Objectives of the Module

Refer booklet: Introduction

This module illustrates how environment protection can form an integral part of the planning and design of mines with benefits to both the company and the community.

Learning Objectives of the Module

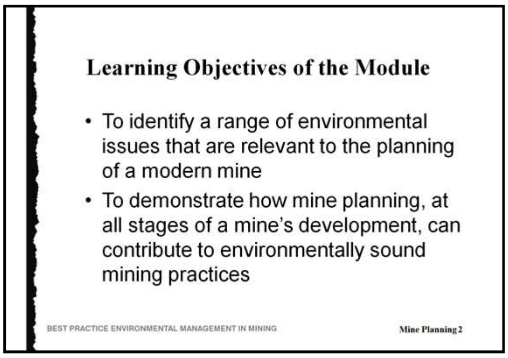
By the end of the session the participants will be able to:

- Identify a range of environmental issues that are relevant to the planning of a modern mine;
- Identify mine planning stages; and
- Explain how environmental safeguards can be introduced to mines to make them acceptable to local communities and to demonstrate how mining can coexist with other land uses.

Environmental issues must be considered at all stages of a mine's development including:

- Planning and concept development;
- Exploration;
- Approval processes;
- Development and construction;
- Operations; and
- Mine closure and rehabilitation.

Each mining project is unique in its combination of physical, social and resource opportunities and constraints. Nevertheless, the use of consistently appropriate mine planning is the most effective way to harmonise mining with the environment.



TIPS

Many aspects must be covered in the mine planning process. Most of the other booklets in the BPEM series are relevant to mine planning. Some of the key issues are covered in *Water Management, Cyanide Management, Tailings Containment and Rehabilitation and Revegetation.*

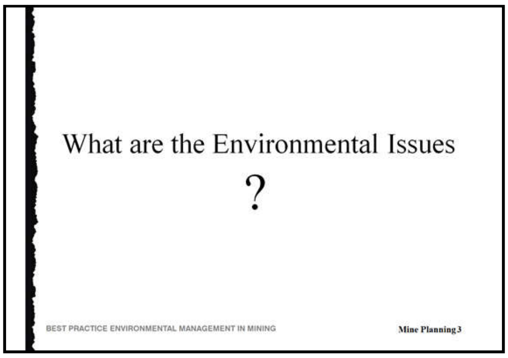
Defining Environmental Issues (i)

Refer booklet: Section 1

The first step in planning is to recognise the environmental issues that need to be faced in designing a feasible mine layout.

As well as the method and rate of mining, some of the issues to be considered during mine planning for environment protection include the location of mine infrastructure such as:

- Haul roads;
- Ventilation shafts;
- Surface facilities (offices, workshops, car parks, warehouses, hardstands, power station);
- Tailings and waste disposal areas and methods;
- Transport and service corridors (railway lines, roads, pipelines, conveyors, power, water and gas corridors);
- Product stockpiles;
- Ore processing facilities;
- Chemical and fuel storage; and
- Township and housing location.



TIPS

Exercise 1

This slide is deliberately blank.

- **Use the slide to pose the question for small group discussion.**
- **Ask the participants to think about and list the environmental issues that may be associated with mining activities.**
- **Each small group may record their responses on Worksheet 1 which gives an example to get them started.**
- **After a set time period of 10 to 15 minutes the groups will then report back. Write their responses on the white board or post the sheets of paper with their responses around the room.**
- **Compare the group responses with the next slide.**

For advice and information on how to conduct small group work see the *General Trainers' Guide* **in Volume 1.**

Defining Environmental Issues (ii)

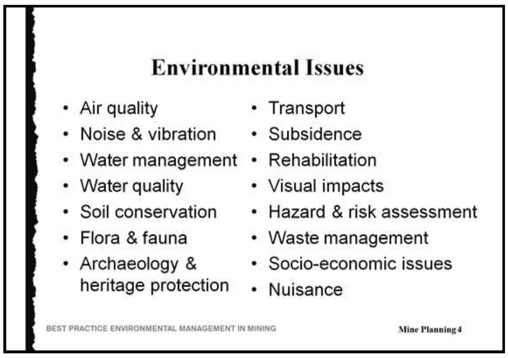
Refer booklet: Section 1

These are typical issues that should be considered by mine planners in conjunction with specialist scientists, engineers, planners, consultants and the community for the development of a mine and its associated infrastructure.

Determining the acceptability of environmental impacts is a complex and evolving process that includes careful consideration of and sometimes trade-offs between, community expectations, government requirements, financial constraints and technological and engineering feasibility.

These environmental issues are examined in turn in the following overheads.

The move toward using triple bottom line accounting takes into account economic, social and environmental costs and benefits of an operation.



TIPS

Show this slide after the group discussion. Some of the issues on the overhead will be on the list contributed by the participants. Congratulate them for their efforts.

There may be some issues on the slide which the group did not identify. Indicate these and ask the group if these issues are a problem at their mine.

There may also be issues identified by the groups that are not included in the slide. You may wish to add these to the topics for discussion.

Use group work to discuss the issues most relevant to your situation. The following slides provide prompts.

Air Quality

Refer booklet: Section 1.1

The main **air quality** issue associated with mining is dust particles.

Large concentrations of dust can be a health hazard.

High levels of dust deposition or concentrations may result in a loss of environmental amenity.

Visible dust plumes, especially from blasting, are classed as an aesthetic impact.

Dust deposition is measured by deposition gauges and reported in units of g/m^2 per month of dust fallout. Pre-mining background dust levels and total amounts of deposited dust are the usual measures against which limits are set.

Dust concentrations are monitored with mechanical, high volume air samplers and limits are placed on average and peak hourly values. Dust concentration standards are set to protect the respiratory health of workers and members of the community.

External air quality is rarely a problem for underground mines except for impacts from transport and storage and the management of slimes and tailings ponds.

Open-cut mining can create a dust nuisance if improperly planned.

Control measures include minimising the area of pre-stripping, properly constructed haul roads, minimising overburden haulage distances and rehabilitating mined land as soon as possible. At least 50% of transport- related dust can be eliminated by carefully watering haul roads.

Environmentally benign agglomerating or binding agents may also be suitable for use on haul road surfaces and ore stock-piles.

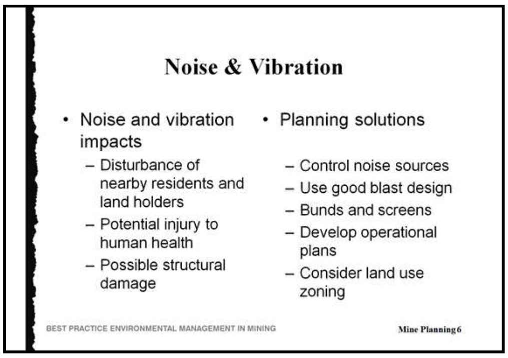
TIPS

- **Airborne particles smaller than 10 micrometres in size (PM_{10}) are small enough to penetrate deep into the lungs, causing health problems such as asthma, breathing difficulties or cancer. Acidic PM_{10} can also cause damage to human-made materials and is a major cause of reduced visibility.**
- **The Victorian EPA has set a one day standard for PM_{10} of 50 micrograms per cubic metre.**
- **The USEPA standard for PM_{10} is 50 micrograms per cubic metre, expressed as an annual mean, and 150 micrograms per cubic metre measured as a daily concentration.**
- **New studies suggest that fine particles (smaller than 2.5 micrometres in diameter) may cause serious health effects. As a result, the USEPA is considering setting a new standard for $PM_{2.5}$.**

The BPEM in Mining series includes a booklet on *Dust Control*. **If dust is a problem at your site, it may provide useful information.**

Noise and Vibration

Refer booklet: Section 1.2



TIPS

More information about noise and vibration mitigation measures can be found in the BPEM in Mining booklet *Noise, Vibration and Airblast Control.*

Noise can be an issue because mines normally operate 24 hours a day and sound levels can fluctuate widely.

Surface mines mainly generate noise from overburden excavation and transport. The major noise sources from underground mines are ventilation fans, the surface facilities and product transport as well as blasting for initial portal development.

Stringent noise requirements are normally applied to mines located near populated areas especially at night when nearby residents wish to relax or sleep.

Noise is measured on a logarithmic scale expressed in units of decibels. If two identical noise sources of 50dB are placed together the overall noise is 3 decibels higher. The decibel scale is commonly adjusted to an 'A' weighted scale to give a better correlation between perceived and measured noise levels. A noise perceived as being twice as loud would be 8 to 10 dB(A) higher than the initial noise level.

Background noise levels are defined as the noise level which is exceeded 90% of the time. Regulations typically limit peak noise levels to 5 to 10 dB(A) above background noise levels. Depending on the location of a mine, higher levels, up to 20dB(A) above background, may be permitted during construction because the duration of impacts is short.

Climatic conditions, such as thermal inversions, may affect the distance noise travels.

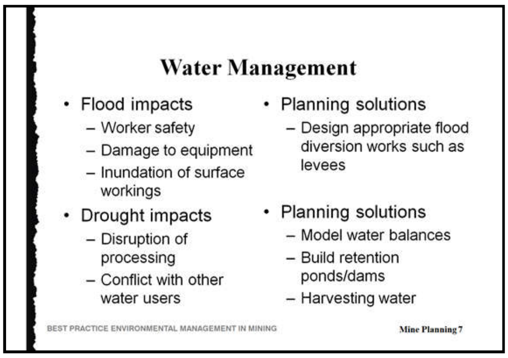
The construction of bunds or protective screens can reduce operational noise. These may be combined with noise attenuation materials to reduce fixed plant noise emissions and better operational planning for noise minimisation.

Planners limit blasting noise in the same way as dust, by distinguishing between the levels which would cause physical damage or injure human health from those that people find intrusive or annoying. Blast designs can reduce noise by limiting the maximum instantaneous charge detonated simultaneously, by using good quality stemming in drill holes and by eliminating surface detonation chord between adjacent charges.

Blast planning must also limit ground **vibration** to avoid damage to building structures and annoyance to people living in the area. Vibration limits for environmental amenity are usually set much lower than for structural damage.

Water Management (i)

Refer booklet: Section 1.3



Mine planners must consider how their facilities will cope with **floods**.

Extreme floods can inundate surface workings which may affect mining equipment, worker safety, the integrity of tailings dams and water emplacements and the continued operation of the mine.

Planners have conventionally planned for a 1 in 100 year flood event, but it is prudent to consider more extreme events up to the Probable Maximum Flood to assess the size of levees or other protection required.

The reliability of water supplies should be tested in both wet weather and drought.

Runoff during extended wet weather may exceed the capacity of normal water pollution controls, such as retention ponds and tailings dams. This may result in uncontrolled release of surface water.

In **droughts**, a lack of water can reduce the effectiveness of dust suppression and can ultimately disrupt ore processing.

A useful way to test mine performance is to model water balances using computer simulations based on long term meteorological data.

Harvesting water for mines can result in conflict with other water users, especially surrounding farms, and with environmental flow requirements.

Whether water is drawn from local rivers and/or harvested from site runoff, there is often a need to consider downstream water users.

Where excessive groundwater extraction causes nearby wells or bores to run dry, the mining company may need to provide alternative water supplies or offer to compensate for shortfalls to affected community members. This issue may be raised during community consultation. If groundwater extraction is planned then regional groundwater modeling may be a useful tool in planning.

TIPS

Water management issues are covered in more detail in the ***Water Management*** **booklet. It provides more information on flood issues, water balances and regional groundwater implications.**

Water Management (ii)

Refer booklet: Section 1.4

Mines can affect **surface runoff** and **groundwater quality** through contamination with dissolved and suspended material.

One of the most common surface water contaminants is sediment. If sediment is deposited in streams and rivers it can affect fish and other aquatic life.

Planners can minimise sediment transport off site by passing runoff and discharge water through sedimentation ponds. These ponds are generally very effective for sand and silt particles but less so for fine clays. Each pond should be individually designed to meet the needs of the site and provide for adequate retention time.

Best practice water management separates the different classes of water. Uncontaminated water should be diverted around disturbed areas to prevent contamination from stockpiles, process plants, workshops and vehicle wash-down pads. This can be controlled by grit and oil arresters with associated oil separators.

Drainage from oxidation of sulphur or sulphidic ores is highly acidic and can contain dissolved metals. Significant concentrations of these metals are toxic to aquatic life. Control measures can include neutralisation with lime. However, it is better to identify potential acid generating materials and bury or cover them to prevent the entry of air and water.

Salinity control may be a significant issue if mine development disrupts saline aquifers or allows salt to be leached from freshly shattered overburden.

Mine designers must also guard against the release of chemically or radiologically contaminated water. Contaminants may include cyanide, hydrocarbons from fuels and lubricants, sewage, excess fertiliser from rehabilitated areas and chemicals used to separate ores.

Dry weather release of water from mines into rivers or streams is generally environmentally unacceptable and the water management program for the site should take this into account.

TIPS

Managing Sulphidic Mine Waste and Acid Drainage, Cyanide Management **and** *Water Management* **are addressed in detail in separate modules in this training series. Refer to these for more detail on issues relevant to your operation.**

Soil Conservation

Refer booklet: Section 1.5

Topsoil management should be planned to conserve available soils for reuse in rehabilitation programs.

Careful handling, storage and use of topsoil to avoid erosion and promote rehabilitation is a significant planning task.

Topsoil can promote revegetation by preserving plant seeds, soil nutrients, fungi and other soil organisms that assist in the rehabilitation of the mine site.

TIPS

Details on soil surveys and soil handling are outlined in the BPEM in Mining booklet on *Rehabilitation and Revegetation*.

Flora and Fauna

Refer booklet: Section 1.6

An accepted part of pre-mining investigations is a survey of existing **flora and fauna**.

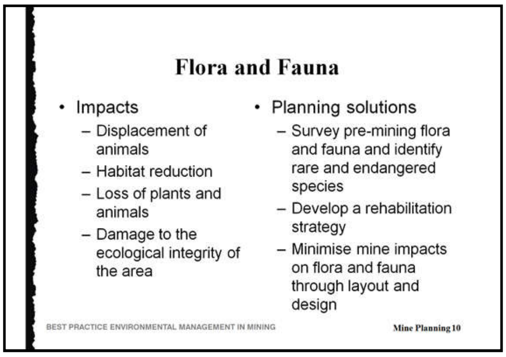
Apart from identifying rare and endangered plants and animals, planners must consider the ecological integrity of the area and the role it plays as part of a regional environment.

Baseline data on flora and fauna is essential for planning programs for rehabilitation, closure and restoration. Adequate data will provide useful tools for scientifically defending these programs.

Climate, soils and the rehabilitation strategy are important considerations in minimising impacts on native flora and fauna.

In some areas native plant regrowth may be extremely slow so that animals and insects are displaced for long periods of time. In this case safeguards can be adopted such as linking of remaining habitat areas and minimising potential impacts of feral pests.

The developer should attach great importance to conserving native plants and animals from which the community has potential to derive livelihood. The planning process for any new project should focus on minimising the impacts of mines on flora and fauna through their layout and design.



TIPS

Exercise 2

List the plants and animals that are important to local people. This importance could be as sources food or medicines or it could be religious, economic or cultural significance.

How could these values be preserved when developing a mine in your area?

Archaeology and Heritage Protection

Refer booklet: Section 1.7

Mine sites should be surveyed for **archaeological and heritage** importance.

Surveys may identify artefacts or sites that are of scientific or cultural importance. Artefacts and sites may also be of spiritual importance to indigenous people in the region.

Establishing good baseline data is essential for planning and implementing adequate rehabilitation strategies.

Consulting the local community is invaluable in identifying these sites and can help to find mutually beneficial solutions for their conservation.

As with flora and fauna, a key aim of the project planning team is to devise a means of allowing the project to proceed while minimising disturbance to, or taking steps to conserve, archaeological and heritage sites.

TIPS

Useful information is found in the BPEM booklet *Community Consultation.*

Transport

Refer booklet: Section 1.8

Mine planners generally seek to use existing regional **transport** links to build the mine, to haul raw materials and products and to provide access for the mine's workforce. Rail transport is attractive but most mines use public roads for their transport needs.

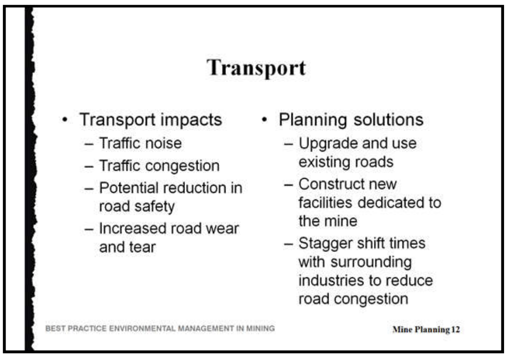
Relevant environmental issues include whether mine vehicles will increase traffic noise and congestion, reduce road safety and contribute to pavement wear.

Planning options include:

- Upgrading and using existing roads; and
- Constructing new facilities. (This option requires consideration of the environmental impact of new construction itself.)

While building new facilities can improve safety and reduce impacts on residents, it may be of no lasting benefit to the community once mining is finished.

In some cases a simple approach of staggering shift times with those of surrounding industries can alleviate potential road congestion.



TIPS

Exercise 3

What are the transport links available at the site?

Are they adequate for existing demands?

Could the mine's needs be met by the existing facilities?

If a decision were made to build new facilities, what environmental issues would need to be considered?

Subsidence

Refer booklet: Section 1.9

The excavation of underground coal or minerals can disturb the surface of the land. Surface structures may also be damaged by tilting or lowering of the land surface as a result of subsidence.

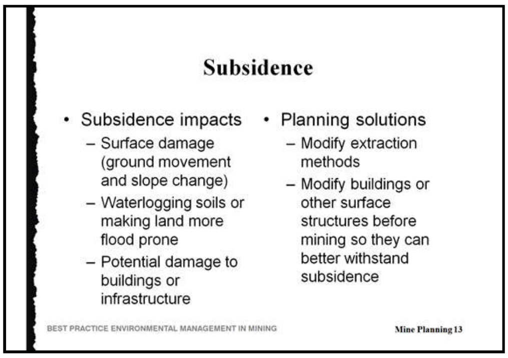
Natural features can also be modified by making land more flood-prone or waterlogging soils.

In some cases a trade-off must be made between the cost of surface damage and the potential cost of not being able to mine the resource.

Mine planners can sometimes modify extraction methods to keep damage within acceptable limits.

Other measures are to modify surface structures before **subsidence** occurs so that they can better withstand land movement. For example, cables can be loosened on electricity transmission lines so that towers and poles can tilt without interrupting electricity services.

The amount of ground movement during mining can be predicted with models or computer simulations. This can assist in taking precautions (e.g. alternate mine plan) to minimise damage to archaeological sites, historic buildings and natural heritage features.

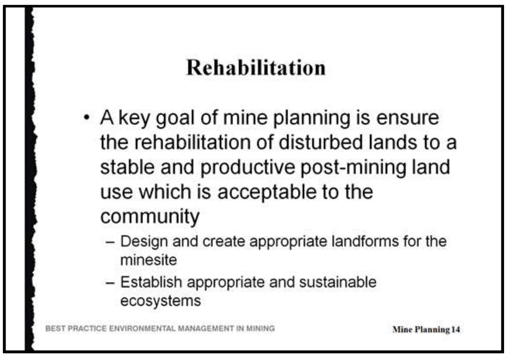


TIPS

Land subsidence can be caused by withdrawal of ground water. A useful Guidebook on this topic published by UNESCO can be downloaded from
http://wwwrcamnl.wr.usgs.gov/rgws/Unesco

Rehabilitation

Refer booklet: Section 1.10



Mining is often a short-term land use. An important aspect of mine planning is the **rehabilitation** of disturbed lands to a stable and productive post-mining landform which is acceptable to the community.

The rehabilitation plan should be an integral part of the mine planning process.

It should take into account an appropriate and agreed final land use for the area. This should include the level of management that will be required to maintain the land use and to prevent long-term off-site impacts, especially on water quality.

The post-mining land use should be decided in consultation with the community, government departments and any traditional owners.

Apart from being a cornerstone of sustainable development, rehabilitation is a fundamental community expectation from environmentally sound mining.

Rehabilitation usually consists of:

- Developing designs for appropriate landforms for the minesite;
- Creating landforms that will behave and evolve in a predictable manner; and
- Establishing appropriate and sustainable ecosystems.

Consideration must also be given to the pre-mining land use of an area. For example, if the area was previously grazing land, a sensible option would be to rehabilitate the land to a stage that can again be used as grazing land, rather than attempting to convert the site to an open forest ecosystem.

TIPS

The principles and practices of mine rehabilitation are covered in more detail in the Best Practice Environmental Management in Mining booklet *Rehabilitation and Revegetation.*

The case study of Hunter Valley No 1 mine (Case study 2 in the *Mine Planning for Environment Protection* **booklet) shows what can be achieved if rehabilitation is part of the original planning of a mine.**

Visual Impacts

Refer booklet: Section 1.11

The scale of modern mines leads to the potential for significant **visual impacts**.

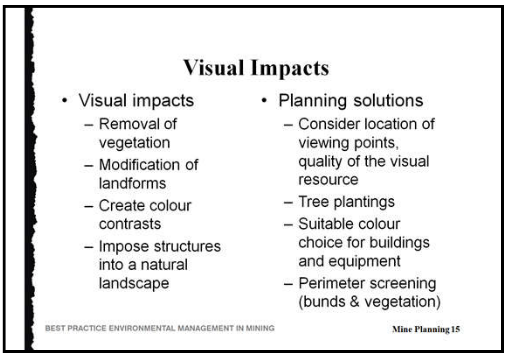
Mining can remove vegetation cover, modify landforms, create colour contrasts and impose large structures into natural landscapes.

It is often impracticable to completely hide a mine but they can be made much less obtrusive.

Planners should consider what people outside the mine can see of the site and how the mine fits in with its surroundings.

Visual safeguards could include tree plantings, community forestation projects, suitable colour selection for equipment and buildings and site perimeter screening with bunds or vegetation.

The appearance of an operation can affect the community's attitude to a mine. It is worthwhile taking time to reduce visual impacts and to ensure good housekeeping to improve community relations.



TIPS

A site visit or a number of colour slides can be used here to illustrate good and bad examples of managing visual impacts.

Hazard and Risk Assessment

Refer booklet: Section 1.12

Hazard and risk assessment is an essential part of mine planning.

Excavation may involve risks such as wall failure and roof or floor instability, surface subsidence and mine water inflows.

Mines can be flooded or disturbed by natural disasters including fires and earthquakes.

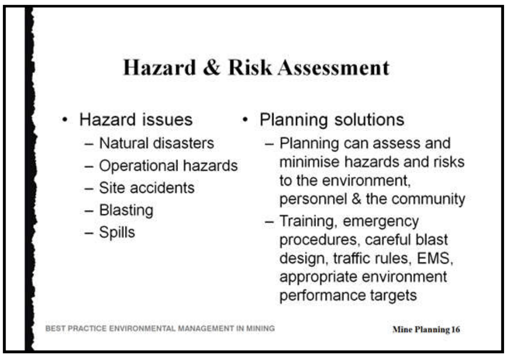
Operational hazards include dam-wall failures and the release of tailings, slimes or water.

Site accidents can include chemical spills, vehicle collisions and overbalanced mining equipment.

Risks associated with blasting include hazardous materials storage and flyrock.

The construction of bunds, elevated tanks, clean-up procedures, traffic rules, operator training and established procedures are all matters that need to be addressed in mine planning for environment protection.

Planning from the outset, including design of a sound EMS and setting environmental protection targets reflecting the sensitivity of local species, can minimise hazards and risks to the environment, personnel and the community.



TIPS

Hazard and risk assessment are addressed in detail by the the ***Environmental Risk Management*** **booklet.**

Waste Management

Refer booklet: Section 1.13

Mining generates many different **waste** products.

Removing waste overburden and interburden is a major physical activity on most mine sites. Effective handling of these materials is a major economic and environmental issue.

The other major class of waste is from ore processing plants including slimes, muds and tailings from ore concentrators.

These have traditionally been disposed of in wet ponds. However, there are many options available to choose from. These include mechanical de-watering, co-disposal, in-pit disposal and incineration of coal wastes in fluidised bed furnaces to generate electricity.

Other wastes include spent reagent solutions and maintenance wastes such as lubricating oils and greases.

Sewage and grey water are also generated from staff shower and toilet blocks. If these are unable to be connected to town sewerage systems, then mines must treat and dispose of the wastes on-site. Treated effluent may be disposed of via land irrigation systems.

During mine planning, the location, quality and character of all mine wastes must be examined so that they can be managed and their impact on the environment minimised.

TIPS

The *Tailings Containment* booklet details the environmental, planning and engineering considerations associated with this subject.

Socio-Economic Issues

Refer booklet: Section 1.14

Mining projects affect local and national economies in a variety of ways.

Mines are a dominant land use which can shape settlement patterns. Mines are built by their owners to provide wealth to their shareholders but they may also provide economic benefits to the community and the government.

Some people will benefit directly from the mine through employment and business opportunities.

Other people who do not benefit directly and who see negative impacts on the environment, may feel unhappy about the project proceeding.

Where there is a community living around potential minesite, mining impacts on the environment can significantly alter their lifestyles and influence community attitudes to the operation.

Mine planners need to make allowance for sensitive adjoining land uses and neighbours, in particular, those living downstream whose lifestyle may be impacted through degraded water quality.

Nearby indigenous communities, often disadvantaged in areas of health, education and wealth, may require more specific programs to accommodate their needs, e.g. health, education, family planning, agricultural and other social services and technical assistance programs. Often it is their specific social and historical characteristics which make them particularly susceptible to risks posed by development projects.

Successful mine planning should include and accommodate the concerns and needs of the local people.

TIPS

For further information on community consultation please refer to the Best Practice Environmental Management in Mining booklet *Community Consultation*.

Additional information regarding development impacts on indigenous communities may be found at the World Bank web site – *Operational Directive OD 4.20.*
http://wbln0018.worldbank.org/institutional/manuals/opmanual.nsf

Many mining companies now publish reports on their socio-economic impacts. An example is the *WMC Community Report,* **which can be found at:**
http://www.wmc.com/sustain/community

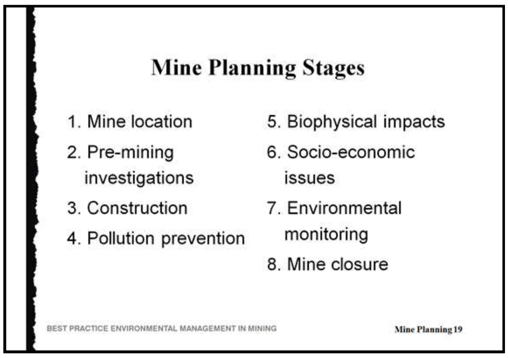
The concept of triple bottom line accounting is gaining favour. A triple bottom line report covers economic, environmental and social aspects of an operation. More information can be found on the Ecosteps website at:
http://www.ecosteps.com.au/sustainabilitytree/3bl.html

Stages of Mine Planning (i)

Refer booklet: Section 2

Proper planning of all stages in the **mining cycle** can reduce environmental impacts and enhance public perception of the mining industry as one which is able to operate in an ecologically sustainable way.

The following summary sheets will discuss the planning issues related to each of these stages in the mining cycle in turn.



TIPS

Consider using a workshop format for the next section of the module. For each slide address the environmental issues summarised in the previous 15 slides.

Example 4

One strategy is to divide participants into three groups and assign 5 of the issues to each group. Each group can report back on the results of their discussions.

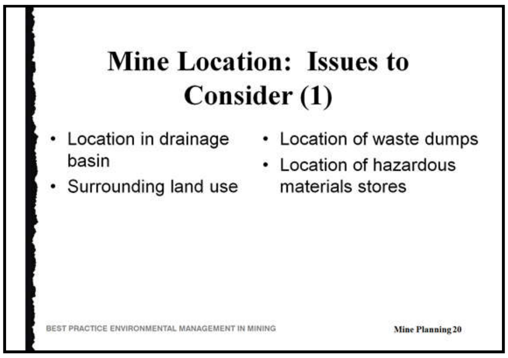
It would be best to use a scenario set in an area that is familiar to you and the participants. This will allow you to apply principles that apply in your own country or region.

Alternately, you could use one of the case studies provided on the CD ROM or access another case study from the BPEM booklets posted on the Environment Australia website.

Stages of Mine Planning (ii)

Refer booklet: Section 2.1

When reviewing a potential mine site it is useful to consider its general environmental constraints.



Location in the drainage basin:

- Will it flood?
- Is there enough water to operate the mine?
- Who uses water downstream and for what purpose?

Surrounding land use:

- How is the land around the mine used?
- What is the zoning for future development?
- Are there sensitive land uses that need to be considered?
- Are there indigenous people living nearby who need to be considered?

Location of waste dumps:

- Will the dumps pose a hazard to local residents?
- Will the dumps be visually offensive?

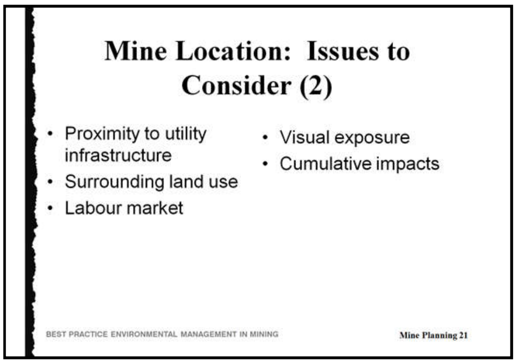
Location of hazardous materials stores:

- Can hazardous materials be sited to minimise risks to workers or local residents?

TIPS

Use the questions to foster discussion of environmental constraints that must be considered when planning a mine.

Stages of Mine Planning (iii)



Proximity to utility infrastructure:

- Where are the nearest roads, railways, water supply, electricity, ports?
- Do they have sufficient capacity and will their increased use cause environmental impacts?
- Can they be modified to meet the diverse needs, including the needs of the mine?

Surrounding land use:

- How is the land around the mine used?
- What is the zoning for future development?
- Are there sensitive land uses that need to be considered?
- Are there indigenous people living nearby who need to be considered?

Labour market:

- Is there an adequate local labour market or is there a need to employ people from outside the area? What impact may this have on local communities?
- If employees need to move to the area are there adequate housing and community facilities to serve a larger local community?
- If these is no local town, should employees be flown in and out or should a settlement be established?
- Consider water and waste water treatment plants, infrastructure and landfill.

Visual exposure:

- Is the ore body in a visually prominent area and will this matter to the local community?
- Can the location of facilities be changed or can screening be used to reduce these impacts?

Cumulative impacts:

- Is there a potential for the impacts of the new mine proposal to add to those from existing mining or industrial operations?
- Will these increased impacts be within environmental regulatory guidelines?
- Will there be competition for water, transport, services or employees?

TIPS

Use the questions to foster discussion of environmental constraints that must be considered when planning a mine.

Stages of Mine Planning (iv)

Refer booklet: Section 2.2

Baseline information is necessary for mines to be planned in an environmentally responsible way.

It is important to define the extent of the deposit itself. If the resource is found to be inadequate to sustain a profitable operation after money has already been committed, considerable environmental damage can be done if the mine has to be reconfigured. Initial excavations may have to be abandoned and the mine may have to close. In cases like this, decommissioning and rehabilitation procedures are often not carried out adequately because no cash flow or profits are available to fund this work. These problems can be avoided by pre-mining investigations and good baseline information.

Mine planners also need a good understanding of baseline environmental conditions.

This can be achieved by an integrated monitoring program that establishes pre-mining conditions for weather, flora and fauna, water quality, noise levels, air quality, transport, demographics and other characteristics of the site and surrounding area.

This baseline environmental information is usually collected over at least 12 months to allow for differences between seasons. If the proposed mine is a very large operation, or is to be located in a very sensitive environment, it is desirable to collect data for as long as possible, over at least 3 years.

This baseline data is essential to help mine planners and environmental and social scientists to understand the issues that will need to be addressed.

TIPS

Exercise 5

Try to develop a table or spreadsheet of issues that should be included in pre-mining investigations. Use the issues covered earlier in this module as a guide.

Stages of Mine Planning (v)

Refer booklet: Section 2.3

A number of significant environmental impacts can occur during the construction phase.

Often during this phase, worker numbers often peak which puts strain on local temporary housing. Construction workers may not be from the local area and may not have the same concern for the local environment and community as workers from the permanent local population. This may lead to conflict.

Volumes of construction materials and mining equipment being moved are often larger during this phase than transport during the mining phase and this can disrupt transport routes.

There may also be a need to transport bulk samples or trial shipments from the mine by truck before new mine transport infrastructure is in place. This will place extra pressure on local roads which were not designed for the demands of the mine.

Building environmental safeguards during construction can itself cause disruption to the community. For example, constructing earthen noise bunds is a major earth-moving operation and will cause a lot of noise that is impossible to screen. So the community may experience higher noise levels during the construction phase than later during normal operation.

Communication and consultation with the community before and during the construction phase may help allay community concerns.

Remember that best practice demands the use of exactly the same environmental safeguards during construction as for operation. This includes careful topsoil management, dust suppression and using well-maintained equipment with mufflers to reduce noise.

TIPS

Exercise 6 - Case Study:

The trainer may wish to introduce a case study here to help the participants to fully understand consequence analysis.

A case study and a series of suggested questions have been prepared based on the example of air quality problems associated with inadequate planning during mine construction.

The case study and suggested questions are presented on Worksheet 2 which can be given to participants to read and record their responses to the questions. The exercise may be conducted as small group work or individually.

Set a time limit of 10 to 15 minutes for participants to complete the exercise.

After the allocated time bring the class back together and lead a discussion based on the responses of each group.

Stages of Mine Planning (vi)

Refer booklet: Section 2.4

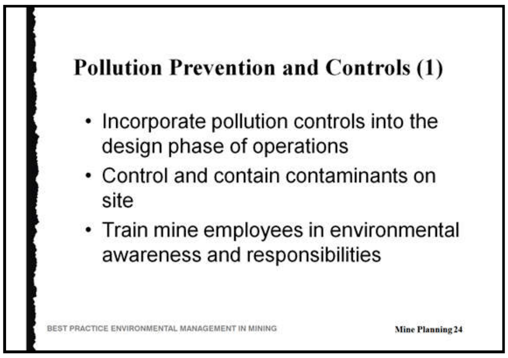
Pollution prevention and controls must be routinely incorporated into the design phase of operations.

The underlying principle for effective pollution prevention and control is to contain and treat contaminants on the site itself.

This can include:

- Cover reagent tanks and chemical stockpiles;
- Bund chemical and fuel storage facilities to prevent accidental releases and to guard against fires;
- Avoid unplanned equipment maintenance without pollution safeguards; and
- Plan for plant emergencies.

A critical factor in successful pollution prevention and control is thorough workforce training. No matter how good the mine design and planning is, ultimately environment protection can only be achieved with the understanding and commitment of every person on the site. For example, an untrained bulldozer driver can cause significant harm and expose a company to serious legal liabilities.



TIPS

The next slide considers specific pollution control measures.

Emergency response plans are key elements of planning for pollution prevention. The UNEP publication *APELL for Mining--Guidance for the Mining Industry in Raising Awareness and Preparedness for Emergencies at Local Level* **provides useful guidance. It can be downloaded from:** http://www.uneptie.org/pc/apell/index.html

Stages of Mine Planning (vii)

Refer booklet: Section 2.4

On-site ore concentration plant or smelter

- Contain and recycle process liquids and slurries;
- Design plant floor to include a graded floor and make allowance for sumps and pumps to fully cater for all liquids in the event of a plant failure; and
- Thickeners should have adequate dump ponds so that, if it is necessary to empty the thickener, the operator can reasonably manage the situation.

Air Quality

- Use water tankers for dust suppression;
- Install water sprays on conveyors and product stockpiles;
- Implement controls on blasting during adverse weather conditions;
- Consider environmental impacts when designing haul roads; and
- Make sure haul roads are well maintained.

Noise

- Limit activities carried out at night;
- Apply efficient blasting design;
- Control noise on mining equipment; and
- Locate major haul roads so they are shielded by bunds or mine workings.

Water pollution

- Separate clean water from contaminated runoff;
- Use recycling and reuse of site runoff to minimise site releases;
- Treat excess water and effluent so that it can be safely disposed off site if necessary; and
- Avoid water releases during times of low flow in local streams.

Pollution Prevention and Controls (2)

- Containment of contaminants
- Air quality
- Noise
- Water pollution

BEST PRACTICE ENVIRONMENTAL MANAGEMENT IN MINING Mine Planning 25

TIPS

Exercise 7

Small group work may be useful here.

Ask the class to identify pollution control measures related to activities or issues relevant to your mine site. These may include:

- **On-site ore concentration or smelting;**
- **Noise generation;**
- **Air quality controls; and**
- **Water pollution prevention and control.**

After a set time period of 10 to 15 minutes call the class back together and discuss the responses in relation to the pollution prevention practices and controls at your mine operation.

The groups will have identified many issues for each environmental aspect. Some of these issues are listed to the left in the notes. Compare the group responses with this list and discuss any relevant issues that the groups did not identify.

An example is provided on Worksheet 3 to help the groups get started.

For advice and information on how to conduct small group work see the ***General Trainers' Guide.***

Stages of Mine Planning (viii)

Refer booklet: Section 2.5

Biophysical impacts

Design safeguards can minimise biophysical impacts.

These biophysical impacts were discussed in summary sheets 5 to 12 in this module.

Examples of design safeguards to minimise environmental impacts are given below.

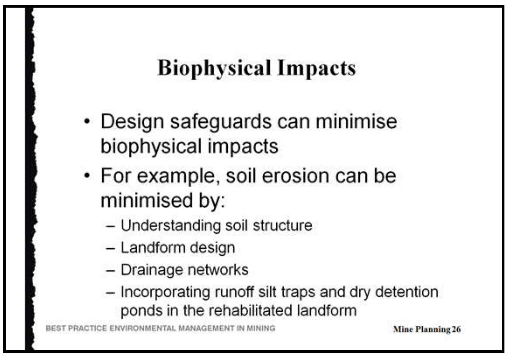
Soil Erosion can be minimised by:

- A proper understanding of soil structure;
- Conservative landform design;
- Using complex drainage networks; and
- Incorporating runoff silt traps and dry retention ponds in the rehabilitated landform.

Careful use of **top soil** can promote vegetation cover. If top soil is handled carefully, it can provide a bank of seeds for regeneration of native plant species.

Selection of **native vegetation species** can result in a stable and robust vegetation cover. Using freshly stripped topsoil and replacing the native flora can also assist in minimising impacts on **fauna**.

Mining activities often create 'vegetation islands' which are too small to ensure the long term ecological viability of resident flora and fauna populations. These areas can be linked by planting or leaving natural vegetation corridors, using fauna culverts and other protective measures to give better protection against predators or fires and to provide better breeding opportunities.



TIPS

The BPEM booklet *Landform Design and Rehabilitation* **provides useful insights into this topic.**

Stages of Mine Planning (ix)

Refer booklet: Section 2.6

Measures are available to promote the positive aspects of mining while recognising and addressing any potentially adverse side effects.

This can be applied to:

- Community infrastructure;
- Employment;
- Archaeological and heritage items; and
- Land use planning.

One of the most sensitive social issues is what policies should be adopted for property or land acquisition. Acquisition programs are most likely to succeed if they:

- Are transparent and equitable;
- Respond to the needs of individuals; and
- Are developed in close consultation with affected members of the community.

It may not always be possible to meet all the desires or needs of nearby property owners however close and frequent discussions can lead to better outcomes.

Other issues include:

- Issues of specific indigenous peoples;
- Social and economic issues upon mine closure, including sudden closure (i.e. mine sustainability issues);
- Financial bonds: If a bond is required of the mining company, is it adequate to meet the cost of mine rehabilitation in case of an unexpected closure?
- Migration and ethnic conflict issues; and
- Relocation issues including squatters, illegal mining communities etc.

TIPS

Case Study No 2 in the ***Mine Planning for Environment Protection*** **booklet provides an example of active cooperation with neighbours which resulted in mutually beneficial outcomes.**

Stages of Mine Planning (x)

Refer booklet: Section 2.7

Ongoing operational environmental monitoring provides factual information to:

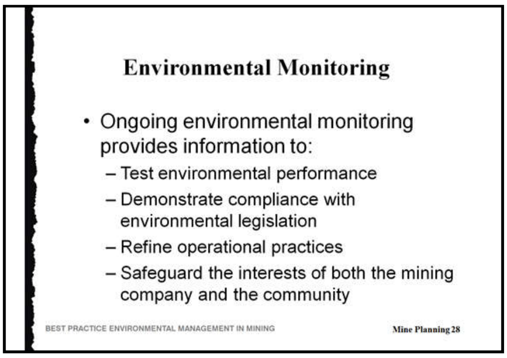
- Test environmental performance;
- Demonstrate compliance with environmental legislation;
- Refine operational practices; and
- Safeguard the interests of both the mining company and the surrounding community.

Attention needs to be given to what is being measured, how it is being measured and the ultimate use of the data.

Monitoring within the mine site is useful for checking emissions but does not tell us very much about the environmental effects on the surrounding area.

Environmental monitoring should be extended to areas that may be affected around the mine site e.g. downstream or downwind.

Monitoring results, including social impacts (e.g. health), can provide useful information for the ongoing relationship between miners and the surrounding community as part of a formal community monitoring committee or through a more informal arrangement.



TIPS

More details on the value and approaches to environmental monitoring are provided in the *Environmental Monitoring and Performance* Module of this training series.

Exercise 8

Ask the groups to identify parameters that should be monitored. Where should monitoring stations be located? Think about timing of monitoring. How long before construction should monitoring begin? What baseline data needs do you need? Who needs to be informed of results of monitoring? How will monitoring data be used?

Remember that monitoring data is only useful if it is acted upon!

Stages of Mine Planning (xi)

Refer booklet: Section 2.8

Ideally mine closure should be planned at the commencement of operations. If this is not possible because the mine has already been established for a long time, there is better potential for proper closure if it is integrated with the final years of the mine's operations.

Issues and questions to consider:

Long term water management - Should stormwater runoff be directed into or away from final voids? Should runoff be connected with existing rivers? If the mine is underground should the workings be sealed and deliberately flooded to minimise acid mine drainage?

Post-mining land use - What will be the environmental condition of the site at the end of operation? What does the community desire for the site? Can the mine workshops, transport links and other infrastructure be put to new uses after the mine closes?

Final rehabilitation - If restoration to the pre-mining condition is required, then roads and buildings need to be removed and the site rehabilitated and revegetated.

Progressive work to a final rehabilitation plan will make mine closure easier and prove-up the techniques during the active period of the mining project.

Safety of final mining voids - Voids can be valuable access points for future extraction. It may also be possible to use the void of one mine to dispose of the overburden or tailings from an adjoining mine or to provide make-up water for other operations. A planned approach to the issue of final voids for adjacent mines can significantly reduce environmental impacts.

Sustainability - Issues include minimising the social and economic impacts of closure on surrounding communities and leaving benefits to the community after closure. For example, can the community gain long-term benefits from remaining infrastructure.

TIPS

Exercise 9

Use group work to explore the issues listed above. Make sure that social as well as physical issues are considered.

See the BPEM booklets *Landform Design for Rehabilitation* **and** *Rehabilitation and Revegetation.*

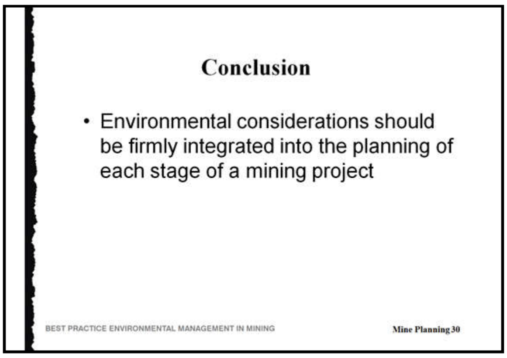
Conclusion

Refer booklet: Conclusion

Environmental considerations should be fully integrated into the planning of each stage of a mining project. This module has set out the issues that mining companies need to address to achieve economically worthwhile projects, while meeting community expectations and minimising environmental and social impacts.

1. **Understand the resource deposit** (extent, quality, geological constraints)
2. **Understand the environment** (baseline environmental monitoring and data collection)
3. **Understand social implications and community expectations** (planners need to understand surrounding land uses, town planning requirements, community desires and to conduct effective consultation)
4. **Develop extraction alternatives** (assess each option for economic feasibility, resource utilisation, community acceptability and residual environmental and social impact)
5. **Test and modify the mine plan** during the environmental impact assessment (EIA) phase
6. **Implement environmental and planning work** through all stages of the mine life cycle
7. **Workforce training and awareness** is necessary for effective implementation of an environment protection plan for the mine
8. **Environmental compliance and monitoring audits** are essential
9. Steps taken during well executed mine planning will contribute to implementation of an **environmental management system.**

While each mineral deposit is unique, the application of integrated planning procedures is a fundamental component of best practice environmental management in mining.



TIPS

Exercise 10

The trainer may wish to explore one or more case studies at this point. This may involve the participants in small group work or with the class as a whole. If using small group work allocate each group one or two questions to examine. After a set time period of 10 to 15 minutes ask each group to contribute their answers to the class as a whole during discussion.

You may use any of the case studies described in the *Mine Planning for Environment Protection* **booklet or you may construct your own case study relevant to your mining operation.**

Example questions for the class may include:

- **What environmental or social impacts were identified in this case study?**
- **Group these impacts into each of the phases of the mine life cycle.**
- **What planning solutions were/or could be found to address each of these impacts?**
- **What pollution prevention controls were/or could be implemented to address the impacts you have identified in this case study?**
- **How did community consultation play a role in mine planning in this case study? OR Could community consultation have been better addressed in this case study and how do you think the outcome would have changed?**

Worksheet 4 lists these questions and may be used as an aid during case study activities.

Feedback

Use the feedback form in the *General Trainers' Guide* **to record reactions of the group.**