, where appropriate, combine this with green offset initiatives such as construction of corridors to re-establish linkages between remaining areas of native habitat.

  Clear demarcation of all protected areas is required to avoid inadvertent destruction through ignorance or carelessness. In some areas this will require fencing. In other cases, broad scale areas, controls implemented in conjunction with other landholders may be required.

  Controls on the how vegetation (and associated fauna) is removed also need to be specified to maximise the use of seed and other plant propagules, soil nutrients and soil biota, decaying organic matter, logs and other potential fauna habitat that can be valuable for rehabilitation. This will help ensure that clearing operations are fully integrated with the requirements of subsequent rehabilitation operations, as described in Module 3.

- Management of pest plants and animals;

  Introduction of pest species in the form of weeds and feral fauna species has often accompanied expansion of mining into greenfield areas. In some cases these pests can have significant impacts on local species well beyond the mine lease area. A good example is the introduction of domestic cats into areas with no similar predators. There have also been a number of examples where rehabilitation has introduced weed species that have become pests due to their success in colonising disturbed areas. Strict controls on employees keeping native animals as pets, and vehicle washing/disinfection to control weeds and plant disease are all examples of controls that may be required.

- Research and development programmes;

  In the ESIA phase, major gaps in knowledge of biodiversity on the site and in adjacent areas will have been identified and addressed to the extent necessary to gain project approval. In the operational phase, that knowledge base is further developed through ongoing research. This research is usually targeted towards gaining additional knowledge that improves the revegetation/rehabilitation (see Module 3). However there are likely to be other aspects that relate to the broader region surrounding the mine. These may include understanding the impacts of land use changes in the area (that may have eventuated from secondary impacts), the behaviour of invasive pests, through to integration into species recovery programmes and other detailed studies of individual species of fauna and flora of interest to the local community.

Key

Aspects and Risks

Operation

- Revegetation trials are a specific subset of the research programme targeted at gaining more information on the nuances of the requirements and techniques for successful rehabilitation. Module 3 describes these in greater detail.

- Research on aspects relevant to the wider setting of the mine may also be required or valuable in providing a better understanding of the regional interactions. This is often the case where mines have been established in remote areas that have been poorly studied, and the ESIA may represent the single most intensive study. Extending the range of that knowledge base may provide additional information relevant to the site, but will also extend the overall knowledge base.

3.3.5 *Implement Preventative and Mitigative Responses to Identified Biodiversity Aspects*

Accountability for biodiversity management within the organisation should be allocated to a senior management role, one that has the capability to ensure that biodiversity and social aspects are considered equally with production goals.

For each of the actions identified in the previous section, accountabilities and budgets should be assigned and documented, to ensure that the necessary staffing, skills and resources are available to implement the tasks.

At the operational stage, all management procedures documented in the EMS and essential for the later implementation of successful mine rehabilitation must be carried out. These will usually include selective handling of overburden materials, topsoil management to conserve nutrients and plant propagules, construction of landforms that will control erosion and prevent any long-term impacts on biodiversity values of surrounding waterways, and progressive rehabilitation of areas as they become available.

Key

Stakeholder Consultation

Operation

Successful integration of the mining operations and rehabilitation stages, as described in Module 3, will not only result in better biodiversity outcomes, but in many cases will reduce costs by ensuring that companies 'get it right the first time'.

Other EMS procedures that need to work effectively in practice at the operational stage include such components as spill response procedures, to ensure that any impacts on biota are minimised. Another key component of the implementation section of the EMS is communication. This has developed substantially since ISO14001 was released in 1996. Effective, transparent communication both within and external to organisations is now expected, and is continually improving and starting to become commonplace.

Communication

Stakeholder engagement and public reporting for biodiversity issues are essential steps to build a credible and workable biodiversity management plan. Sound management of biodiversity extends beyond the boundaries of the operation and needs effective two-way interaction and support to be successful. Companies should seek to involve traditional owners and any other indigenous groups, NGOs, local community, associations and institutions in biodiversity management, monitoring and conservation programmes. In addition, the provision of support for community education programmes on biodiversity management enables companies to share sound management of biodiversity with social responsibility. Companies should avoid the appearance of 'greenwashing'. That is, companies should be aware that honesty is the best policy and good accomplishments should not be glorified beyond what they are. In addition, companies should not be reluctant to indicate problems and describe how they are being addressed.

Training, Awareness and Competence

The effectiveness of any programme depends on all involved having a sound understanding of the objectives and their role in the programme. Induction and training programmes are fundamental to this.

- All employees, contractors and visitors need to be aware of and understand the objectives of the biodiversity management plan and their role in its success.
- Regular monitoring (through audits, observation, and survey) is required to evaluate the effectiveness of the awareness and training programmes.
- At many mines, there is an excellent opportunity for involving employees with ecologists in useful data gathering such as reporting of uncommon flora and fauna species which may not be detected in shorter duration surveys. However, for this to be successful, employees must have the necessary training, support and encouragement.

- The awareness programmes should extend beyond the mine staff and include those in communities around the mine and adjacent land users whose activities may also impact biodiversity and the success of the operation's plans.

Whilst not unique to biodiversity management, conducting training and awareness programmes on an ongoing basis is essential if the various management endeavours are to be implemented effectively. Training will raise awareness, competence and commitment amongst company staff. This in turn will assist staff to understand the consequences of biodiversity risks that may arise from their jobs.

Case Study: Integrating biodiversity into environmental management systems. Alcoa, global.

Background

Mining often occurs in or near sensitive natural environments, so biodiversity protection needs to be a key part of the operation's environmental management programmemes. Impacts resulting from exploration and mining operations can be widespread or confined, direct or indirect, permanent or transient, and positive or negative. In addition, interactions between mining operations and local communities can multiply or offset biodiversity impacts.

Possible Biodiversity Impacts of Mining

The amount of damage done to local biodiversity during mining or the enhancement of it that is accomplished will depend on:

- How well the potential impacts were foreseen during baseline surveys, environmental impact assessment and project development;
- How well the impacts are managed during exploration, operational mining, rehabilitation and closure; and
- Whether the rehabilitated land, infrastructure and management are sustainable after mining has gone.

Examples of direct negative effects are fairly obvious: damage or clearing of native vegetation leading not only to direct losses but also to fragmentation of habitat; rainfall runoff from disturbed land leading to soil erosion, turbidity, saltation or pollution of local streams; introduction of spread of weeds (including agricultural and commercial exotic species), pests and diseases of native flora and fauna; alteration of groundwater levels through mine de-watering, resulting in vegetation impacts; and exposure of acid generating rock or subsoil that leads to contamination of waterways with acid and mobile metals.

Indirect negative impacts often involve interactions between the mining operations, its workforce and local communities. Many examples of this relate to an operation's opening up access to remote regions, to migration and settlement of people in the region, and to the impacts these people have on the local biodiversity. Some types of mining might also restrict access to land that was previously used by local communities – uses that may have been linked to traditional subsistence livelihoods or to recreational uses in affluent societies. Either way, pressures for these land uses can be transferred to new undisturbed lands, with subsequent impacts on biodiversity.

Case Study: Integrating biodiversity into environmental management systems. Alcoa, global, cont.

Yet mining can also contribute positively to biodiversity outcomes beyond the impacts or activities of the operations, through a wide range of programmemes such as:

- Regional flora and fauna surveys;
- Education and training;
- Research funding;
- Sponsorship of community environmental groups or projects; and
- Local and regional economic developments that have biodiversity spin-offs.

Many of the negative impacts listed above can be avoided or can even result in positive biodiversity outcomes if appropriate consultation with regulators and local communities is undertaken and if planning and management are applied. Engagement, collaboration and cooperation between government, local communities and mining companies are all critical for optimum biodiversity outcomes to be realised. An example of a positive outcome is mine rehabilitation designed to produce a fuelwood plantation, agroforestry or grazing land.

Environmental Management Systems

In essence, an Environmental Management System (EMS) can be considered:

- A tool to improve environmental performance;
- A means of systematically managing an organisation's environmental affairs;
- The part of an organisation's overall management structure that addresses immediate and long-term as well as direct and indirect impacts of its products, services and processes on the environment; and
- An ordered and consistent way for organisations to address environmental concerns through optimisation of resource allocation, transparent assignment of responsibility and ongoing evaluation of practices, procedures and processes – with a focus on continual improvement.

Integrating Biodiversity

In terms of biodiversity, the company should prepare a register or relevant legal regulations and voluntary practices, including corporate standards and environmental guidance and codes of practice published by professional and industrial bodies the organisation belongs to, such as ICMM. The register might also include:

- Information on protected areas and their legal status;
- Listed vulnerable species and risk of impacts in areas of operations; and
- Biodiversity Action Plans for the areas in question.

If there are significant potential impacts on biodiversity that could arise during or following major accidents or emergencies, the company should undertake a more detailed risk analysis, identifying vulnerable resources and sites and drawing up plans for emergency preparedness and contingency measures for each potential impact. This is particularly relevant if the project is in or near a sensitive biodiversity areas.

In cases where biodiversity is a significant aspect of one or more projects, biodiversity criteria may also be incorporated in existing performance contracts in order to emphasise the focus on biodiversity within line management.

3.3.6 *Monitor, Measure and Report Performance on Biodiversity Management*

Key

Monitor & Report

Operation

Changes in biodiversity attributes need to be monitored to evaluate the success of management plans, rehabilitation trials, research projects and equally importantly, the general changes in the biodiversity of the area around the site that may be influenced by non-mine factors. As long-term decisions are based on this information, the programme needs to be soundly designed according to accepted statistical principles (e.g. see Green 1974), highly credible to all stakeholders, and the data collection processes must be readily verifiable.

- Detailed monitoring programmes are required to provide the information on which to base decisions of the success or otherwise of projects, and evaluate changes in the biodiversity resulting from both internal and external factors.

- It must be realised that, in some cases, impacts can extend some distance from the mine, for example changes to water quality or hydrology. This possibility of such impacts must be taken into account in the design of the monitoring programme.

- Monitoring needs to be conducted using transparent and scientifically rigorous procedures, and the use of external experts is often required. These programmes need to be both cost-effective and highly credible to regulators, local communities and other interested parties.

- Publication in peer-reviewed journals is an excellent means of transferring knowledge to a wider audience and evaluating the validity of the programme.

This step is central to determining the effectiveness of biodiversity management systems on the site, and an essential component of adaptive management (do-monitor-evaluate-revise). To build and maintain the necessary credibility for this component, it is essential that peer review and similar external or third party checking be conducted. Community review groups, external advisory panels and similar approaches need to be used to ensure that the information collected and the analyses made are considered by the majority of stakeholders to be fair and reasonable.

Monitoring provides a method of measuring progress against an objective. Various techniques can be used involving repeated measurement and sampling of indicator species over time. Biodiversity monitoring can be undertaken in-house or in partnerships with various institutions such as universities and other learning centres. Biodiversity monitoring techniques are comprehensively described in the literature and are not repeated in this guidance. A selection of references is provided in the appendices.

Key

Review

Operation

Reporting usually includes both formal government reporting requirements and information provided for the broader public and other stakeholders. Government annual and triennial reports are designed to help ensure accountability with regulatory authorities. Public reporting on biodiversity aspects can range from publications in the scientific literature to annual sustainability reports. Public reporting often tends to concentrate on case studies, however, it is more important and valuable to provide comprehensive reports on the effectiveness of actions taken to protect or enhance biodiversity. A number of case studies are used in this guidance material and many more are available in the public domain (see bibliography). The GRI has a set of biodiversity related criteria against which companies are encouraged to report. The two core indicators are:

- EN6. Location and size of land owned, leased, or managed in biodiversity-rich habitats; and

- EN7. Description of the major impacts on biodiversity associated with activities and/or products and services in terrestrial, freshwater, and marine environments.

In addition to these two core indicators, additional indicators some of which are likely to be explicitly concerned with biodiversity, include:

EN23. For mining: Total amount of land owned, leased, and managed for production activities or extractive use. 1. Total land disturbed and not yet rehabilitated (opening balance); 2. Total amount of land newly disturbed within the reporting period; 3. Total amount of land newly rehabilitated within the reporting period to agreed upon end use; 4. Total land disturbed and not yet rehabilitated (closing balance). The above set of figures allows the reader to assess both the stock of land disturbed and the annual changes. Disturbance may include both physical and chemical disturbance.
EN27. Objectives, programmes and targets for protecting and restoring native ecosystems and species in degraded areas.
MM8. The number/percentage of sites identified as requiring biodiversity action plans with updated plans in place should also be reported. Also include criteria for deciding that a biodiversity management plan is required.
EN25. Impacts of activities and operations on protected and sensitive areas. Note that impacts are not limited to the land space directly adjacent or managed by company. In addition, the term "sensitive" is not limited to those areas with formally recognised status as protected.

There are a further seven 'Additional Indicators' which are described at www.globalreporting.org/guidelines/2002/c48.asp.

Detailed reporting on biodiversity aspects at specific sites is more commonly delivered through research and occasional papers (see bibliography for examples), or, in some cases, in specific sections of reports prepared for government.

Key

Continuous Improvement

Operation

Overall, reporting should be presented in a transparent and clear fashion, whether it is voluntary or for legal purposes. The aim of reporting monitoring results is to indicate whether the performance of a company is in line with the objectives, or whether activities need to be modified to ensure biodiversity is managed to the level prescribed in the EMS.

3.3.7 Management Review

In the EMS, management review requires senior management to undertake a review of the relevance and success of the EMS. From a biodiversity perspective, this stage should include seeking input from all relevant stakeholders. Changes are then proposed based on the experience gained and the outcomes identified through the monitoring stage. External factors such as increased knowledge of the ecosystems around the mine, change in the official status of a species, or additional external threats to those ecosystems may also warrant a change in the objectives.

3.3.8 Continuous Improvement

If the above steps are rigorously followed, it should be possible to demonstrate to a critical observer that the operation is managing its potential impacts and learning from the results and improving performance, so that biodiversity risks are managed to ensure biodiversity conservation. That improvement may be through enhanced biodiversity outcomes or through more effective implementation of existing plans and actions, thereby ensuring reduced impacts on biodiversity and improved re-establishment of biodiversity values following rehabilitation.

Furthermore, a company biodiversity action plan is a dynamic process, not only with respect to biodiversity conservation, but also for opportunities for investor relations and access to capital. There is growing evidence to indicate that investors are now taking a triple bottom line approach, and the ability to deal well with biodiversity management may also indicate overall competent company management (Earthwatch, 2002).

Key

Stakeholder Consultation

Operation

3.4 INTEGRATING BIODIVERSITY INTO COMMUNITY DEVELOPMENT PROGRAMMES

IMPLEMENTATION GUIDANCE:

Key steps towards a participatory community development programme should include:

- Engaging stakeholders in a two-way consultation and negotiation process, starting at the earliest stages of exploration;
- Engaging all parts of the community on biodiversity issues;
- Allowing for clear and accessible information on the project to all stakeholders; and
- Maintain a continuous, clear, open and honest communication throughout the life cycle of the mine.

3.4.1 *Introduction*

CDPs do not have a standard framework, but they are generally recognised as:

A programme that outlines a method of engaging the community in a consultative process. The programme should identify and understand the project-affected people, allow access to adequate transparent information about the project, studies and results and allow public participation in the process.

3.4.2 *Key Steps in Developing a Successful Participatory Community Development Programme*

Key steps towards a participatory community development programme should include:

- Engaging stakeholders in a two-way consultation and negotiation process, starting at the earliest stages of exploration;
- Engaging all parts of the community on biodiversity issues;
- Allowing for clear and accessible information on the project to all stakeholders; and
- Maintain a continuous, clear, open and honest communication throughout the life cycle of the mine.

Key

Stakeholder Consultation

Operation

3.4.3 *Biodiversity in Social Sustainability*

Social sustainability occurs when the formal and informal processes, systems, structures and relationships actively support the capacity of current and future generations to create liveable and healthy communities. Socially sustainable communities are equitable, diverse, connected and democratic and provide a good quality of life (Western Australian Council of Social Services, 2000).

Supporting social sustainability during mining projects will, in most cases, require incorporating biodiversity within the CDP. Mining companies are now recognising the importance of investing in the future through effective communications with stakeholders. Effective communication by the mining company can earn trust and respect by the stakeholders through the life cycle of a mine.

The following case study demonstrates how effective stakeholder engagement can benefit the interests of all parities.

Case Study: Stakeholder involvement in defining a national park boundary. Mining Association of Canada, Canada.

The lands set aside for a proposed Tuktusiuqvialuk National Park in Canada's western High Arctic included much of the critical habitat of the endangered Peary caribou herd. Yet a mineral and energy resource assessment found a very high mineral and hydrocarbon potential in many of the areas used by the caribou. The Canadian Nature Federation approached the Mining Association of Canada (MAC) to determine whether mining companies would waive their interest in Bathurst Island in order to protect the caribou. After some discussions with its members, MAC suggested that one part of the eastern side of the island be excluded from the proposed park but agreed to support a moratorium on exploration and development throughout the area until the Peary caribou herd was no longer considered at risk of extinction.

One effective method of communication used by mining companies is development of collaborative or partnership programmes with government, environmental, educational and indigenous communities. Such partnerships may involve provision of technical knowledge, funds, employment, management and technical skills by the mining company to the community.

Where opportunities exist, partnership programmes with the community should involve programmes with indigenous people who may possess unique knowledge of their environment and methods of conserving its biodiversity. Traditional ecological knowledge can provide valuable insight into understanding the biodiversity context of a site and the surrounding area. Opportunities for employing local indigenous people in work and monitoring programmes should be sought, both as part of community development programmes, and to access this valuable knowledge.

Collaborative programmes can occur with the broader scientific community and allow for sharing of technical knowledge to educational organisations or sponsorship of community environmental groups, management and restoration of significant habitats, or species conservation programmes.

Key

Stakeholder Consultation

Operation

3.5 COMMUNITY AND STAKEHOLDER CONSULTATION

Local communities have both an explicit right to be involved in setting biodiversity management objectives and the commensurate plans, but also have significant potential to assist in the successful undertaking of the projects that arise. Local communities, if they have been in the locale for many years, will have a good understanding of temporal changes in flora and fauna, and will usually know where key faunal feeding, shelter and breeding areas are located, and so on. In some cases, they may even know of species that were present in the area, but have become locally extinct; there may be the opportunity for reintroduction of such species in conjunction with government conservation authorities. The knowledge of local communities and traditional groups may not be expressed in scientific terms, but should be sought out and used as appropriate, with due respect.

Successful biodiversity management practices and outcomes are more likely to be achieved when there is extensive community participation throughout the lifecycle of the mine. Whilst it is not the objective of these guidelines to reproduce social assessment or community development guidelines, there are key aspects that need to be addressed in gaining a thorough understanding of the potential impacts on biodiversity as a result of mining activity.

3.5.1 Collaborative Approaches

The success of biodiversity management programmes can be strongly influenced by the level of community and stakeholder participation. Many international and national mining projects have adopted community-based approaches towards biodiversity conservation.

Some of these include Community Development Programmes (CDPs), global partnership programmes, national policy development, regional and local programmes, community memberships/councils, voluntary initiatives and stakeholder participation planning programmes and corporate environmental management systems. Examples of these are provided below.

Community Development Programmes

Key

Stakeholder Consultation

Operation

CDPs are programmes initiated by community groups with an interest in biodiversity management. There are a number of case studies including:

- Creating Foundations for Sustainable Mining – Escondida Mining Corporation in Chile recognises that mining carries potential risks to the community. The company has assisted the community through the establishment of the Escondida Foundation, which aims to ensure mining is sustainable by minimising impacts on health, education and quality of life (IFC, 2000);
- Integrated Development Plan for Mutale Municipality –Tshikondeni Coal Mine in South Africa are involved in community development programmes, mainly for human resources and economic development such as conducting awareness programmes on science and technology (Choshi, 2001);
- Social Investment – Richards Bay Minerals in South Africa has established a number of community partnerships focusing on the provision of schooling, health services, job creation and community development, e.g. creation of Tisand Technical High School for technical skill development (IFC, 2000); and
- Community Business Forum – Kyrgyzstan Community and Business Forum was established to promote dialogue between various stakeholders, build partnerships and encourage sustainable social, economic and environmental benefits around Kumtor Gold Mine (joint venture between the Canadian and Kyrgyz Government) (Kozielle and Omosa, 2003).

Global Partnership Programmes

Global partnership programmes have been established between the mining and minerals industry and NGOs such as Birdlife International, Earthwatch, Conservation International and Fauna & Flora International. There are numerous examples of global partnership programmes, including:

- Fellowship programme – Rio Tinto has been engaged in a partnership with Earthwatch International. The employee fellowship enables Rio Tinto employees to participate in scientific programmes around the world. Capacity building programmes enable Rio Tinto employees to help provide training to African and Indonesian conservation scientists in the latest techniques of conservation biology (Anstee, 2000).

National Policy Development

Key

Stakeholder Consultation

Operation

Development of national policies for the mining sector continues to play a critical role in biodiversity conservation. The resource industry, government and conservation groups are actively involved in preparing national policies and legislation for biodiversity conservation and mining. There are numerous examples of national policy development, including:

- Species at Risk Legislation – Mining Association of Canada is working together with major conservation organisations such as Canadian Nature Federation, Canadian Wildlife Federation and Sierra Club of Canada to prepare Species at Risk legislation (Anstee, 2000); and

- Development Forum – All major projects in Papua New Guinea are negotiated through a development forum, which involves negotiations and creation of Memoranda of Agreement between community members, local and regional governments, developers and national government. It defines responsibilities for all interested parties and the benefits of the resource project (IFC, 2000).

Regional and Local Programmes

Regional and local programmes have been initiated by NGOs, the resource industry, conservation groups and government. There are a number of regional and local programmes created for biodiversity conservation and mining, including:

- Conservation of Lahontoan Cutthroat Trout – Barrick Goldstrike and Anglo Gold (Nevada) are involved in a project for the conservation of the habitat for the endangered Lahontoan Cutthroat Trout (Anstee, 2000); and

- Mule Deer Conservation – Newmont Mining Corporation is involved in the Bobs Flat Wildlife Enhancement Project, which involves ensuring that offset mining disturbance to public lands enhances the mule deer winter range on private lands (Anstee, 2000).

An example of a highly successful four way partnership between industry, government, education and community follows:

Case Study: Restoring Australia's arid lands A highly successful four way partnership. WMC Resources, Australia, cont.

Aims of Arid Recovery

When Arid Recovery was established, the new partners agreed on the following as their aims:

- To facilitate ecological restoration or arid ecosystems;
- To provide transferable knowledge, information and technology for broad-scale environmental management of Australia's arid lands; and
- To apply the principles developed to demonstrate how mining, pastoralism, tourism and conservation organisations can work together to achieve tangible benefits from sustainable ecological outcomes.

Project Coverage and Successes

The project started small, with construction of a 14 square kilometre fenced reserve. After four expansions, the protected area now covers 60 square kilometres. The next expansion will take the reserve to 86 square kilometres.

After thousands of hours of staff, students and volunteer labour, all cats, rabbits and foxes were eradicated from the entire reserve. This created an area of complete protection into which four locally extinct species were reintroduced:

- Greater Stick Nest Rat, *Leporillus conditor*;
- Burrowing Bettong, *Bettongia lesuer;*
- Greater Bilby, *Macrotis lagotis;*
- Western Barred Bandicoot, *Perameles bougainville*

Each of these reintroductions was successful, and all four species are now living and breeding within the reserve. The numbers of existing native species in the fenced are have also increased, and there are now three times as many small mammals inside the reserve as there are outside. A comprehensive plant monitoring programmeme has also demonstrated considerable recovery of the reserve's vegetation.

Community Memberships/Councils

The development of national policies and biodiversity conservation programmes has also resulted in the formation of internal conservation committees, conservation groups and councils. Some examples of existing biodiversity conservation committees and councils include:

Key

Stakeholder Consultation

Operation

- Wildlife Habitat Council – formation of this Council, a non-profit, non-lobbying organisation, with membership base with companies such as Coca Cola, Dupont and Pharmacia and Upjohn. They also have corporate memberships such as WWF, Bat Conservation International, Ducks Unlimited and Izaak Walton League of America (Goshi, 2001); and
- Mining, Minerals and Sustainable Development (MMSD) has developed structures and reports for North America, Australia, South America and South Africa, e.g. committees, regulatory bodies, NGOs and other stakeholders (Goshi, 2001).

Voluntary Initiatives

Voluntary initiatives are often sector, industry-wide, national or international level. Voluntary initiatives in the mining industry include a number already in place or actively being evaluated:

- Ombudsman model – enforced by independent and credible ombudsman body, e.g. IFC (MMSD, 2002);
- Industry Codes of Conduct – Best practice statements may be formulated and endorsed by industry, such as the Minerals Council of Australia Enduring Value Code for Sustainable Development and the ICMM Sustainable Development Charter, or initiated by other parties and much broader than the mining and minerals industry such as the UN Global Compact (MMSD, 2002);
- Responsible Care model – programme that incorporates a set of policies, guiding principles and specific code of conduct for the environment, health and safety, social performance and community relations (MMSD, 2002); and
- Stewardship Council Model with certification – Forest and Marine Stewardship Councils governed by industry, NGOs and other stakeholders to make decisions in creating and administering a set of standards on which certification is based (MMSD, 2002).

Examples of voluntary initiatives include:

- ICMM Sustainable Development Charter (2003) (MMSD, 2003);
- Australian Minerals Industry 'Enduring Value' (2004) (MCA, 2004);
- UN Global Compact (1999) (Greene, 2002);
- Mining Certification Evaluation Project (2003) (Greene, 2003);
- Responsible Care (1985) (Greene, 2002); and
- ICMM Toronto Declaration (2002) (IUCN, 2003).

Stakeholder Participation Planning Programme

Key

Stakeholder Consultation

Operation

It is important that government and resource industries work together to ensure that the local community is informed about the processes involved in mining and their impacts on biodiversity conservation. There are many examples of such community participation in the mining sector, including:

- Placer Dome's Wallaby Project – Granny Smith Mine (Western Australia) initiated a stakeholder consultation and participatory planning programme to identify the local community concerns, the likely impacts of mining on wallabies and the approval process required for the proposed mine site (DIR, 2004); and

- Whitehorse Mining Initiative – Mining Association of Canada recognised the need for the mineral industry to engage the industry, including key stakeholders and the local community to consider more sustainable approaches to mining (EIG, 1994).

The importance of local communities to the success of biodiversity management programmes has been identified in a number of case studies. This Module will enable companies, Government and other stakeholders to build on those experiences, by describing and referencing successful strategies for community involvement in biodiversity management. The following case studies provide such an example:

Case Study: Providing environmental education for a community's children. Alcoa Aluminio S/A, Brazil.

Environmental education is provided in Brazil to schoolchildren at a centre built by Alcoa especially for the purpose near Pocos de Caldas in the State of Minas Gerais. The project began with a need to survey local plant and wildlife for Alcoa's mine rehabilitation works. The company asked an NGO from Curitiba for help with a survey of birds. The company was so impressed with environmental education classes that the group run each summer, that it decided to set up a full-time centre. After 11 years of operation, the Centro de Estudos e Pesquisas Ambientais – Alcoa has provided environmental instruction for 65,000 youngsters.

Case Study: Success through Partnership, Sarshatali Coal Mine, India

Overview

An open cast coal mine is to be developed in the Asansol sub-division of Burdwan District in West Bengal. The mine is the first major private sector mining initiative in India, and as such represents an opportunity for the private sector to take a lead in the quality of social provision (asset compensation, social impact mitigation and community development). The project sponsor - ICML (a subsidiary of the Calcutta-based electricity generating and distribution company CESC) - is being assisted in meeting this objective by the International Finance Corporation (IFC) of the World Bank. The IFC has agreed in principle to part-finance the project through equity and loans. The project is currently in its pre-construction phase. The majority of compensation arrangements have been implemented, and plans for social and environmental impact mitigation and community development prepared.

Partnership Building

Following an orchestrated process of multi-sector dialogue towards the end of 1999, the project sponsor entered into a pilot partnership arrangement with two local NGOs (ASHA and Suchetana) and representatives from local Panchayat and District level government authorities. The shared aim of the partnership is to build trust with those who will be most affected by the forthcoming mine, and to identify priority livelihood needs. This information will then feed into the design of community development activities, including a proposed community Trust Fund.

Case Study: Stillwater River (Montana) – Part 1 2002

The Stillwater Mine Good Neighbour Agreement is a formal agreement negotiated among four parties in Montana: the Northern Plains Resource Council (NPRC), the Stillwater Protective Association, the Cottonwood Resource Council, and the Stillwater Mining Company (SMC). The agreement arose in part to forestall lawsuits against SMC's proposed expansion of its platinum-palladium mining complex in Montana's remote Stillwater and East Boulder River watersheds. Local residents feared that the expansion would create unmanageable social and environmental impacts and would lead to the degradation of local rivers and streams. NPRC and its local "affiliate" groups have worked to reduce impacts from the mine for much of its 15-years existence. NPRC felt that state and federal regulation of the mine had been lax, and the environmental reviews of the upcoming mine expansion were less than rigorous. The decision to try to negotiate a workable agreement came when NPRC and related organizations learned of the use of good neighbour agreements between managers of various industrial facilities and neighbouring or host communities. SMC is a company that seeks to maintain a reputation as a socially and environmentally responsible producer. The possibility for a negotiated agreement arose at an informal gathering at the home of a local resident. The subsequent agreement is the first good neighbour agreement ever applied to a metal mine.

Biodiversity, particularly through the wildlife impacts were a major concern of the communities involved.

Case Study: Stillwater Part 2 – 2004 Conservationists, Stillwater make deal to preserve land

By CLAIR JOHNSON
Of The Gazette Staff (October 2004)

The Stillwater Mining Co. has donated conservation easements on two ranch properties as part of a Good Neighbour Agreement between the mine and conservation groups, the parties announced Tuesday. Through the agreement, the mine has now donated conservation easements on six ranches totalling 2,990 acres in Stillwater and Sweet Grass counties. Francis R. McAllister, the company's chairman and chief executive officer, said, "Stillwater Mining Co. is pleased to contribute these two additional conservation easements as we continue to fulfill commitments made at a time when the mine was expanding its operations. The conservation easements ensure that these properties will continue to have the rural qualities and beauty we all enjoy.''

The company donated easements on properties known as the Magpie Ranch, which totals 600 acres, and the Robinson Draw parcels, which cover 160 acres, to the Montana Land Reliance, a Montana-based land trust. The properties are located near the company's Hertzler tailings management facility near Nye. Last year, the company donated conservation easements on four ranches in Stillwater and Sweet Grass counties. The Good Neighbour Agreement was signed in 2000 by the mining company, the Northern Plains Resource Council and its affiliates, the Stillwater Protective Association and the Cottonwood Resources Council. "When the minerals are gone, these ranches will still be ranches. The main thing about a conservation easement is it maintains land as it is now and preserves open space,'' said Stillwater County rancher Jack Heyneman, who is on the local mine oversight committee. "Farm and ranch land are part of what makes this area a good place to live and work. This donation is a demonstration that Stillwater Mining Co. truly is a good neighbor.''

The agreement required the company to establish conservation easements on non-mining properties to preserve agricultural lands, open spaces, wildlife habitat and riparian corridors. With the donation of the two easements, the mine has fulfilled its conservation easement obligations under the agreement, the parties said. In addition to conservation easements, the Good Neighbor Agreement reduces mine traffic on county roads, encourages innovative technologies for cleaner air and water and invites citizen participation in oversight of the mine's environmental performance.

Ralph Green, a spokesman for the mine, said the easements run with the title to the properties in perpetuity. The easements prohibit subdivision of the land and additional industrial development. Green said the Hertzler tailings facility is on a large parcel of property that initially was three or four ranches acquired by the company. Other than the tailings facility, the peripheral lands have no mining purpose, he said. "We and the good-neighbor groups recognized they also have some conservation values we wanted to preserve,'' Green said.

Stillwater Mining Co. is the only U.S. producer of palladium and platinum and is the largest producer of platinum group metals outside South Africa. The metals are used in vehicle catalytic converters and in some industrial processes. The company has two mines, one on the East Boulder River south of Big Timber and one near Nye on the Stillwater River.

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4 MODULE 3 - INTEGRATING BIODIVERSITY INTO MINE REHABILITATION AND CLOSURE

Key

Planning

MINE CLOSURE

4.1 INTRODUCTION

Mine rehabilitation provides an opportunity to re-establish sustainable biodiversity values. The extent to which this is successfully achieved depends on how effectively the mining company has taken biodiversity considerations into account in the project development and operational phases, and how well it plans and implements its rehabilitation programme. It is critical that the links between all phases of the operation are clearly understood and managed on a whole-of-mine-life basis, as well as a whole-of-lease basis.

This Module describes the processes, tools and techniques that are likely to be required to meet the biodiversity objectives outlined in the 'Introduction' of this guidance document. It is divided into six sections:

- *Planning;*
- *Site Preparation;*
- *Rehabilitation Operations;*
- *Monitoring and Research;*
- *Closure and Completion Criteria; and*
- *Links into the Environmental Management System (EMS).*

Figure 4.1 shows how this module integrates biodiversity at the end of the mine cycle during mine rehabilitation and closure.

Key

Planning

Closure Planning

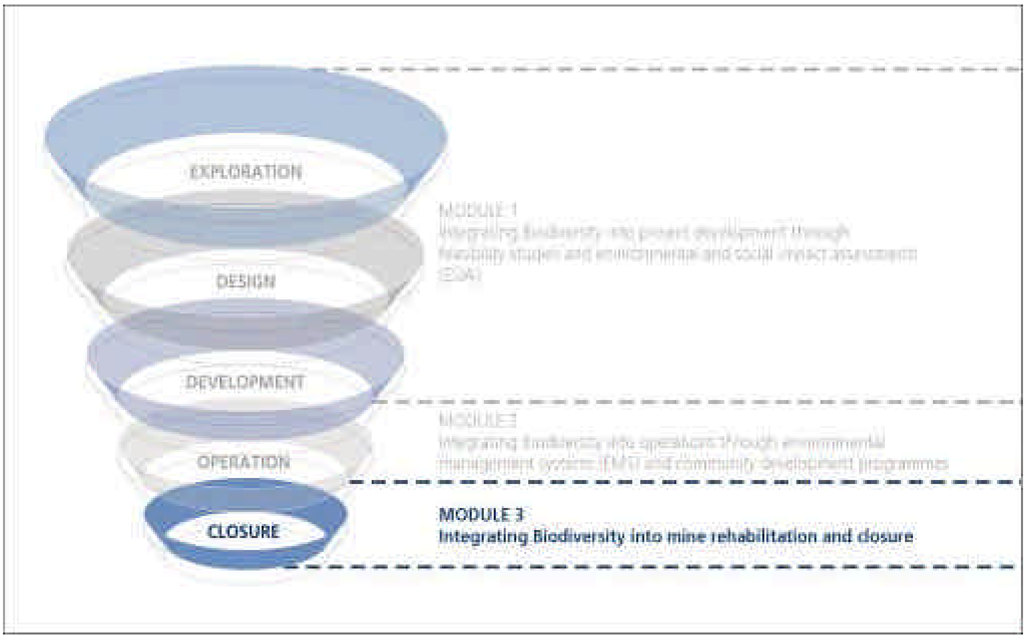


Figure 4.1 Integrating Biodiversity into the Mine Cycle during Mine Rehabilitation and Closure – Module 3

4.2 PLANNING

Implementation Guidance

A Comprehensive Closure Strategy and Plan should:

- *Identify and address all relevant regulatory requirements relating to mine closure and lease relinquishment;*
- *Focus on the long-term sustainability of ecosystem structure, function and processes potentially affected by mining, and address both direct and secondary impact;*
- *Be developed based on the findings of baseline and ongoing survey gathered during the pre-feasibility and EIS stage;*
- *Take a whole-of-mine-life perspective to biodiversity management and address all aspects of mine closure;*
- *Set achievable objectives and targets for biodiversity re-establishment; and*
- *Be reviewed at least once every five years (more frequently as closure approaches) and updated as new information and techniques become available.*

Key

Planning

Closure Planning

4.2.1 *Comprehensive Closure Strategy and Plan*

A Comprehensive Closure Strategy and Plan should be developed at the project development phase, as described in Module 1. This is an essential component of biodiversity conservation and the restoration, where possible, of biodiversity values affected during the exploration and operations phase. It must identify and address all relevant regulatory requirements relating to mine closure and lease relinquishment. It must also focus on the long-term sustainability of ecosystem structure, function and processes potentially affected by mining, and address both direct and secondary impacts.

Existing mining operations, for which a Closure Strategy and Plan has not previously been developed, should produce one as a priority. The closer the mine is to closure, the more detail this should contain.

The plan should be based on the findings of baseline and ongoing surveys, as well as objectives and targets described in Section 4.1.2, which have been established with effective community consultation. It must take a whole-of-mine-life perspective and address all aspects of mine closure, not just those relating to biodiversity conservation and rehabilitation (for example, in many cases, these will include off-site impacts, and decontamination of hydrocarbon spills near workshops). It will also highlight post-rehabilitation maintenance, management and long-term monitoring requirements as well as post-closure monitoring based on the need for the sustainable achievement of biodiversity objectives and targets.

A critical aspect of the overall mine closure strategy is the issue of dedicated financial provisioning. Closure funds must be sufficient to complete all necessary works, dedicated to the purpose, and should be controlled by independent third parties. In many countries a Government bond or security system exists; however this should only be seen as an 'insurance guarantee' and should not reduce any obligations for the company to carry out good practice rehabilitation. The financial provisions must be transparent, not only to shareholders but also to other interested stakeholders. They must be structured to deal with the financial and technical consequences of unexpected premature closure, and temporary 'care and maintenance' due to economic downturn.

The Closure Strategy and Plan should be reviewed at least once every five years (more frequently as closure approaches) and updated as new information and techniques become available.

4.2.2 *Objectives and Targets*

Key

Planning

Closure Planning

Achievable objectives and targets for biodiversity re-establishment are needed not only to give the company a framework on which to base its rehabilitation programme, but also to provide measurable standards against which regulatory authorities and other stakeholders can determine whether the company has met all necessary requirements prior to mine closure and lease relinquishment.

When setting biodiversity Objectives and Targets, the following aspects should always be taken into account:

- *Relevant regulatory requirements and other guidelines*: These will usually include conditions set as part of the Environmental Impact Statement (EIS), as well as other applicable government laws, regulations, policies and guidelines (e.g. those pertaining to biodiversity protection and rare species conservation and recovery programmes). The EMS legal register should be checked and requirements discussed with national, state/province and local government authorities

- *Effective consultation with key stakeholders*; Consultation with relevant stakeholders on matters relating to long-term land use, mine rehabilitation and mine closure should commence at the beginning of the Project Development Phase (see Module 2). Initially, it will focus on broader issues of post-mining land use. However, as information becomes available on biodiversity values through baseline monitoring and surveys, rehabilitation scenarios can be developed and discussed with government regulators and other stakeholders. An example of how the local community can be involved in developing a mine closure plan is given in the case study from BHP Billiton – Mitsubishi Alliance's (BMA's) Gregory Coal Mine in the Bowen Basin of Queensland, Australia.

- *All relevant information gathered during the pre-feasibility and EIS stage*: This will reveal what biodiversity values were present prior to mining, and, based on this, the company will need to decide which of these it can realistically attempt to replace, using recognised good practice rehabilitation methods with adaptive management. The information needs to be viewed from a whole functioning ecosystem basis, and account taken of aspects such as floral and faunal communities, fauna habitat, key indicator and functional species, rare, threatened or uncommon species, and the community's wishes.

- *Technical limitations*: Some mining operations result in significant changes to soil characteristics, microclimate resulting from changes in soil, topography, and hydrology. Propagation methods for some plant species may be unknown. These and other technical limitations need to be considered so that the objectives set are achievable.

Case Study: Involving Communities in Mine Life Planning. Gregory Crinum Coal Mine, Queensland, Australia

Gregory Crinum consists of two mines. Operations at the Gregory open-cut mine commenced in 1979, while the nearby Crinum underground mine opened in 1995. Both are operated by BHPBilliton Mitsubishi Alliance (BMA). The open cut and underground operations feed coal to a single wash plant and rail loadout. The mines are situated in an area that has been extensively cleared for grazing and agriculture, but also contains areas of remnant vegetation, some of which have conservation value due to their scarcity. The community consultation methods used by BMA to develop its Mine Life Plan are an example of how mining companies can involve stakeholders in helping to make key decisions on long-term land use issues.

Pasture and shelter trees on mine spoil

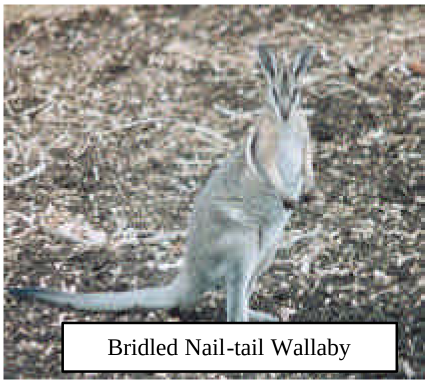
The process commenced with a public meeting held in September 2002. A Community Working Group was formed from local stakeholders. This consisted of representatives of landcare, environmental, regional planning and agricultural groups, as well as local government, the Queensland Environmental Protection Agency, and Gregory Crinum mine management, environmental and community relations personnel. An independent facilitator was contracted to help the process work smoothly Input from the group was used to help work out what are the best future use options for different land units (or domains) on the whole mining lease, so that the mine could do the necessary earthworks, establish the right trees, shrubs and grasses and anything else required to translate the plan into reality. The group also helped develop criteria that will be used to judge whether Gregory Crinum's future rehabilitation efforts are successfully progressing towards that land use. A review process was developed to ensure the Plan evolves over time to reflect changing community values and advances in scientific knowledge.

Unmined Yellowood scrub

The Community Working Group met 16 times over 8 months. Members soon reached consensus that a number of land uses were possible on the various domains. These included native vegetation conservation, grazing, agroforestry, recreation, cropping and industrial areas. Specific success measures were developed, based on the potential range of post-mining land uses. The criteria fell into various categories including vegetation establishment (density, composition, species richness, and sustainability); management of dust, fire, weeds and feral animals; ecosystem function; connectivity, i.e. linking areas of environmental significance; post-mining land management; and sustainability of proposed post-mining land uses. Protection of remnant stands of Brigalow was recognised as important for the ongoing conservation of endangered ecosystems that are part of the habitat for the rare Bridled Nail-tail Wallaby

Case Study: Involving Communities in Mine Life Planning. Gregory Crinum Coal Mine, Queensland, Australia, cont

The ongoing review process will involve Gregory Crinum circulating information on any developments that may impact on the mine plan. Then, once a year, current members of the Community Working Group and invited community members and groups will meet to review the Mine Life Plan, measure current rehabilitation progress against success measures and if necessary, make changes to the Plan. BMA is now using a similar approach to develop rehabilitation and mine closure strategies at the company's other coal mines.



Bridled Nail-tail Wallaby

(Information for this case study was provided by BMA's, Gregory Crimun Mine. Further information on the community consultation process used can be obtained by contacting BMA via www.bmacoal.com).

- *Existing land uses and the degree of disturbance*: It is important that the company takes into account the pre-existing land use and the degree of disturbance before deciding the extent to which it will attempt to establish a native ecosystem following mining. Expectations of stakeholders will clearly be higher in cases where mining is taking place in a relatively undisturbed ecosystem, than in an area that has been heavily impacted by clearing, grazing, logging, and/or other land uses. In situations where pre-existing disturbances have affected biodiversity values – which will often be the case - companies should only be required to put back values comparable to those that existed prior to mining. However, companies committed to excellence will often choose to do better than this, as part of a net biodiversity gain. For example, those mining in heavily cleared and overgrazed areas may choose to re-establish a vegetation community with significantly higher conservation values than existed before mining (See photos below). In the example shown, both ground and tree cover, as well as habitat diversity for bird and many other fauna species would all be greater in the rehabilitated site than in the heavily grazed site.

Five year-old eucalypt woodland rehabilitation at the Wesfarmers Curragh coal mine in central Queensland, Australia (above) compared with grazed land adjacent to the mining lease (below), typical of much of the site prior to mining.

Key

Planning

Closure Planning

- *Post-mining land tenure and land uses*: These should be addressed in the ESIA. Post-mining land tenure will influence what conservation objectives are possible. Due to population pressures, many countries do not have the luxury of 'hands-off' conservation areas. In these situations, objectives and targets for biodiversity conservation in mined and other leasehold areas will need to take into account other land uses, and focus on outcomes that deliver the best overall environmental, economic and social outcomes. A good example of rehabilitation with a strong focus on both biodiversity conservation and sustainable land use outcomes beneficial to the local community is illustrated in the Bamburi Cement case study.

Case Study: Rehabilitating difficult sites to achieve both biodiversity conservation and sustainable land use outcomes. Bamburi Cement, Mombasa, Kenya

The cement quarries run by Bamburi Cement around Mombasa, Kenya are typical of extensive open cast limestone quarries that utilise coral deposits on the coastal fringe of equatorial East Africa. Characteristically the quarrying process exploits 6 metres or so of coral deposit for use in cement production. This involves complete removal of very thin topsoils and forest trees and leaves a barren rock surface with little opportunity for ecological re-colonisation or economic and community re-use. Between 1977 and 1986 the industry quarried some 1.5 km^2, and the process continues today.

The long-term restoration and regeneration outlook was bleak for the mined areas, and it looked as though the quarries would join the mining legacy that affects parts of Kenya/Africa and some other developing nations. Fortunately, due to the foresight and energy of Dr. Rene Haller and the support of Bamburi Cement, the outcome has been very different from what might have been.

Following some chance observations of *Casuarina equisetifolia* trees growing in a remote part of the quarry, a programme of tree planting commenced with these and other trees.

Appropriate technologies have been developed and over a million trees planted as part of the 'kick-starting' of ecological functioning. Once trees were planted at a density of between 2,500 to 10,000 trees per hectare, quarried areas improved rapidly and began to support forest again as the soil provided feedstock for the woodland plantings. The humic layer of leaves that began to build up was exploited by millipedes and other invertebrates, and gradually ecological function returned. As Casuarina trees reached maturity and re- created topsoil became deeper, more native trees have been interplanted and full ecological function is now evident.

Case Study: Rehabilitating difficult sites to achieve both biodiversity conservation and sustainable land use outcomes. Bamburi Cement, Mombasa, Kenya, cont

A Sustainable Development approach ensured that secondary land-use following mining included farming, sustainable use of wildlife, tourism, fish farming etc. As a result of this, the local community were able to benefit from, and remain committed to, the ongoing success of rehabilitation efforts.

The work at Bamburi continues today as the operations are now part of the LAFARGE group, whilst the work and approach of Dr Haller, who has now retired, continues through the Haller Foundation, a charity dedicated to sustainable development and landscape restoration. For further information, see www.lafargeecosytems.com or www.thehallerfoundation.com

(Information for this study was provided by Ian Davies and the Haller Foundation; The photographs are copyright by Ian Davies and the Haller Foundation).

- *Integration into whole-of-lease biodiversity management*: Unlike some aspects of rehabilitation, for biodiversity conservation and re-establishment, it is very important to minimise impacts on the floral and faunal communities of surrounding areas. Initiatives such as reducing grazing, controlling introduced predators and herbivores, fire management, weed eradication, establishment of nest boxes and others can be used to enhance conservation values in unmined areas of the lease, and provide the sources of recruitment over the longer term. Local conservation groups are a good source of information on what initiatives might prove the most cost-effective.

- *Opportunities for development of biodiversity offsets*: Modules 1, 2 and the White Paper discuss the general principles in relation to Biodiversity Offsets. These provide an excellent opportunity for integrating mine rehabilitation into regional conservation planning strategies. Examples of Biodiversity Offsets that can enhance local conservation values include protection and rehabilitation of degraded areas (e.g. forests, wetlands), establishment of corridors joining remnant vegetation, and revegetating streamside areas to enhance aquatic biodiversity.

- *Minimising secondary impacts*: Some rehabilitation objectives should focus on minimising secondary impacts of the mining operation, for example by controlling erosion which could increase downstream sediment loads, affecting aquatic biota.

- *Other opportunities for biodiversity improvement*: Discussions with stakeholders prior to the setting of rehabilitation objectives will also reveal other related opportunities for biodiversity improvement that the community may not have the technical or financial resources to implement. Initiatives the company should consider undertaking might include the donation of plants or seed to schools and community groups for local revegetation projects; provision of training programmes on rehabilitation and managing conservation values; communication (through newsletters); and sponsorship of species management and recovery plans. A very good example of a large-scale rehabilitation project that would not have been possible without the combined resources and expertise of mining companies, Government agencies and community groups is the Cornwall Heathland Project (see case study)

Key

Planning

Closure Planning

Case Study: Using Partnerships to Restore Heathland Biodiversity. The Cornwall Heathland Project, Cornwall, United Kingdom

Cornwall's heathland is an ancient semi-natural landscape that has resulted from thousands of years of man's stewardship. It is now highly valued for its biodiversity and landscape attributes. These include its characteristic flora species such as heather *Calluna vulgaris*, and other ericoid species including cross-leaved heath *Erica tetralix* and Cornish heath *Erica vagans*, as well as fauna species such as the nightjar, woodlark and the Dartford warbler and invertebrates which number in the order of over 4,000 species. Unfortunately, the 80,000ha of lowland heath present in Cornwall in 1800 had diminished to less than 7,000 by 1997. Nevertheless, the county still contains 11% of the UK total, which itself represents about 2% of the world total[1].

Formerly valued as an agricultural resource for extensive grazing, Cornwall's heathland landscape went through a period of decline and dereliction during the 19th and 20th centuries, largely due to fundamental changes in land use and economics. Other causes have included unsuitable burning regimes, public access, and mining, whilst today the biggest losses are due to lack of management. Cornwall's china clay mining industry is more than 250 years old, and remains an important part of the county's economy. Current mining operations, utilizing open cast (cut) systems, have a product to waste ratio of 9 tonnes of overburden waste material for every tonne of clay gained. Due to the limited opportunities for backfilling this overburden, which consists predominantly of sand, gravel and stent (unkaolinised rock), is mostly tipped into above-ground tips. Over the years, these tips have grown to occupy 2,200ha in the St. Austell China Clay Area[2]. Increasing concern regarding the cumulative impacts, together with advances in mine rehabilitation technology, led the industry to recognise the potential for reversing this decline through a landscape-scale rehabilitation and restoration programme[3].

The opportunity to implement such a programme emerged in the mid-1990s following the development of the UK's Biodiversity Action Plan (BAP), which highlighted the severity of the lowland heath decline and set targets for its restoration and re-creation. With funding from the Heritage Lottery Fund, projects such as Putting Back the Wild Heart of Cornwall, costing £2.4 million, could commence. Partnerships were established between English Nature, the Cornwall County Council, and the china clay mining companies Imerys and Goonvean.


Respreading topsoil on reshaped

Case Study: Using Partnerships to Restore Heathland Biodiversity. The Cornwall Heathland Project, Cornwall, United Kingdom, cont

A Lowland Heathland Local Area Biodiversity Action Plan was developed for Cornwall1, and was implemented using a sustainable development approach. The project has now resulted in the establishment of 750ha of lowland heath on former mine tips. This has involved the reshaping of spoil heaps to reflect the local topography wherever possible. Based on earlier trials carried out by Liverpool University, Imerys, their consultants Wardell-Armstrong, and English Nature, heathland vegetation has been established by transferring topsoil from areas about to be mined, and re-spread on prepared donor sites. Building on this earlier work, key partners Imerys and English Nature have now developed non-destructive and highly cost-effective techniques that involve seed collection, preparation and spreading using hydroseeding techniques. With the help of volunteers, and through reintroducing appropriate management techniques, a further 1100ha of previously degraded heathland Sites of Special Scientific Interest have also been restored.

After six years, re-establishment of heathland biodiversity has been very successful, with third party verification showing that the project has met 12% of the total UK BAP target for heathland re-creation


Four year old rehabilitation

Meeting the project's objectives would not have been possible without utilizing the partnership approach, which combined the administrative, technical, financial andlabour resources of the participants. As well as the significant conservation benefits, the project has resulted in important socio-economic and heritageoutcomes by rejuvenating local communities, re-establishing sustainable, traditional grazing for 'heathland' beef cattle, and providing valuable education, recreation and tourism opportunities. Impetus from the project has continued, with 800ha of broadleaf woodland currently being restored.

Communities located in areas where there is a long history of mining impacts on conservation values, and where rehabilitation outcomes may be beyond the scope of any single company or institution, would do well to consider utilizing a sustainable development partnership approach similar to that adopted for the Cornwall Heathland Project.

(Information used in this Case Study was provided by Ian Davies (English Nature), Phil Putwain (University of Liverpool), Nick Coppin (Wardell-Armstrong) and Colin Grigg (Imerys). The photographs were taken by Phil Putwain (Copyright)).

[1] Lowland Heathland Local Biodiversity Action Plan website: http://www/swbiodiversity.org.uk/Habitats/Low_heath/low_heath_cornwall.htm [2] Cornwall Country Council Web site: http://www.cornwall.gov.uk/Environment/mlp07.htm
[3] Grigg, C.F.J, Coppin, N.J., Box, J.D. and Davies, I. (1998) Re-creation of heathland habitats in the China Clay mining area of Cornwall. In: Fox, H.R., Moore, H.m. and McIntosh, A.D. (Eds.) Land Reclamation: Achieving Sustainable Benefits. Pp. 131 – 136. A.A. Balkema Press, Rotterdam.

Key

Planning

Closure Planning

An example of a generic rehabilitation objective relating to biodiversity is:

'To establish a sustainable native ecosystem that is as similar to the pre-existing ecosystem as can be achieved within the limits of recognised good practice rehabilitation techniques and the post-mining environment'.

This objective commits the company to implementing good practice rehabilitation aimed to re-establish pre-existing conservation values, but acknowledges that aspects beyond the mine's control (e.g. altered soil, topographical and hydrological characteristics) might limit the extent to which this can be done. Progress towards achieving this objective can be measured by comparing biodiversity parameters in the rehabilitated area with those in selected unmined reference sites.

It is important to recognise that floral and faunal diversity in some unmined and relatively undisturbed native ecosystems is not necessarily very high. For some ecosystems this may be true at any time, whilst in others it may be the case at certain successional stages. For example, species numbers of birds and plants in some forest and rain forest ecosystems may be greater in particular disturbed areas (e.g. edges) than in the 'climax' vegetation community. These situations need to be taken into account when developing rehabilitation objectives; the most diverse ecosystem attainable may not necessarily be the most appropriate target in all cases.

Other additional objectives may address more specific aspects, such as the provision of habitat for rare or uncommon species.

It is important not to raise false expectations amongst stakeholders. Check what other mines have achieved, and what recent research indicates is possible. Local revegetation projects carried out by volunteer groups might also provide useful information on the re-establishment of native vegetation.

Whilst many mining companies have achieved remarkable results in re-establishing native ecosystems, where cost or other site-limiting factors make this impractical, other objectives that still provide biodiversity values should be considered. Examples might include:

- Revegetation using important functional species (e.g. for erosion control, nitrogen fixation), those with aesthetic value, and any local species important for biodiversity conservation that it is practical to establish;

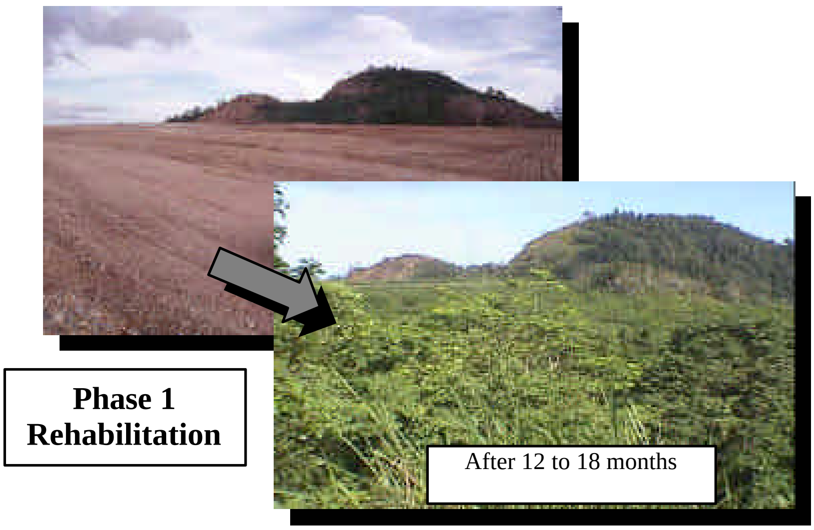
- Situations where other land uses such as the production of foods, medicines or cultural values (see case study Misima Mines Limited) are a priority – in these instances, re-establishment of biodiversity values may be a secondary but compatible objective;

Case Study: Sustainable Multiple Land Uses in a Tropical Rain Forest, Misima Mines Limited (MML), Papua New Guinea

Placer Dome Asia Pacific's Misima Mine is located on the island of Misima, some 600km east of the Papua New Guinea capital city of Port Moresby. The climate is tropical with high temperatures and average rainfall of 3,000mm/year. The original vegetation was predominantly wet tropical rain forest; however, there are now substantial areas of secondary growth comprising regrowth forest (following logging to produce timber for early mining activities) and old 'gardens' (cleared patches locals used for subsistence gardens). The forest and secondary vegetation are utilised by local Misiman villagers as a source of building timbers, wood for carving, food (edible fruits and nuts, hunting and egg collecting), flowers for decoration, medicinal and ceremonial fruits and leaves.

Artisinal mining commenced in the 1880s, with Misima Mines developing a modern open-cut mining operation in the 1980s. The mine is now in the final stages of closure, and serves as a good example of how biodiversity considerations can be integrated into closure planning to meet the socioeconomic and cultural needs of the local population. Misima Mines recognised that complete restoration of the pre-impact ecosystem was not a realistic objective. Through extensive consultation with the PNG Government and the community, the company developed a rehabilitation strategy designed to meet both the requirements of the local people in terms of garden land and forest products, and environmental goals such as long-term stability, biodiversity and ecosystem resilience. The objective of the revegetation programme is 'To form a stable, biologically diverse and resilient ecosystem that is productive for future generations, either as forest or subsistence agricultural land'.

Revegetation of mine dumps is accomplished in three stages, using locals employed from the clan to which the land will revert. Stabilisation involves the rapid establishment of grass and legume ground covers to protect the soil from erosion. These also produce organic matter and build up soil nitrogen. Phase 1 Planting consists of establishing 12 rapid growing species of shade trees that can tolerate the relatively exposed conditions. Finally, after 3-4 years, the trees form a dense canopy which reduces the density of groundcover plants and allows Phase 2 Planting of 'climax' forest tree species to take place. Recognising the importance of botanical diversity in the forest, MML plant around 70 different tree species, propagated in the local nursery.



Case Study: Sustainable Multiple Land Uses in a Tropical Rain Forest, Misima Mines Limited (MML), Papua New Guinea, cont

Progressive rehabilitation has meant that, at the time milling operations ceased in May 2004, 80% of disturbed areas had already been rehabilitated. Over time, colonisation from unmined areas will increase the number of species present, resulting in biodiversity objectives being met, and the development of a sustainable forest capable of providing for the community's needs. However, it is acknowledged that sites will not be able to be utilised as gardens in the near future until soil nutrients reestablish to levels suitable for supporting garden activities. A monitoring programme has been implemented to assess progress towards the long-term rehabilitation objectives. Training and research programmes have been established to provide the community with the knowledge and skills necessary to sustainably manage the forest in conjunction with other commercial agricultural cash crops such as coconuts, vanilla and bananas.

Phase 2 Rehabilitation

(Information for this case study was provided by Misima Mines Ltd. Further information on the rehabilitation and the community development programmemes implemented by MML can be obtained from www.placedome.com/operations/misima/misima.html)

- Focusing on the re-establishment of key species, such as rare or threatened plant species, or developing habitat suitable for the recolonisation of rare or threatened fauna species; and

- Where technical limitations prevent the establishment of native ecosystems, an objective may simply be to establish rehabilitation that is stable, sustainable, and includes the use of native species where possible. Examples of this might include the surface of a tailings dam, where soil structure and chemistry are very different from those of nearby unmined areas. Nevertheless, every effort should be made to construct a soil profile suitable for plant growth, and establish local native plant species that will replace some biodiversity whilst still fulfilling critical functions such as erosion protection and water uptake.

Key

Planning

Closure Planning

Frequently, no specific time limits are given by which rehabilitation objectives must be met. This is a matter for discussion between the company, regulators and other stakeholders. Valid reasons for the uncertainty include unpredictable weather, and limited experience in relation to successional processes in the site's specific post-mining environment. The recommended approach is to establish monitoring and research programmes (Section 4.5) and draft completion criteria (Section 4.6) and agree to review the situation after a designated time period, say 5 or 10 years. This could be less if extensive information is already available, or more if there is little pre-existing information on post-mining succession. It will also depend on the speed of relevant ecological successional processes in the bioregion.

Companies sometimes set more challenging internal objectives than those they publicly commit to. This is to be encouraged, as part of the continuous improvement process. However, it should be made clear that factors beyond the company's control (e.g. weather, technical limitations unknown at the time) may prevent them being attained.

When setting rehabilitation objectives, the company must always take into account what management requirements will be needed to sustain the conservation values in the long-term, who will be responsible for managing them, and how the costs of management will be funded?

4.2.3 *Rehabilitation Plan*

Once objectives and targets have been set, a rehabilitation plan should be produced. This is an integral part of the overall Mining Plan, and the more general Closure Strategy and Plan (which covers all aspects of mine closure) discussed in Section 4.2.1. It will clearly explain to Government regulators and other stakeholders how the company intends to carry out the rehabilitation programme, in order to meet the agreed objectives. Regulatory authorities can use this to determine whether the proposed methods are likely to work, and offer helpful advice regarding alternative methods or new developments. The plan must contain sufficient detail so that, when mining is complete, it will enable company auditors, regulators and any other stakeholders to assess whether rehabilitation operations have been carried out as agreed.

Key

Planning

Closure Planning

As with the objectives and targets set in Section 4.2.2, the rehabilitation plan should be developed taking into account:

- All relevant information on pre-mining and likely post-mining landforms, soils, waste material characteristics, hydrology, land uses, and other biodiversity aspects relevant to rehabilitation;

- The need for clean-up and decontamination of sites, e.g. areas near workshops, where hydrocarbon spills have occurred;

- Any technical limitations posed by the above;

- Pre-mining flora and fauna surveys, and data from established reference monitoring sites; and

- Sustainable financing for rehabilitation management and all related conservation initiatives and offsets.

The rehabilitation plan should describe the final land use(s) and all objectives and targets, and contain full details of:

- Soil and overburden materials handling, to ensure that growth media favourable to plant establishment, and potential problem materials (e.g. acid drainage generating, high metal levels, saline soils, potentially dispersive material) are placed in the correct sequence.

- Topsoil handling procedures, especially those designed to conserve plant propagules, nutrients and soil biota;

- Soil amelioration techniques, e.g. application of lime or gypsum;

- Any techniques for conserving and re-using vegetation, including mulch, brush matting for erosion protection and introduction of seed, log piles for fauna habitat etc.;

- Landscaping procedures, including the construction of erosion control and water management structures;

- Vegetation establishment techniques;

- Weed control measures prior to, and following rehabilitation;

- Fertiliser application; and

- Follow-up planting and maintenance programmemes.

Key

Site Preparation

Closure Planning

The plan should include timing details, and take into account any opportunities for progressive rehabilitation and closure. From a biodiversity conservation and re-establishment point of view, it is particularly important that the extent of disturbed areas is minimised at any point in time.

The rehabilitation plan should be reviewed periodically, as further information on site conditions becomes available, and new rehabilitation procedures are developed.

Commitment to implementing the plan is critical. The best objectives will not be met if all relevant company staff do not understand how, when and why the procedures described in the rehabilitation plan are to be carried out. It is essential that environmental staff and mine planning and operations staff attend the same meetings so that details such as topsoil handling strategies, availability of mining machinery (e.g. dozers and scrapers), location of future waste dumps (e.g. not on existing rehabilitation – unless it needs fixing!), handling of dispersive and acid generating materials are addressed. This might sound obvious, but it doesn't always happen.

A good example of effective mine planning is that of Alcoa World Alumina Australia, which uses a GIS to integrate information on pre-mining conservation values, optimal mining strategies to minimise impacts, and the rehabilitation programme. Rehabilitation Plans are developed in September each year, and from these Soil Movement Plans are prepared. Procedures such as seeding are planned 2-3 years in advance so that adequate seed is available. Work Instructions document how rehabilitation operations are to be carried out, and a checklist based on the requirements of the Rehabilitation Plan is used to confirm that these have been completed to specifications.

4.3 SITE PREPARATION

Implementation Guidance

Successful rehabilitation programmes are always well planned and well organised and should include:

- A detailed revegetation programme providing internal operating detail that staff will need to implement rehabilitation plan; and
- Effective site preparation prior to seeding or planting to ensure optimal conditions exist for establishment of healthy biodiverse vegetation.

Key

Site Preparation

Closure Planning

4.3.1 *Detailed Revegetation Programme*

Once the Rehabilitation Plan has been prepared and agreed to by regulatory authorities and other stakeholders, a detailed revegetation programme must be prepared. This provides the internal operating detail that company staff will need to implement the Plan, and it will determine staff, equipment and budgetary requirements. For example, it will include details of topsoil sources, stripping depths, volumes, handling methods, placement and scheduling. Areas where soil amelioration is needed will be mapped, and details of what is required described. It will describe what plant species and vegetation communities will be established, so that the most appropriate species are used in each area, e.g. sites prone to waterlogging, tailings capping, sustainable vegetation cover to prevent erosion on tailings batters and steep slopes, and species tolerant to low pH, high salinity etc. where these occur.

The programme will need to outline the methods of obtaining and introducing plant propagules. If planting of seedlings is to be used, collection of seeds or cuttings, and growing them in a nursery to a suitable size for planting will need to commence several years before they are actually planted out.

If seeding is used, the revegetation programme must address requirements for seed collection, processing, storage and treatment. Planning for seed collection will need to commence at least 1-2 years before the seed is actually used, so that the volumes needed, and collection sources, can be identified. Wherever possible, local species should be used, and seed should be collected locally, because it will usually be best adapted to the conditions and this will avoid introducing different genetic provenances. After collection, seed must be cleaned and stored under conditions that will maintain maximum viability over the period of storage, and minimise damage due to pests, fungi etc. Any known seed treatment (e.g. treatment for dormancy, rhizobium inoculation, lime pelleting) that may be required, should be described in the revegetation programme. Quality control of the whole seed collecting programme is vitally important to maximise the cost-effectiveness of the seeding operation.

4.3.2 *Effective Site Preparation*

In the context of this Module, effective site preparation refers to the procedures that must take place prior to seeding or planting, in order to ensure that optimal conditions exist for the establishment of healthy, botanically diverse and sustainable vegetation. The procedures will include soil and waste characterisation, selective handling of materials, construction of stable landforms, topsoil handling, ripping, fertilising and soil amendment, and seed bed preparation (e.g. scarifying). Each of these is discussed briefly below.

Key

Site Preparation

Closure Planning

Soil and waste characterisation: The characteristics of soils and waste material are one of the primary determinants of rehabilitation success. Below is a checklist of the properties of substrates known to affect plant growth.

Physical properties:

- Available water capacity
- Infiltration and hydraulic conductivity
- Aeration
- Mechanical impedance

Chemical properties:

- Nutrient availability
- pH
- Sulfide content
- Bioavailability of toxic elements
- Salinity

Microbiological properties:

- Nitrogen fixation (Rhizobium)
- Nutrient uptake (Mycorrhiza)
- Nutrient cycling

It is imperative that the person responsible for the rehabilitation programme understands which of these characteristics may need to be addressed as part of the rehabilitation programme. As early as possible during the life of the mine, soil types and horizons which should be conserved for establishing a post-mining surface medium capable of supporting a self-sustaining vegetative cover should be identified (see Bell 2002a, 2004). This will enable determination of potential plant growth limitations of soils conserved, and possible ameliorative treatments that may be required. Based on these, a soil handling programme for sustainable ecosystem reconstruction can then be planned. The composition of overburden material is also important, because some of this will become the spoil material below the topsoil, into which the plant roots will grow. Overburden material capable of supporting vegetative growth, and which could be used in the root zone, will therefore need to be identified. In some sites, materials toxic to plant growth may be present, and the location and characteristics of these need to be determined. From this, an overburden handling programme for sustainable ecosystem reconstruction can be planned. At other mines, soils contaminated by spills of toxic materials may be present. Prior to rehabilitation, appropriate remediation and management strategies need to be implemented such as those described in the booklet http://www.deh.gov.au/industry/industry-performance/minerals/booklets/contam/index.html

Key

Site Preparation

Closure Planning

Selective handling of materials: Overburden material not suitable for plant growth will need to be buried at a depth below the plant rooting zone. Examples of this could include the deep placement of sulfidic waste prone to generation of acid drainage, and layering of acid- and alkali- producing materials. More favourable materials, such as the surface oxidized zone and any with physical and chemical characteristics suitable for supporting plant growth, can be placed on the surface prior to covering with topsoil (if available). For soils, characterisation will identify those that will be retained, as well as the selected horizons for stripping, and volumes available. This will enable the topsoil handling operations to be planned, as described below.

Construction of stable landforms: Landform stability is critical for the long-term sustainability of rehabilitation. Poorly constructed landforms can result in erosion that severely impacts both the revegetation, and downstream biota.

Constructed landforms should, where possible, blend in with natural landforms. Where this is not possible, they must be designed to minimise erosion through careful design of slopes according to soil type, the use of erosion control structures, and in some cases, matting or spray-on protection, e.g. to prevent wind erosion on heavy mineral sand mines. For practical details of landform construction see Minerals Council of Australia (1998).

Topsoil handling: Topsoil is the surface horizon, which is usually a dark layer enriched in organic matter, nutrients and seeds compared to lower layers. Depending on its properties, the topsoil, identified and characterised as described above, can serve a number of important functions such as the supply of seed and other propagules, contribution of beneficial microorganisms, supply of nutrients, rapid development of groundcover, and the amelioration of adverse properties in the underlying material. All topsoil is important; however, as a general rule, the better the quality of topsoil, the more important it is to conserve its properties and replace them following construction of the post-mining landform. In any case, the topsoil handling plan will need to address topsoil sources, collecting depth, volumes and handling equipment needed, respreading depth, and any follow-up treatment (e.g. scarifying prior to seeding).

Where direct return is prohibitively expensive (e.g. due to long haul distances), topsoil may need to be stockpiled. In such cases, stockpiles should be constructed to minimise deterioration of seed, nutrients and soil biota. This can be achieved by avoiding collecting topsoil when saturated following rainfall (this will promote composting), creating stockpiles of lower height (1-2m), seeding them with a cover of native vegetation (preferably N-fixing legumes) and minimising the duration of stockpiling.

Key

Rehabilitation Operations

Closure

Use of topsoil can, in some cases, confer disadvantages in relation to the establishment of native vegetation. These can include the cost of handling, risk of weed infestation, greater erosion hazard of some soil types, and an increase in the area of land disturbed if needed for stockpiles, or if borrow pits are needed to obtain sufficient material.

All of these factors need to be taken into account when developing a soil handling plan that will maximise the opportunities for re-establishment of a diverse vegetation community.

Ripping, fertilising and soil amendment: Ripping along contour will usually be required to facilitate root penetration through compacted spoil material, and confer protection against erosion. Fertilising will also be required in most cases to replace the nutrient bank lost during the mining process. It is essential that the types and methods of application of nutrients are carefully planned, based on soil characterisation studies and rehabilitation objectives and targets. Inorganic fertilisers are most commonly used; however organic fertilisers such as sewage sludge or vegetation mulch can be a cost-effective alternative as long as they provide the nutrients required and care is taken not to introduce weeds and high concentrations of metals which may occur in sewage from urban and industrial areas. For some soils, the use of amendments such as gypsum or lime will also be required. A detailed overview of how to deal with chemical limitations to plant growth (e.g. nutrient deficiencies, toxicities etc.) is given in Bell (2002b).

4.4 REHABILITATION OPERATIONS

Implementation Guidance

- Handle topsoil during rehabilitation operations in a manner that will conserve plant diversity in the soil seed bank and maximise plant establishment after respreading.
- If pre-mining surveys identify the presence of problem weeds, a weed control programme will be required.
- If feral predators or grazing stock problems are likely, a fauna management plan will be required.
- To achieve the desired botanical diversity, successional aspects must be considered when rehabilitating.
- Good seeding practice is critical to successful rehabilitation for many mines.

Key

Rehabilitation Operations

Closure

- Follow-up maintenance of plantings may be necessary and monitoring is essential to gauge the success of the methods employed.

- The use of planting to establish botanical diversity may provide good opportunities for involving other stakeholders.

- Fauna return to rehabilitated areas should be encouraged by the provision of suitable habitat.

4.4.1 *Introduction*

Good practice rehabilitation operations should usually be integrated to include the components described in the following sections. It is important to note that there will be opportunities to train and employ locals in many aspects of the rehabilitation operations, such as seed collecting, nursery work, planting, and operating equipment. Using the traditional ecological knowledge of local indigenous people can also be of significant benefit to biodiversity management programmes. Useful guidelines on good practice rehabilitation are given in http://www.deh.gov.au/industry/industry-performance/minerals/booklets/rehab.html and the references.

4.4.2 *Topsoil Handling*

General aspects pertaining to topsoil handling are discussed in Section 4.3.2 above. Specific considerations for handling topsoil during rehabilitation operations in a manner that will conserve plant diversity in the soil seed bank and maximise plant establishment after respreading include:

- Collecting topsoil at a time of year when the soil seed bank is likely to be highest;

- Taking into account the effects of burning vegetation prior to mining, if this is likely to influence seed survival or germinability;

- Optimising the depth of collection to ensure that most seed and nutrients are collected, but avoiding excessive dilution (double stripping of hormones and replacement in order may be required to reduce dilution);

- Respreading the topsoil directly onto an area prepared for rehabilitation, where possible;

- Avoiding respreading topsoil too deep – most seeds can only germinate and emerge from relatively shallow depths (<50mm); In some instances, there may be benefit in putting back all of the A horizon, but in layers;

Key

Rehabilitation Operations

Closure

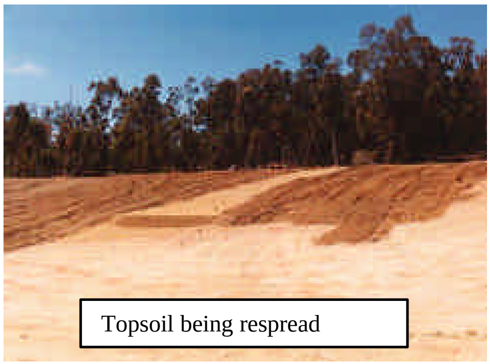
- Where the amount of topsoil available is limited, it is better to spread it at a thinner depth or in strips rather than cover one area and have none left for another;
- Any earthworks considerations, such as scarifying to 'key in' the topsoil and reduce the likelihood of it being lost through erosion. Care needs to be taken not to dilute the topsoil with spoil material.
- The final topsoil surface should be freshly disturbed and suitable for direct seeding, if this is to follow.

Field trials and research may be necessary to fine-tune some of the above aspects, such as the optimal depth for collecting and respreading, as this will vary depending on seed and soil type. An example of a topsoil handling programme that achieves very good results in terms of establishing a diverse vegetation community is that of Alcoa World Alumina Australia, shown in the case study below.

Case Study: Topsoil Handling to Establish Botanical Diversity, Alcoa World Alumina Australia

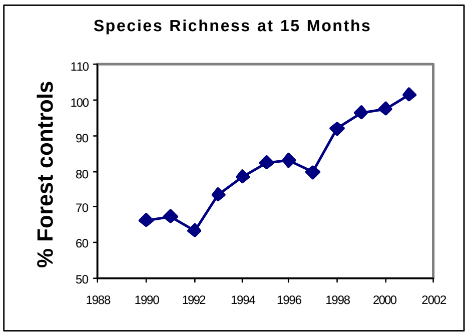
Where topsoil contains a viable native seed source, it should be conserved for re-use following mining. This not only provides a cheap source of plants, but helps ensure that they establish in relative abundances that reflect pre-mining densities, and promotes establishment of species whose seed may be hard to obtain or difficult to germinate[1].


Stripping topsoil


Topsoil being respread

The bauxite mine rehabilitation programme conducted by Alcoa World Alumina Australia in the jarrah forest of south-western Australia is an excellent example of how conservation of the soil seed bank can significantly enhance the botanical diversity of the post-mining vegetation community. After vegetation is cleared, the top 150mm of soil, which contains most of the soil seed bank and nutrients, is stripped prior to mining and then directly returned to a pit about to be rehabilitated, wherever possible. Research has shown that the majority of native plant species (72%) on rehabilitated areas comes from seed stored in topsoil[2]. The importance of directly returning fresh topsoil has been demonstrated by trials comparing this technique with stockpiling[1]. These have shown that disturbance associated with direct return of topsoil results in loss of less than 50% of the seed contained in the pre-mining forest seed store; by contrast, stockpiling results in losses of 80-90%[3]. Other aspects, such as the depth of respreading topsoil, the season when the soil is handled and the timing of seeding, are also important. Seed will not survive if buried too deep[4], and persists better when the soil is moved during the dry season. Also, plant establishment from seeding is greater when the seed is applied to a freshly disturbed surface[2]. Together, the combined use of fresh topsoil return, seeding, and planting of 'recalcitrant' plants have now resulted in numbers of plant species at 15 months of age equal to those recorded in equivalent sized plots in unmined forest. For further information, see www.alcoa.com.au.

Case Study: Topsoil Handling to Establish Botanical Diversity, Alcoa World Alumina Australia, cont



2 year old rehabilitated bauxite mine

[1] Koch, J.M. and Ward, S.C. (1994) Establishment of understorey vegetation for rehabilitation of bauxite mined areas in the jarrah forest of south-western Australia. Journal of Environmental Management 41: 1-15. [2] Ward, S.C., Koch, J.M. and Ainsworth, G.L. (1996) The effect of timing of rehabilitation procedures on the establishment of a jarrah forest after bauxite mining. Restoration Ecology 4(1): 19-24. [3] Koch, J.M., Ward, S.C., Grant, C.D., and Ainsworth, G.L., (1996). Effects of bauxite mine restoration operations on topsoil seed reserves in the jarrah forest of Western Australia. Restoration Ecology 4(4), 368-376.

4.4.3 *Pest Plant and Animal Management*

A weed is a plant that does not belong in an area, and may cause problems by competing with local native plants, creating a fire hazard, poisoning stock etc. If pre-mining surveys identify the presence of problem weeds, a weed control programme must be developed. Animals can also cause significant problems to developing rehabilitation. Grazing stock may need to be excluded by fencing during the establishment period and possibly longer. Feral predators (e.g. foxes and cats in some countries) can significantly reduce numbers of native mammals, while introduced herbivores (e.g. rabbits, goats) can decimate newly established plants. If any of these problems are likely, a fauna management plan will be required. Government departments are usually a useful source of information on weed and feral fauna control. Grazing by native mammals can also be a problem, and may require the use of tree guards (sleeves protecting young plants) or other methods not harmful to the wildlife themselves.

Key

Rehabilitation Operations

Closure

4.4.4 *Plant Establishment*

To establish a diverse vegetation community, you will usually need to use a variety of methods. These might include the use of direct topsoil return, seeding, hydroseeding, planting of seedlings, tissue culture, transplanting, and natural recolonisation. The selected combination of methods will have been determined and described in general in the Rehabilitation Plan, and specific details outlined in the Revegetation Programme. The following sections describe important good practice aspects that need to be considered when implementing each of the establishment methods (apart from direct topsoil return, which has been described in Section 4.4.2).

4.4.5 *Seeding*

Seeding is often the most cost-effective means of establishing a range of native plant species over a large area; however it can be somewhat hit and miss if not carefully planned and implemented, and when unpredictable weather conditions follow seed spreading. The following aspects need to be taken into account to maximise the chances of success using seeding.

After storage, seed of many species may need to be treated to initiate germination. Treatment methods can include heat treatment, scarification, or exposure to smoke or smoked water. Sources of information on what methods might be needed include seed suppliers, research staff, and key references (e.g. Mortlock and Lloyd 2001). In areas where rainfall is unpredictable, it may be prudent not to treat all of the seed, so that some remains alive if follow-up rains do not occur.

The actual seeding rate will need to be determined through consultation with others, monitoring, and operational trials. Seed viability testing will help determine what rate might be necessary to achieve a desired plant density; however, mortality of young seedlings will need to be factored in, and this can be high, depending on the following rainfall. Higher seeding rates of some species will be necessary where erosion protection is critical.

To achieve the desired botanical diversity, successional aspects must be considered. Pioneer species that readily colonise disturbed areas should be included in the seed mix; however species characteristic of later successional stages should also be established early if experience proves this can be done successfully. Relative abundances of species will change as early colonisers die out and longer-lived species, or those that colonise later, become proportionally more dominant. High seeding rates of some early colonising species may reduce overall diversity by out competing other species. Care, and an element of trial and error, is therefore needed in determining the appropriate seeding rates for each species.

Key

Rehabilitation Operations

Closure

The actual methods of spreading seed will partly depend on what labour and equipment are available. They can include spreading by hand, by helicopter, agricultural seed spreader, or by the bulldozer doing the ripping. The method itself is not critical as long as it is likely to spread each species at the selected target rate. Some mechanical methods do not spread some seed types well.

The timing of seeding is critical and can vary significantly depending on local climatic conditions. Usually, the best time to seed is prior to reliable rainfall. However, recent research conducted by Alcoa (Ward et al. 1996) has demonstrated the importance of applying seed onto recently spread topsoil, even if this is months before the reliable rainfall arrives. Seeding success is almost always much higher when seed is applied to freshly disturbed soil compared with soil that has had time to develop a crust.

In some plant communities, such as heathlands, many plant species do not readily release their seeds. Reintroduction of these species can be achieved by collecting vegetation from areas being cleared for mining, and returning it directly to newly rehabilitated areas where it will release its seed and provide erosion protection.

Given the uncertainty that still exists in relation to many aspects of seeding, it is essential that rehabilitation is monitored (see Section 4.5) as this will provide the information needed to achieve continuous improvement in relation to the establishment of a diverse plant community.

In summary, good seeding practice is critical to successful rehabilitation for many mines. Considerable information is available on good practice seeding, but there is also a lot that is not known, due in part to the considerable variation between species and site conditions. As a general rule, it is probably correct to state that the companies that achieve the best outcomes establishing botanical diversity from seeding, are those that are committed to 'learn as they go', and thereby achieve continuous improvement.

4.4.6 *Hydroseeding*

Although more costly that conventional seeding, hydroseeding is sometimes needed to establish vegetation on steep road cuttings, batters and pit walls. It is usually carried out by a commercial contractor, and involves a hydroseeding machine that pumps out a slurry of seed, mulch (e.g. paper mulch), binding agent and water. Keys to successful hydroseeding include the selection of suitable species and seeding rates, and getting the mixing and application rates right.

4.4.7 *Planting of Seedlings*

Key

Rehabilitation Operations

Closure

The use of hand-planted seedlings has both advantages and disadvantages over direct seeding. Advantages include less wastage of seed, more accurate planting densities, better survival rates (in some but not all cases), and usually better survival where weed competition is a problem. Where rapid growth is important (e.g. when sustainable logging is one of the long-term rehabilitation objectives), planting seedlings can give plants a head start over direct seeding. Disadvantages include the higher costs associated with establishing a nursery (or buying plants from a commercial nursery), and the labour costs of hand planting. A decision will need to be made on which establishment methods are best suited to meeting the stated rehabilitation objectives. Many companies use a combination of seeding and planting, depending on the species.

Good practice rehabilitation using planting means that careful thought will have been given to sources of local plants, the age and size of the seedling when planted, site preparation, the planting method, and the time of planting in relation to climatic conditions.

Selecting the correct seedling size usually requires a compromise between smaller (cheaper to produce and handle) and larger (more advanced growth, better survival rate) plants. Local experience in nurseries and other mines and revegetation operations, such as landcare projects, will usually give some indication of the optimal seedling size for planting.

Effective site preparation is extremely important, and can include ripping (to reduce compaction and allow root penetration), mounding (in areas prone to waterlogging) and weed control.

Planting methods need to take into account safety, cost and establishing the plant in a manner that will maximise its chances of survival, as well as its well-being and growth. Safety issues are beyond the scope of this Module, but should address risks related to carrying, walking on uneven ground, exposure etc. Aspects to consider when deciding on the optimal planting method include:

- Whether to use planting tools or machines;
- Plant water availability, e.g. by planting the seedlings in the bottom of riplines into which scarce rainwater will flow;
- Whether to provide water to the plants either by physically watering or establishing a trickle reticulation system. Watering is rarely done on larger rehabilitation projects due to the prohibitively high costs and sometimes scarcity of water; however it may have a role in small areas where establishment would otherwise be extremely difficult;

- Planting seedlings on mounds where waterlogging is likely to be a problem;
- Providing protection from weed competition, e.g. by using spot spraying or weed mats;
- Providing the correct amount and type of fertiliser; and
- Providing protection from grazing of stock, feral herbivores and native mammals.

Key

Rehabilitation Operations

Closure

Follow-up maintenance of plantings may be necessary (Section 4.4.12), and monitoring (Section 4.5) is essential to gauge the success of the methods employed.

Using planting to establish botanical diversity may provide good opportunities for involving other stakeholders. Examples might include:

- Employing local indigenous people to collect seed and work in the nursery (see GEMCO case study);
- Getting schools and local conservation groups involved in the production of some plant species, and in planting of revegetated areas adjoining the mine (e.g. re-establishing streamside vegetation or corridors linking mine rehabilitation with remnant vegetation);
- Donating plants to worthy local biodiversity conservation projects.

As with any project involving non-company employees, care should be taken to ensure that work carried out by others meets accepted quality standards.

Case Study: Involving Traditional Owners in Seed Collecting and Rehabilitation Programmes, GEMCO Manganese Mine, Groote Eylandt, Northern Territory, Australia

Groote Eylandt Mining Company (GEMCO) mines manganese from a number of leases on the western coastal plain of Groote Eylandt. The island has an area of 2,260 km^2 and is wholly owned by the Anindilyakwa Aboriginal people. The mine is located in a part of Australia where knowledge of plant species is limited, and successful rehabilitation can be difficult. The company therefore looked to the traditional owners to assist in returning their land to the way it was.

In 1997, GEMCO committed to an employment and training programme for the Anidilyakwan people. The Aboriginal Employment Strategy has grown to now involve 25 local people carrying out most rehabilitation tasks on site, including all seed collection. This provides them with the skills to pursue a meaningful career with either GEMCO, the mainstream mining industry, or in the local community.

Case Study: Involving Traditional Owners in Seed Collecting and Rehabilitation Programmes, GEMCO Manganese Mine, Groote Eylandt, Northern Territory, Australia, cont

Rehabilitation of the open-cut mines commences with reshaping landforms, followed by double-stripping and fresh return of topsoil, and ripping to 1.6m to reduce compaction. Plant establishment involves using seeding and planting procedures designed to return a variety of plant species and densities that closely represent those found in the adjoining native forests.

The mine's location on an island means that it is important to use locally collected seed for all revegetation work, as plants grown from these seeds are better adapted to the local conditions. Some 25 species of local trees and shrubs are collected from the leases for direct seeding or the growing of seedlings for wet season planting.

The quantities of seed required each season is calculated from previous studies and available sites, and GEMCO relies on the local knowledge of employees to locate the seeds and know when is the optimum time for collection in a particular area.

Seed is collected most of the year, by hand from the ground or low shrubs, from taller shrubs using long-handled pickers or from trees utilising elevated work platforms. All seeds are cleaned to remove the husks, trash, flesh or other unwanted material which may inhibit germination. After cleaning and drying of the seeds, data are recorded on the location, weight and date of collection, the seed is treated with carbon dioxide to reduce insect attack, and vacuum sealed. The freshly packed seed is then placed into an air conditioned storage room to maximise long term viability. Significant training has been provided to allow these activities to be achieved in an efficient and professional manner.

The Aboriginal people are also responsible for all direct seeding and planting of seedlings on site along with all weed control. As the traditional owners of these lands, it is in their interest and gives them great pride to see their land returned to as close to its original form as possible.

Utilising the employees traditional knowledge of the local plants and the seasonal changes that affect seed collection in northern Australia has meant GEMCO is able to meet its seed requirements each year and know that those working to restore the forest see more in what they are doing than merely another job. The Rehabilitation Section of GEMCO has made vast improvements in rehabilitation practices over the past five years, winning several awards and recognition as carrying out best practice rehabilitation.

Maintaining 25 local full time employees within GEMCO has also meant vastly improved communication between the local traditional owners and the company, an important factor in maintaining good relationships.

(Information for this case study was provided by the Groote Eylandt Mining Company; the photographs are copyright GEMCO).

4.4.8 *Tissue Culture, Cuttings and Other Methods*

Key

Rehabilitation Operations

Closure

Some plant species are difficult or impossible to establish from seeds, and do not come up readily even when fresh topsoil is used. For these species, the only practical method of establishing them may be to use procedures such as tissue culture, cuttings and other methods. Production of cuttings may be relatively straightforward and inexpensive, and can be a viable option for some species in rain forest environments, for example. By contrast, tissue culture is relatively expensive and requires sophisticated equipment. It is usually only suitable for high priority species such as those that are rare or fulfil key functional roles, and/or where the priority is to establish, as far as practicable, the full range of species that occur in unmined reference sites. An example of the use of tissue culture and cuttings for establishing 'recalcitrant' plants is that of Alcoa World Alumina Australia which, in 2003, used these methods to produce and plant 184,000 plants of 23 different species at an average cost of around $US2.80 per plant in the ground.

4.4.9 *Transplanting*

Transplanting whole plants or clumps of plants can be a viable option in some circumstances. For example, Consolidated Rutile Limited uses this method to establish Grasstrees (*Xanthorrhoea johnsonii*) in rehabilitated areas of their heavy mineral sand mine on North Stradbroke Island in Queensland, Australia. The Grasstrees are an important component of the pre-mining ecosystem and serve as valuable fauna habitat. However, they are very slow-growing and, although they are included in the seed mix, plants would take many decades to reach maturity. The company has addressed this problem by using excavators and trucks to transplant whole plants, with a 90% success rate.

Transplanting is also an effective way of establishing wetland rushes and sedges. Seed can be difficult to obtain from many of these species, and fluctuating water levels can result in very low success rates from seeding. Transplanting of whole clumps at intervals along the waterline can be a much more reliable way of rapidly establishing fringing vegetation. A very good example of wetland creation can be seen at the Wildfowl and Wetland Trust's Barn Elms site in the London suburb of Barnes (see www.wwt.org.uk).

A final option similar to both of the above examples involves the collection and transplanting of whole clumps of plants in patches using, for example, a front-end loader. This can prove useful on a small scale where establishment of particular 'recalcitrant' species is a high priority.

Key

Monitor & Research

Closure

4.4.10 *Natural Recolonisation*

Surprisingly, many companies ignore the role of natural recolonisation. In many cases, over time, some native species colonise naturally through wind, water, or fauna (e.g. seed in bird droppings). There is little point in purchasing and applying seed of species that colonise naturally within an acceptable time frame. However, where natural colonisation takes a very long time, seeding or planting may be needed to establish some key species in order to meet rehabilitation objectives and stakeholders' expectations.

4.4.11 *Provision of Fauna Habitat*

Fauna return to rehabilitated areas should be encouraged by the provision of suitable habitat. Establishment of vegetation communities similar to those that existed prior to mining should ensure that most species would recolonise in time. With the exception of some created, isolated water bodies, natural fauna recolonisation is preferable to physically reintroducing animals, as there is no cost involved, and fauna will return when the habitat meets their requirements (which may not be the case if they are re-introduced too early). Some important aspects of fauna habitat re-establishment on rehabilitated mines are illustrated in case study from the Gregg River Mine in Canada.

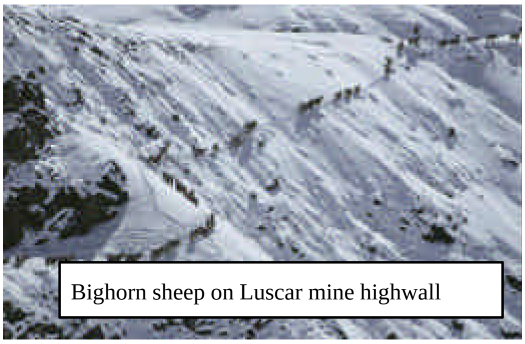
Case Study: Creating Wildlife Habitat, Gregg River Mine, Alberta, Canada

Luscar Ltd.'s Gregg River Mine is located adjacent to the Rocky Mountains in the Upper Foothills Subregion of western Alberta. Coal mining operations commenced in 1981 and were completed in 2000, with reclamation commencing in 1982 and continuing until 2004. The reclamation process involves reshaping spoil material, then covering it with 30-40cm of regolith and topsoil, followed by revegetation[1]. The end land use was identified as watershed protection, wildlife habitat and commercial forestry[2].

Elk utilising forest edge.

The creation of wildlife habitat has been key objective of reclamation at both the Gregg River Mine, and also at the adjacent Luscar Mine, which was also partly owned by Luscar Ltd. until 2003. The key to success has been to assess the area's biodiversity, develop a sound understanding of each representative faunal group's habitat requirements, incorporate this into the reclamation programme, and monitor species use of created habitat so that adaptive management can take place[3]. Care must also be taken to maintain linkages to adjacent remnant habitat, to allow for species to recolonise when the habitat reaches the stage where it meets their requirements. Seasonal variation must also be considered, as many species' habitat requirements vary significantly between winter and summer. The differences in species preferred habitats are well illustrated by ungulates.

Reclamation of habitat for bighorn sheep has been particularly successful on both the Gregg River and Luscar Mines, with the reclaimed landscape used primarily as winter range but also for lambing, rutting and summer use. Newly established grassland and subalpine meadows provide grazing areas while retained sections of benched highwall provide escape from predators. The 2002 fall population for both mines combined was 798, one of the biggest herds in North America.



Bighorn sheep on Luscar mine highwall

Elk have colonised the Luscar Mine and, to a lesser extent, Gregg River.

They utilise the grassland/forest edge, and the suitability of habitat for them depends on forage quality, cover, and distance from the forest[3]. Mule deer are common at both mines and utilise forage/cover habitat in a similar fashion to elk.

Bighorn Elk on Luscar mine

The presence of a diverse prey base including these ungulates and many other smaller mammal species attract a range of predators. The gray wolf, coyote, red fox and grizzly bear have colonized both mines, while others such as wolverine, cougar and Canada Lynx have occasionally been recorded.

Techniques used to create habitat for other fauna species include construction of rock and brush piles, selecting plants for their forage and cover value, planting trees and shrubs on the lee side of shelters, and reconstructing stream channels and wetland habitats[4]. The techniques used range from the microhabitat scale up to broad landscape scale. Successful recolonisation by a diversity of wildlife is gradually being achieved by adopting an ecosystem approach to reclamation that focuses on species' habitat requirements. Information used in this Case Study was provided by Beth MacCallum (Bighorn Environmental Design Ltd.). The photographs were taken by Beth MacCallum and Owen Nichols (Copyright).

[1] Leskiw, L.A., Enzsol, T. and Zroback, R. (2001) Soil reclamation at the Gregg River Mine. In: Proceedings of the 25th Annual Canadian Land Reclamation Association and the 4th Annual International Affiliation of Land Reclamationists Meetings. September 17-20, 2000. Edmonton, Alberta. CD.

[2] Patriquin, D.L. and Komers, P. (2001) An Ecosystem Approach to Reclamation: The Gregg River Mine Experience. In: Proceedings of the 25th Annual Canadian Land Reclamation Association and the 4th Annual International Affiliation of Land Reclamationists Meetings. September 17-20, 2000. Edmonton, Alberta. CD.

[3] MacCallum, B. (2001) Wildlife response to reclamation in the Alberta foothills. In: Proceedings of the 25th Annual Canadian Land Reclamation Association and the 4th Annual International Affiliation of Land Reclamationists Meetings. September 17-20, 2000. Edmonton, Alberta. CD.

[4] MacCallum, B. (2002) Reclamation to wildlife habitat in Alberta's foothills. Paper presented at the British Columbia Reclamation Symposium, September 18, 2003.

Key

Monitor & Research

Closure

In some cases, key components of fauna species' habitat requirements may not be present in rehabilitation for many decades. Examples include:

- Hollows in trees, which many bird and mammal species use for shelter;
- Logs and log piles, which ground-dwelling species shelter in or under;
- Perches, used by raptors and other birds (who may introduce seeds);
- Old dead trees which provide hollows, crevices, exfoliating bark etc. – all useful shelter for many smaller reptile and invertebrate species;

A project entitled 'Innovative Techniques for Establishing Fauna Habitat Following Mining' has recently been completed by ACMER and provides practical advice on methods mining companies are using to establish these and other fauna habitats (see www.acmer.com.au).

4.4.12 Rehabilitation Maintenance and Management

Good practice rehabilitation to establish a diverse vegetation community does not end with the spreading of seed and planting of plants. Rehabilitated sites should regularly be inspected to confirm that plants are successfully establishing (see also Section 4.5) and determine what follow-up maintenance may be required. This will usually depend on a range of factors including rainfall, successional processes, presence of weeds etc. Where relevant, it may be necessary to carry out:

- Follow-up planting due to low survival. This will be necessary where survival rates of plants have been low due, for example, to drought, severe erosion, or overgrazing;
- Follow-up planting as part of normal succession. In rain forests, pioneer species are usually established first, followed by the planting of shade-tolerant species when a canopy has developed. This mimics the successional processes that occur when gaps develop due to trees falling and being replaced by secondary growth;
- Weed control will be required where there is a risk of weeds affecting survival of existing plants, or recruitment of other native plants; and
- Depending on soil nutrient stores and plant (e.g. tree) growth objectives, follow-up application of fertiliser may be required.

Other post-establishment management that it may be necessary to carry out could include:

- Maintenance of fences or other barriers to exclude stock and other grazing herbivores;

Key

Monitor & Research

Closure

- Control of public access where this may affect rehabilitation establishment; and
- Fire management.

These are just a few of the maintenance and management actions that may be required; they will vary considerably according to local environmental and socioeconomic conditions. Good practice rehabilitation standards require that the company identifies these requirements and provides sufficient labour and funding to carry them out. This forms an essential component of the Closure Strategy and Plan described in Section 4.2.1, and should be closely linked to the actual closure process described in Section 4.6.

4.5 MONITORING AND RESEARCH

Implementation Guidance

Good rehabilitation monitoring programmes must be designed in a manner that ensures they will fulfil their purpose as quality control checklists, demonstrate continuous improvement, and measure success of biodiversity initiatives. A rehabilitation programme must include:

- Baseline and ongoing monitoring of unmined reference areas;
- Documentation of the rehabilitation procedures carried out;
- Initial Establishment Monitoring, which serves as the quality control step;
- Long Term Monitoring;
- Incorporate the principles of experimental design;
- Parameters or indicators that will be monitored;
- Selection and monitoring suitable reference sites; and
- Consider links to other monitoring programmes.

4.5.1 *Introduction*

Monitoring and research are essential but often-neglected components of good-practice rehabilitation for biodiversity establishment. The principal purposes of monitoring and research are to:

- Act as a quality control checklist to confirm that rehabilitation operations have been carried out according to agreed procedures;

Key

Monitor & Research

Closure

- Provide the data necessary for adaptive management; in other words, for a company to achieve the continuous improvement required as part of an ISO 14001-compatible EMS (see Module 2), it will need to obtain monitoring data on rehabilitation performance ('how is it going?'), and research data comparing methods of biodiversity establishment ('how can we improve it?');
- Reveal to the company and key stakeholders whether biodiversity objectives are being met – or will be within an acceptable time frame; and
- Assess long-term sustainability of rehabilitated areas under the proposed management regime.

Good rehabilitation monitoring programmes must therefore be designed in a manner that ensures they will fulfil the above purposes, as well as taking into account the practicalities of monitoring, cost and safety. They should contain the following four linked components:

- Baseline and ongoing monitoring of unmined reference areas established during pre-mining mapping and surveys (see Section 2.6), to define the values that need to be protected or replaced;

- Documentation of the rehabilitation procedures carried out; for example, details of topsoil sources and handling methods, seed mix composition, rates and application methods, densities of species planted, etc. – these are all critical for interpreting the findings of later rehabilitation monitoring results;

- Initial Establishment Monitoring, which serves as the quality control step. It is carried out soon after rehabilitation establishment operations have been completed, and records whether they have been carried out as required, and initial establishment success. It is recommended that you develop establishment targets and standards which, if not met, require that specified corrective actions be undertaken;

- Long Term Monitoring, which commences some time later; usually 2-3 years, depending on the rate of successional development in the region. Long-term monitoring evaluates the progress of rehabilitation towards fulfilling long-term land use objectives. It also provides the information needed to determine whether the rehabilitated ecosystem would be sustainable over the long term (see case study from Richards Bay Minerals, South Africa).When designing the monitoring programme, the following details should always be addressed:

Key

Closure & Completion

Closure

- Incorporate the principles of experimental design, ensuring that it is statistically valid where possible, taking into account aspects such as random sampling, sufficient replicates, and avoiding 'confounding' (i.e. where two factors may influence one outcome, making it impossible to determine the cause of an observed effect);

- Carefully select which parameters or indicators that will be monitored, so that in combination they will provide the information the mining company and other stakeholders require to assess rehabilitation performance and sustainability. These may include species richness and diversity, density of key flora and fauna species, similarity to unmined sites, and others;

- Select and monitor suitable reference sites as noted above. These should be located in unmined areas typical of the habitat affected, and that which is being restored or established, but safe from further mining disturbance. Monitoring reference sites provides ecosystem function and biodiversity information from a site likely to be functioning sustainably. Note that the term 'reference' site is commonly used because, in most cases, insufficient information will be available to set a goal of exactly matching a specific unmined site, particularly given the variability that exists between unmined sites and limitations of the post-mining environment. Instead, unmined monitoring sites are used for reference, to give guidance on the performance of rehabilitation over time; and

- Consider links to other monitoring programmes (e.g. soil development, nutrient cycling, fauna monitoring, timber and agricultural production) and also to research projects. In general, monitoring of rehabilitation should identify any problems, and then research should find ways of overcoming them.

Based on the above factors, a suitable, cost-effective monitoring programme should be designed and implemented, ensuring that there is sufficient commitment, skills and resources in the company for it to be carried out.

As with initial impact assessment, opportunities should be sought for involving the local community and indigenous people in monitoring, both from an employment point of view, and to incorporate their often substantial knowledge on local biodiversity. The benefits of this approach are being clearly demonstrated through a number of biodiversity management initiatives in central Australia, where the skills and knowledge of the local Aboriginal people are making a significant contribution to the biological surveys, and the development of species and fire management plans (see Nesbitt and Baker 2004).

Key

Closure & Completion

Closure

At the research level, ecosystem development and sustainable management projects carried out as part of University projects not only provide the company with useful information, but also at the same time provide graduates with valuable practical research experience.

4.6 CLOSURE AND COMPLETION CRITERIA

Implementation Guidance

- Ensure that all of the procedures integrated into the Closure Strategy and Plan have been carried out in order to achieve signoff with all regulatory authorities and any other stakeholders.
- Conservation and sustainable management of biodiversity values is an ongoing process.
- The Closure Strategy and Plan must include workable solutions to post-closure management and monitoring issues, that clearly define what needs to be done, and who is responsible for doing it.
- Completion criteria are an essential component of any mine rehabilitation and closure plan and should be based on the objectives and targets, and detailed discussion with regulatory authorities and all other key stakeholders.
- Good practice mine closure strategies will have clearly identified responsibilities for continuing conservation initiatives and maintaining conservation values, as well as the sources of funding required for these purposes.
- It is important that a condition of mine transfers is that the new company is legally required to meet all existing objectives, targets and completion criteria.

4.6.1 *The Mine Closure Process*

The actual mine closure and decommissioning process must ensure that all of the procedures discussed in Module 3 and integrated into the Closure Strategy and Plan have been carried out in order to achieve signoff with all regulatory authorities and any other stakeholders, whilst at the same time ensuring that biodiversity outcomes stipulated in the Plan have been achieved. This process will not only include rehabilitation of disturbed areas, but may also require decontamination of areas where spills have occurred, management of off-site impacts, reinstatment of drainage patterns to allow for wetland ecosystem recovery, and addressing any other impacts on biodiversity. A useful summary of issues that need to be addressed in the mine decommissioning process is given in the best practice booklet http://www.deh.gov.au/industry/industry-performance / minerals / booklets /mine/index.html

Key

Closure & Completion

Closure

Conservation and sustainable management of biodiversity values is an ongoing process. Following mine closure and lease relinquishment, all rehabilitated mined land will require management (see Section 4.4.12) and, for a period, monitoring. The Closure Strategy and Plan must therefore include workable solutions to post-closure management and monitoring issues, that clearly define what needs to be done, and who is responsible for doing it. In many instances this will require caveats to ensure that the subsequent landowner is committed to sustainable management of the area's environmental, social and economic values. Species recovery plans, for example, can extend beyond the life of the mine. Sources of funding for ongoing management costs also need to be identified, and in some cases, this may require the establishment of trusts from which funds can be accessed to cover these costs.

All aspects relating to closure and decommissioning should be clarified as early as possible in the planning and operational stages of the mine, through open and effective dialogue with regulators, the local community, indigenous groups and traditional owners, conservation NGOs, and any other stakeholders. However, in most instances, clarification of these details has to be an ongoing process because of changes in the location of ore bodies, land ownership, information available on biodiversity values, species status, economic and social aspects, and other factors.

4.6.2 *Development of Completion Criteria*

Completion criteria are an essential component of any mine rehabilitation and closure plan. They are needed so that the mining company, government regulators and other stakeholders can determine when all rehabilitation objectives have been fulfilled, and the lease can be relinquished without the subsequent landowner incurring any ongoing liability. Specific ecological completion criteria should:

- Indicate whether rehabilitation has been 'successful', by meeting all agreed objectives;
- Be used in the design of biodiversity monitoring and rehabilitation programmes, as noted in Section 4.5 (i.e. monitoring should determine whether they have been met, rehabilitation is the means of meeting them);
- Confirm that post-mining conservation values are likely to be sustained, if the land is managed correctly; and
- Define post-closure management requirements.

Key

Closure & Completion

Closure

The development of the actual criteria is a learning process, especially for biodiversity establishment. It will often not be possible to finalise the criteria until practical experience and monitoring demonstrate what can realistically be achieved. As well as being achievable, the criteria should be based on the objectives and targets noted in Section 4.2.2, and detailed discussion with regulatory authorities and all other key stakeholders.

When developing completion criteria, particular attention should be given to:

- Consultation with Government regulators and all other relevant stakeholders, especially the subsequent landholder(s); and
- Setting criteria for all stages of the mining operation: planning, rehabilitation establishment, rehabilitation development, and the final monitoring and maintenance phase.

Recognising that post-relinquishment management of the site's biodiversity will, in most cases, no longer be the mining company's responsibility, it is important that the closure strategy addresses all relevant who, what and how questions. Good practice mine closure strategies will have clearly identified responsibilities for continuing conservation initiatives and maintaining conservation values, as well as the sources of funding required for these purposes.

If, at any stage, the mining operation is sold or part of the mining lease is sub-leased to another company, all biodiversity management programmes, rehabilitation standards and other conservation initiatives must be maintained. It is therefore important that a condition of the transfer is that the new company is legally required to meet all existing objectives, targets and completion criteria.

4.7 LINKS INTO THE EMS AND THE OVERALL ENVIRONMENTAL MANAGEMENT PROGRAMME

Implementation Guidance

Good practice rehabilitation by any company requires the following:

- Effective integration of rehabilitation planning, operations and monitoring into an ISO 14001-compatible EMS.
- Effective communication.
- Corporate commitment to biodiversity conservation and re-establishment.
- Training programmes.
- Dedicated financial provisioning.
- Integration of biodiversity conservation initiatives on a whole-of-lease basis.

Establishment of native ecosystems through good practice rehabilitation does not happen by chance – it requires commitment and the co-ordinated efforts of the mining company's environmental, mining, accounting, public relations and other departments as well as effective liaison with government regulators and other stakeholders. Key aspects of mine rehabilitation and sustainable mine closure should all be documented in Mine Plans and in the Environmental Management Programme.

Key

Closure & Completion

Closure

Good practice rehabilitation by any company requires the following:

- Effective integration of rehabilitation planning, operations and monitoring into an ISO 14001-compatible EMS that includes clear objectives, stakeholder consultation, work instructions, monitoring, continuous improvement and management review (see Module 2). All are critical components of a well-managed rehabilitation programme.

- Effective communication must take place within the company through meetings and other fora to ensure that all employees clearly understand and are able to carry out their roles in relation to rehabilitation and mine closure.

- Corporate commitment to biodiversity conservation and re-establishment is essential. This commitment needs to be more than just publicly stated undertakings. It must also engender an awareness of the important role played by all levels of the workforce in biodiversity conservation, and their commitment to meeting rehabilitation objectives. This in turn must be backed up by the provision of adequate financial resources to ensure that the labour and equipment needed to carry out rehabilitation operations are available.

- Training programmes will be required to ensure that employees have the necessary technical skills required to carry out the rehabilitation programme.

- Dedicated financial provisioning is needed to complete rehabilitation operations through to lease relinquishment.

- Integration of biodiversity conservation initiatives on a whole-of-lease basis, or even in a regional context, can be enhanced through workforce and community awareness and training programmes. These can include tree planting days, training workshops, joint involvement in local volunteer projects and other initiatives.

Some companies have recently incorporated environmental milestones into their departmental Key Performance Indicators. Meeting these milestones translates into a greater annual salary bonus for all employees in the department. This provides a significant incentive to achieve good environmental performance.

Key

Closure & Completion

Closure

As part of its EMS and dedication to good practice environmental management, the company should undertake regular self-auditing that includes the addressing of biodiversity impacts and mitigation measures.

4.8 OTHER SOURCES OF INFORMATION

The above sections and case studies give a general overview of what constitutes good practice in relation to biodiversity considerations for mine rehabilitation and closure. However, because of the huge variation in mining operations, climate, soils and landforms, ecosystems, and socioeconomic aspects, it is impossible to provide the full amount of detail required to specifically tailor rehabilitation programmes to each mine's local conditions. It is therefore important that each company develops its own biodiversity conservation and rehabilitation programme, based on the guidance presented in Modules 1, 2 and 3.

Valuable local sources of information include government regulators, NGOs research organisations and the traditional ecological knowledge of local indigenous people. It is important that all of these are consulted.

The guidance provides a list of key references relevant to biodiversity conservation and rehabilitation aspects of mining operations. It is recommended that the reader consult these references, as they include comprehensive, up-to-date and relevant publications on the topics covered.

Case Study: Long-term Monitoring to Assess Ecosystem Development, Richards Bay Minerals, South Africa

Richards Bay Minerals (RBM), a company jointly owned by Rio Tinto and BHP Billiton, commenced mining for titanium and ferric minerals in coastal dunes northeast of Richards Bay in 1977. The natural vegetation in the area consists of subtropical coastal dune forests, an ecotype in the Maputaland centre of endemism. These are some of the last remaining contiguous dune forest patches in South Africa[1]. At the commencement of mining, the lease area comprised 60% plantations, 20% grassland and 20% coastal dune forest. Following discussions with the local landowner and Government, a decision was made to establish beefwood plantations for future development of a charcoal industry on the landward side of the dunes (about 66%) and to restore indigenous coastal forests on the seaward side (33%), to provide protection against erosion and allow for recruitment of plants and animals from an adjacent coastal strip left unmined for this purpose. The objective of RBM's dune forest rehabilitation programme is thus the restoration of the biodiversity and function of a typical coastal dune forest.

The mining method used is a dredging operation that progressively moves along dunes, reshaping and revegetating the dune behind the mining path. Rehabilitation of the reconstructed dunes is carried out by a local contractor who employs local staff. It involves the respreading of topsoil, followed by application of a seed mix containing native grass, herb, shrub and tree species as well as a cover crop, and then the construction of windbreaks for erosion protection. Assessment monitoring by RBM Supervision takes place during the initial months to confirm that rehabilitation operations have been carried out as required, and that seed is germinating and plants are establishing. Further monitoring of alien weeds is carried out by RBM Supervision and control methods used where necessary. Employees from the local communities are contracted to monitor and remove cattle from young rehabilitation.

Seeding annual plant species

Depending on the season, rainfall and aspect, the windbreaks can be removed after three to nine months. After 12 months the cover crop dies off leaving dense stands of indigenous grass and herbaceous species. Other indigenous species come from the topsoil. Gradually, Acacia kosiensis shrubs and other species develop into a woodland and forest plant and animal species start colonising[1]. At around 18-24 years, A. kosiensis begins to senesce, and tree species typical of adjacent unmined areas begin to occupy the canopy gaps[2].

Spreading topsoil (L) and 3 month old rehab (R)

The first rehabilitation was carried out in 1977.

There is therefore a long history of rehabilitation from which RBM has been able to learn a great deal in relation to the success of its methods. Monitoring and research programmes have been conducted since 1991. The developmental monitoring programme is designed to monitor time- or age-related changes in a number of ecological variables, chiefly focused on the structure and composition of the community, in three different biological trophic groups (plants, millipedes, and birds)[3]. The Ecological Restoration Research Programme is designed to complement and support the monitoring programme, specifically to investigate problems that may be identified through monitoring, as well as increase RBM's understanding of ecosystem restoration. Much of this has work been carried out by the University of Pretoria's Conservation Ecology Research Unit (CERU - see www.up.ac.za/academic/zoology/ceru), whose studies have focused on the development of plant and animal communities, and ecosystem function[1]. Key faunal groups studied have included millipedes[1,4,5], birds[6],[8], rodents[7],[8] and others. As a general rule, pioneer species of each of these groups colonise younger rehabilitation sites, whilst species typical of mature forest communities colonise later.


Approx. 20 year old rehabilitating

CERU assessed data from these studies against set criteria reflecting the compositional, structural and functional aspects of the regenerating ecosystem and concluded that rehabilitation is likely to be successful provided source areas remain intact[1]. This is because more than ten years of monitoring data show that, in general, the compositional and structural attributes of the regenerating tree, bird, rodent, millipede, dung beetle and herb assemblages, together with those of soil characteristics, are converging towards those typical of undisturbed forests in the region[9]. These communities also develop at least as fast or faster than the rate of development in naturally regenerating areas. Further time will be required for some components such as tree diversity and species composition, as well as faunal communities, to fully match those of unmined forests. However, this is expected to occur in time. The studies are continuing to provide RBM with information that is used as feedback for the rehabilitation programme, and will prove extremely valuable in the implementation of its sustainable mine closure strategy.

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(Information for this case study was provided by T. Wassenaar and R. Van Aarde (University of Pretoria's CERU) and R Kok (Richards Bay Minerals). See also www.richardsbayminerals.co.za. All photographs are copyright by Rudi Van Aarde.).

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Elliott, P., Gardner, J., Allen, D. and Butcher, G. (1996) **Completion criteria for Alcoa of Australia Limited's Bauxite Mine Rehabilitation**. 3rd International 21st Annual minerals Council of Australia Environmental Workshop. Pp 79-89.

Environment Australia's Best Practice Guidelines, particularly:

- Rehabilitation and revegetation:

http://www.deh.gov.au/industry/industry-performance/minerals/booklets/rehab.html

- Landform design:

http://www.deh.gov.au/industry/industry-performance/minerals/booklets/rehab.html

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