ENVIRONMENTAL ASSESSMENT
GUIDELINE FOR MINES AND QUARRIES

May 2012
Foreword

In 1999, the National Environment Commission published six sectoral environmental assessment guidelines for the mining, roads, industries, hydropower, power transmission lines and forestry sectors. These guidelines were intended to guide different project proponents through the process of acquiring an environmental clearance for their projects. These sectoral guidelines were later revised in the year 2003 to make them more practical and relevant to the Bhutanese context and also to streamline with the provisions of the Environmental Assessment Act 2000 and its Regulation 2002.

The revised sectoral guidelines of 2003 have played a very instrumental role in guiding the proponents and the sector agencies in the Environment Assessment (EA) process. However, these sectoral guidelines were long overdue for revision and through the World Bank IDF grant the guidelines were revisited and proposed for revision. All the relevant stakeholders were consulted several times for this revision and through the expert input from both local and international consultants the guidelines were revised to align with the changing government policies and rules and with the long-term objectives of protecting our pristine environment.

The NEC is grateful to the World Bank for their financial assistance to revise and update these guidelines. The revision and updating of these guidelines were accomplished through close consultation with all the relevant stakeholders. We would also like to express our gratitude and appreciation to all the ministries and stakeholders for their active participation, support and inputs. The NEC would also like to thank the team from the Centre for Science and Environment, New Delhi for their hard work and inputs in updating these guidelines especially Mr. Chandra Bhushan, Mr. Sujit Kumar Singh and Ms. Swati Singh Syambal. We are confident that the revised guidelines will be more useful documents that facilitate and expedite the environmental clearance process.

The environmental assessment process endeavors to mitigate and prevent undesirable impacts of developmental activities. It is in no way intended to hamper socio-economic development in Bhutan but to guide project proponents and sector agencies in making right investments in land, manpower, technology and mitigation measures to ensure that their projects have the least possible impacts on the environment. It’s the sincere wish and hopes of NEC that all the stakeholders’ make the best use of these guidelines, which in turn will help in protecting our fragile ecosystem. Sound implementation of these guidelines will go a long way in minimizing the negative impacts of developmental activities on Bhutan’s environment.

Dr. Ugyen Tshewang
Secretary, NEC
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1. Initial Environmental Examination Form (IEE Form)
2. Reviewer checklist for mining and quarry projects

List of Abbreviations

AMD  Acid Mine Drainage
BAP  Biodiversity Action Plan
CA  Competent Authority
CSE  Centre for Science and Environment
CSR  Corporate Social Responsibility
EA  Environmental Assessment
EC  Environmental Clearance
EIA  Environmental Impact Assessment
EMP  Environment Management Plan
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETP</td>
<td>Effluent Treatment Plant</td>
</tr>
<tr>
<td>FDM</td>
<td>Fugitive Dust Model</td>
</tr>
<tr>
<td>HAPs</td>
<td>Habitat Action Plans</td>
</tr>
<tr>
<td>NEC</td>
<td>National Environment Commission</td>
</tr>
<tr>
<td>NEERI</td>
<td>National Environmental Engineering Research Institute</td>
</tr>
<tr>
<td>NOC</td>
<td>No Objection Certificate</td>
</tr>
<tr>
<td>PAP</td>
<td>Project-affected Population</td>
</tr>
<tr>
<td>PM</td>
<td>Particulate Matter</td>
</tr>
<tr>
<td>PPV</td>
<td>Peak Particle Velocity</td>
</tr>
<tr>
<td>R&amp;R</td>
<td>Resettlement and Rehabilitation Plan</td>
</tr>
<tr>
<td>SAPs</td>
<td>Species Action Plan</td>
</tr>
<tr>
<td>STP</td>
<td>Sewage Treatment Plant</td>
</tr>
<tr>
<td>ToR</td>
<td>Terms of Reference</td>
</tr>
<tr>
<td>DGMS</td>
<td>Director General of Mines Safety</td>
</tr>
</tbody>
</table>
CHAPTER 1

An Introduction to the Mining and Quarry sector

1.1 Introduction

Mineral resources are a major source of raw materials for an industry and an essential component of modern-day development by adding on to the economy and the national wellbeing. But at the same time, this sector also brings significant environmental and social impacts. In the initial stages of mine development, the impacts include loss of biodiversity due to forestland diversion and land clearing; economic loss or loss of livelihood due to displacement and diversion of agricultural land; and loss of local water resources due to reduction in catchment area and destruction of streams and natural drains. Some other land-related impacts such as air and water pollution from waste dumps and other mining operations are more pronounced at the operational stages. Post-operational impacts stand out prominently when mine reclamation is not carried out properly.

Mining projects in most countries today require an Environmental Impact Assessment (EIA) study before they are accorded environmental clearance. This holds true for Bhutan as well. It is regulated under the Environmental Assessment (EA) Act, 2000 and Regulation for Environmental Clearance of Projects, 2002. The EA Act establishes procedures for the assessment of potential effects of strategic plans, policies, programs and projects on the environment, and for the determination of policies and measures to reduce potential adverse effects and to promote environmental benefits. According to the EA Act, Environmental Clearance (EC) is mandatory for any project/activity that may have adverse impact(s) on the environment. The EC Regulation defines responsibilities and procedures for the implementation of the EA Act concerning the issuance and enforcement of environmental clearances. According to the current legal framework, the National Environmental Commission (NEC) and Competent Authority (CA) is the nodal agency for administering and granting Environmental Clearance (EC).

The scope of the guideline is as follows:

- Provide guidance and assistance to various stakeholders involved in the EA process.
- Assist the regulatory agency and EIA practitioners to understand the main areas of concern and use that understanding to enhance the quality of the EIA study and report.
- Inform the regulatory agency and EIA practitioners about the best environmental management practices in the mining sector.
• Assist the regulatory agency to better assess the EIA report and arrive at a sound decision.

1.2 An Introduction to Environmental Impact Assessment (EIA)

According to the United Nations Environment Programme’s Division of Technology, Industry and Economics, an EIA is a tool used to identify the environmental, social and economic impacts of a project prior to decision-making. It aims to predict environmental impacts at an early stage in project planning and design, finding ways and means to reduce the adverse impacts, shaping projects to suit the local environment, and presenting options to decision-makers.

An EIA can bring about both environmental and economic benefits, such as reduction in costs and time taken for implementation and design of a project and lesser intervention of legalities and regulations. A properly conducted EIA lessens conflicts by promoting community participation, informs decision-makers, and helps lay the base for environmentally sound projects (See Box 1: Integration of EIA in the project cycle).

1.3 Generic steps in the EIA Process

The EIA process comprises of six key steps:

i. **Screening**: This first step helps decide whether an EIA is required for a project. An appropriately designed screening system can prove to be an effective tool to prevent the squandering of time and money on assessing projects with insignificant environmental impacts.

ii. **Scoping**: Scoping is considered the backbone of an EIA process, and is ideally undertaken at the project planning stage. The main objective of the scoping process is to establish the environmental and social priorities, set the boundaries for the study and define the Terms of Reference (ToR). Systematic and well planned scoping forms the basis of an effective and efficient EIA process. It also helps avoid unfocused and voluminous reports. Ideally, the role of scoping is to determine three key issues: a) Site

<table>
<thead>
<tr>
<th>SCOPING HELPS FIND ANSWERS TO QUESTIONS LIKE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• What are the issues to be addressed?</td>
</tr>
<tr>
<td>• How should one proceed with the EIA study?</td>
</tr>
<tr>
<td>• What is the extent of the analysis needed?</td>
</tr>
<tr>
<td>• What is the infrastructure needed?</td>
</tr>
<tr>
<td>• What kind of people</td>
</tr>
</tbody>
</table>

...
alternatives, b) Design alternatives, c) Justifications for the project

iii. **Baseline data generation:** Baseline data provides a detailed description of the existing status of various environmental and social components in the study area. Both primary and secondary data is collected to describe this status

**Box 1: Integration of EIA in the project cycle**

<table>
<thead>
<tr>
<th>Mine and quarry project is accomplished in six stages: (1) Project concept (2) Pre-feasibility (3) Feasibility (4) Design and engineering (5) Implementation and (6) Monitoring and evaluation. Environment Impact Assessment plays an important role in every stage of this cycle. Most of the EIA activities take place during the pre-feasibility and feasibility stages. Between project concept and pre-feasibility stage, the EIA process involves site selection, screening, initial assessment and scoping on significant issues. Detailed EIA assessment starts at the project feasibility stage. This includes an evaluation of significant impacts, including the gathering of baseline information, prediction and quantification of impacts, and a review of the EIA by the regulatory agency. Following these initial steps, environmental protection measures are identified, environmental operating conditions are determined, and environmental management is established. In the last phase of the feasibility study, the monitoring needs are identified, and an environmental monitoring programme and environment management plan are formulated. Environmental monitoring is designed to generate information on the actual impact due to the project activity, compliance with environmental conditions and the effectiveness of the environmental mitigation measures. The environmental management plan, which describes the mitigation measures, is considered in the project cycle right from the implementation of the project (during construction, operation and maintenance); the plan’s aim is to reduce the environmental impacts.</th>
</tr>
</thead>
</table>

iv. **Impact assessment:** In this step, the characteristics of potential impacts are identified, evaluated and predicted using the baseline information on one hand
and the features of the project on the other (cause-effect relationship). Impact predictions are normally done by using common methodologies and models.

v. **Mitigation of impacts**: At this stage, the possible preventive, remedial and compensatory measures for each adverse impact are determined and recommended.

vi. **Environmental Management Plan**: An environmental management plan (EMP), also referred to as an impact management plan, is usually prepared as part of the EIA reporting process. It translates recommended mitigation and monitoring measures into specific actions that have to be carried out by the proponent. Depending upon specific requirements, the plan may be included in the EIA report or can be prepared as a separate document.

### 1.4 Good practices in EIA

An EIA should not be used just as a tool for obtaining an environmental clearance; rather, the project proponent should see it as a management tool for sound planning of the proposed site selected. On the other hand, it should be the responsibility of NEC and the Competent Authorities to ensure that the project causes minimal environmental impacts and brings maximum social and economic benefits.

The effectiveness of the EIA process depends on many guiding factors – these include:

- the extent and kind of legal support it is getting in the host countries
- how the EIA is being conducted
- the stakeholders involvement at different stages
- the quality of the EIA report
- accreditation status of consultants who prepare the EIA report
- composition and skills of the review committee

As a good practice, it is always recommended to conduct an Initial Environmental Examination (IEE) of the project to determine if it requires an EIA or not. It is also advisable to involve the public from the very beginning from scoping process to the review of the EIA report (See Figure 1.1: Best Practices in EIA). It is also recommended to consider the size, scale, site sensitivity and pollution potential while deciding the study area, duration and scope of the EIA study.

Best practices in the EIA process include preparing a report which is comprehensive and focused, and contains only the significant parameters instead of data and information which are irrelevant to the overall assessment of the project. The extent of the assessment required should be decided after careful examination of likely impacts on the environmental and existing socio-economic settings at the project site.
Figure 1.1: Best practices in EIA

Proposal Identification

Screening

EIA Required → Initial environmental examination → No EIA

→ Scoping

→ Impact Analysis

Mitigation and impact management

EIA Report

Review

→ Decision-making

Approved

→ Implementation and follow up

Not approved

→ Information from this process contributes to effective future EIA

*Public involvement typically occurs at these points. It may also occur at any other stage of the EIA process

Approved

→ Resubmit

→ Redesign
1.5 Environmental and socio-economic impacts

Due to diverse impacts, mining projects have significant environmental and social footprint, caused primarily due to change in land use and release of significant amounts of dust that is generated during various activities such as drilling, blasting; excavation, breaking, stockpiling, conveying, loading etc.

The magnitude of environmental and social impacts of mining and quarry project depends on the size of the project and location sensitivity. The mode of extraction and selection of mining technology depends on the mine characteristics such as geology, depth, thickness and configuration of the mineral. Besides geological setting, economic and environmental considerations also influence mining methods.

Minerals deposits can be mined by either open-cast or underground mining. Currently in Bhutan, minerals are mined only by open cast mining. In open-cast mining, the topsoil, earth, rock and other material — called overburden — are completely removed to provide access to the deposits. The mining, whether open-cast or underground, generally progresses through four stages of development. These are:

- **Prospecting** or search for deposits
- **Exploration**: Once the deposit is assured, this is done to assess the size, shape, location and economic value of the deposit.
- **Development**, or the work of preparing access to the deposit so that the minerals deposit can be extracted
- **Exploitation** or the extraction of minerals deposit
- **Closure**

Out of these four stages, development and exploitation leave behind the highest social and ecological footprints.

**Open-cast mining**

When mineral deposits are available near the surface, they may be economically exploited by using the open cut method, also referred to as open-cast, open pit, or strip mining. If the deposit is present in a flat terrain, it is exploited by open pit surface mining method. If it is present in a hilly terrain, strip mining is employed. *The pollution potential of opencast mining is many times higher than that of underground mines such as  impacts on forests, biodiversity and water resources. Displacement is a key challenge in open-cast mining and so is the impact on livelihoods.*

In open-cast mine or quarry, heavy equipments are used to remove the trees, earth and rock to make access to the deposits. Holes are drilled into the rock and explosives are placed in these holes. This is the conventional drilling and blasting technique. In some
cases, when the deposits are soft and seams are uniform, surface miners are also used. Surface miners are more environment-friendly as there is no associated noise, vibration or dust generation as compared to drilling and blasting. In the initial stages of mine development, huge quantity of wastes materials are accumulated and stored in a heap, referred to as overburden dumps, which in turn are a potential source of air and water pollution.

The technologies used for mining of stones quarry vary from manual excavations up to highly atomized large scale blasting with mechanical excavations. The mined stones are transported to the crusher sites using vehicles of various capacities starting from bullock carts, trailers up to automatic dumpers. Most of the transportation vehicles have hydraulically operated tilting arrangement for easy and faster unloading of stones at the crusher sites. In stone quarry, various types of crusher are used for crushing stone such as jaw crushers, roller crushers, cone crushers, impactor, rotopactor etc. Generally, jaw crusher is used as primary crushers. For secondary and tertiary crushing - jaw, cone, roller, impactor or rotopactor type crushers are used.

1.5.1 Impact on land

In the initial stages of mine or quarry development, the impacts include loss of biodiversity due to forestland diversion and land clearing; displacement, diversion of agricultural land; loss of local water resources due to reduction in catchment areas and destruction of streams and natural drains. Some other land-related impacts such as air and water pollution from waste dumps are more pronounced at the operational stages. Post-operational impacts stand out prominently when reclamation is not carried out properly. In open-cast mining projects, these impacts on land depend on a number of factors: the existing land use pattern, topography of the area, characteristic of deposit, stripping ratio, mining technology and quarry depth.

1.5.2 Impact on biodiversity

Biodiversity is important for maintaining the natural balance and sustenance of the ecosystem. It is defined as the ‘sum of life’. Its components and processes include the variety of living plants, animals and other organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary process that keeps them functional. Biodiversity helps human beings in many ways — from providing products such as timber, firewood and food to providing services such as flood control, carbon sequestration, etc (See Figure 1.2: The economic value of biodiversity). Development activities like mining and quarry can significantly alter the biodiversity of an area. The magnitude of impact on biodiversity again depends on land use pattern, size of plant, site sensitivity etc.
At present, in many parts of the world, mining projects are threatening forests as well as livelihoods of people dependent on forest-based economies, and creating conflict between wild animals and local inhabitants due to loss of forest cover (See Table 1.1: Mining activities and their impact on biodiversity). Assessing the impacts on biodiversity is an integral part of the EA process. In a country like Bhutan which is rich in biodiversity, impact of a mining project may be severe, if acquired land is close to forest or diverting forest land, which house endangered or threatened or restricted species. Moreover, most of the land in the country is forestland and thus any large scale change in land use pattern would lead to loss of biodiversity.

It is also true that all mining projects do not require an exhaustive biodiversity assessment. However, in case the project is coming up in an ecologically sensitive area, a detailed biodiversity assessment is recommended.

**Figure 1.2: The economic value of biodiversity**


**Table 1.1: Mining activities and their impact on biodiversity**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Examples of aspects</th>
<th>Examples of biodiversity impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraction</td>
<td>Land clearing</td>
<td>Loss of habitat, introduction of plant diseases, siltation of water courses</td>
</tr>
<tr>
<td>Blasting</td>
<td>Dust, noise, vibration</td>
<td>Smothering stomata, disturbance of fauna</td>
</tr>
<tr>
<td>Digging and hauling</td>
<td>Dust, noise, vibration, water pollution</td>
<td>Disruption of water courses, impacts on aquatic ecosystems due to changes in hydrology and water quality</td>
</tr>
</tbody>
</table>
### 1.5.3 Mining and quarry wastes and its impacts

Mining or quarry operations generate significant quantity of wastes, which is referred as "overburden". The ratio of wastes materials to the amount of mineral excavated is called as **stripping ratio**. For example, a stripping ratio of 4:1 means that four tonnes of waste rock are removed to extract one tonne of mineral. *Higher the ratio, the greater is the waste generation; higher the waste generation, the greater is the air and water pollution potential – also, more land is required for waste disposal.*

Overburden is normally stored in big piles within the mine lease area. The bigger the scale of the mine, greater is the quantum of waste generation. The waste generation in the mines depends on the depth of the mine. Deeper the deposit, the higher would be the potential for waste generation. The availability of the number of seams and the vertical depth between two seams are other factors that influence waste generation.

Most mining wastes are inert solid material. However, depending on the rock strata characteristics some toxics are inherently present in the overburden material — for example, heavy metals such as mercury, arsenic, lead, zinc, cadmium etc. These heavy metals leach out of the stored waste piles, contaminating the local environment. As a good environmental practice, it is crucial to understand the chemical characteristics of the waste and overburden before disposing it off.
The best use for waste rock is as a material for backfilling the excavated land; alternatively, it can be used for building roads or in construction – but all this is rarely done. In fact, in many cases, overburden and waste rock is left unattended which may leads to potential source of air and water pollution.

1.5.4 Impact on air environment

The impact of mining on air starts from the exploration phase, increases manifold during the operational phases, and may extend beyond the mine or quarry closure. The impact can be ascertained by the coating of black dust that covers everything in coal mining areas, similarly, in iron ore mining, everything appears reddish in colour. This is fugitive dust, a common phenomenon related to any type of mining; it comes from almost all the operations such as land clearing, drilling, blasting, loading, transportation, crushing, storage and waste handling and storage.

Fugitive emission is more significant in the open-cast mining or quarry area. The intensity of dust generation is also influenced by factors such as wind speed, hardness of the rock, mining technology, mode of transportation and the level of mechanisation. Conventional mining technologies – involving drilling and blasting — generate much more dust as compared to environment-friendly technologies like surface miners, ripers and rock breakers. Dust pollution potential of a mine or quarry gets exaggerated in semi-arid and arid areas. Poor mine planning and haphazard excavation tend to aggravate dust pollution as loose materials at broken sites are easily picked up by the wind, adding to the ambient dust levels.

In addition, inadequate dust suppression measures and poor mine or quarry management practices also cause air pollution, leading to widespread impact on local public health. The impact is more noticeable when the dust contains particles less than 10 microns in size; these particles are small enough to be inhaled.

During quarry operations, the potential sources of fugitive dust includes (a) the settled dust by wind (b) machine movement and transportation (c) size reduction (The fine dust increases with subsequent stages of crushing i.e., more fine dust is generated in secondary crusher as compared to primary) (d) handling of the stones at various stages. For detailed information of quarry impacts See Table 1.2: Quarry-related activities and potential environmental and social impact.
Table 1.2: Quarry-related activities and potential environmental and social impact

<table>
<thead>
<tr>
<th>Activity</th>
<th>Potential Impacts</th>
</tr>
</thead>
</table>
| Site clearing                         | • Land acquisition: Displacement and loss of livelihood  
• Civil works such as earth moving: Dust pollution, noise pollution, loss of biodiversity  
• Site runoff: Increase in erosion / sediment deposition  
• Influx of construction workers: Pressure on local resources and amenities  
• Heavy equipment movement and operation: Noise pollution, dust generation, annoyance, health impacts on workers  
• Habitat fragmentation and loss of habitat |
| Overburden and stockpiles             | • Land degradation  
• Land instability from incorrect earth removal or unstable deposition of spoil, leading to landslides or erosion  
• Discharge of sediment into water courses affecting in stream habitat  
• Dust emissions affecting amenity and health. |
| Material handling (loading/unloading, transfer, storage, etc.) | • Air pollution, public nuisance and occupational health hazard |
| Noise, air blast and vibration from blasting, machinery and traffic | • Annoyance/disturbance  
• Damage to structures due to ground vibrations |
| Quarry traffic                        | • Nuisance and safety issues for locals  
• Noise and dust |
| Storage and use of fuel, chemicals and explosives. | • Contamination of local water resources |
| Altering water flow                   | • Reduced water flow from springs  
• Changes in water flow direction  
• Increased stormwater run off |
| Site restoration.                    | • Erosion and landscape scarring after quarrying has ceased.  
• Weed infestations |

Emission factors from various sources
According USEPA study, particulate emission factors for various stone processing operations is given in Table 1.3

Table 1.3: Particulate emission factors for stone-processing operations

<table>
<thead>
<tr>
<th>Process operation</th>
<th>Uncontrolled Emission Factor, Kg/ton</th>
<th>% Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary crushing</td>
<td>0.25</td>
<td>4.5</td>
</tr>
<tr>
<td>Secondary crushing and screening</td>
<td>0.75</td>
<td>13.6</td>
</tr>
<tr>
<td>Tertiary crushing and screening</td>
<td>3.0</td>
<td>54.5</td>
</tr>
<tr>
<td>Recrushing and screening</td>
<td>2.545.5</td>
<td>45.5</td>
</tr>
<tr>
<td>Conveying and material handling</td>
<td>1.0</td>
<td>18.2</td>
</tr>
<tr>
<td>Total</td>
<td>5.5</td>
<td>100</td>
</tr>
</tbody>
</table>
The above table indicates that maximum emissions occur during tertiary crushing followed by re-crushing and screening, the contribution of primary crushing is less mainly due bigger size of material.

1.5.5 Impact on water resources

Mining operations have very high impact on both the quality and quantity of water resources — both groundwater and surface water. Water is mainly used for ancillary activities such as dust suppression — spraying on haul roads, conveyors, waste dumps, loading and unloading points etc. — plantation and domestic consumption. The water consumption at a mine site depends on the size, method of mining and the equipment used. A large mine is likely to have higher water consumption as it has longer haul roads.

Mining and quarry projects also reduce the surface water resources by disturbing the catchment area and by destroying streams and natural drains in the lease area. The impact is more pronounced on the local communities if they depend on these streams and waterways to meet their water requirements. The severity of impact on water resource depends on a number of factors: drainage patterns, the hydrology of the area, characteristics of the water, wastewater being discharged from the mine and the quantity of discharge, chemical composition of the mineral and over burden, erosion potential of the area, overburden management, and the ability of surface water to assimilate the pollution load.

Mining operation also disturbs soil and rock in the course of constructing and maintaining roads, opening pits, and creating waste dumps. In the absence of adequate prevention and control strategies, erosion of the exposed earth carries substantial amounts of sediments and silt into streams, rivers and lakes. Excessive sediments can clog riverbeds and choke watershed vegetation, wildlife habitat and aquatic organisms. Silt blankets at a stream’s bottom can cut off the food supply of fishes. River siltation and deposition of silt on agricultural land can be very high if the mine is located on a hilly terrain and receives high rainfall.

1.5.6 Noise and vibration impact

High level of noise is a key concern in mining and quarry projects. Noise pollution from mining or quarry operations is caused during drilling, blasting, loading and unloading, transportation and crushing, etc. This often leads to occupational hazards and causes annoyance to the local community (when human settlements are located close to the mining operations or when the transport route passes through human habitation) in the case of surface mining.

In addition to noise, another environmental and social repercussion of mining or quarry project is the ground vibration during blasting, which causes significant impact and
causes direct loss to property such as cracks in houses and sometimes it may lead to collapse of temporary or permanent structures close to the mine. Mining operations that use deep hole drilling and blasting employing the delay detonators are bound to produce ground vibrations. The stress waves generated during blasting propagates radically in all directions and cause the rock particles to oscillate. This oscillation is felt in the form of ground vibration. This ground vibration is measured as the Peak Particle Velocity (PPV).

### 1.5.7 Occupational hazards

The working climate in a mine depends not only on local geological conditions, but also on the mine layout, mining methods, machinery used, extraction processes, and transportation modes. In mining and quarry project, the occupational health impacts primarily depend upon the dust composition, size and physico-chemical properties of dust. Particles 5 micron or less in size, usually referred to as PM 5, is the main causes of respiratory diseases such as asthma and pneumoconiosis. The chances of high health impact occur when particles are in the size range from 0.3 to 1 micron and the free silica content in the dust is high.

Respiratory diseases are common among workers and non-workers in open-cast mining areas due to the fugitive dust generated during mining activities. Other common diseases are common in mining and quarry area are bronchitis, severe dyspnea (shortness of breath) and eye afflictions such as cataract, conjunctivitis, corneal ulcers, glaucoma and squint trachoma. Dust suppression and the use of personal protective equipment are the only safeguards.

High noise is another occupational hazard in mining or quarry operation, where miners are exposed to high noise levels during the operation of noisy machinery at the face and loading point. The use of earplugs or earmuffs, work rotation, and encapsulation of noisy equipment as far as practicable are the possible remedial options.

Management of occupational health and adequate safety in mines is not a one-time job; it requires periodic evaluation and corrective action. Regular safety assessments, continual improvement and monitoring are some of the important components of mine safety. Mine safety management should not be restricted to a mine’s life, it is equally important to address these issues when the mine is closed down. Open voids, reclaimed as water reservoirs, have also led to many deaths due to people slipping and falling in them. In mine safety and management, monitoring and statutory compliance is crucial.

### 1.5.8 Mine closure

Mine or quarry reclamation is a crucial component of mine management and an important part of the life cycle of a mine. Reclamation of mines not only improves the landscape of
the deformed area, but also helps control air and water pollution. Today, mine reclamation is a big challenge for governments as well as mine owners.

A mine or a quarry closure plan should be prepared before it starts operating. A good closure plan is one in which the lease area is converted to functional land use, beneficial to the local community. There is a general tendency to keep a mine void as a water body but this is a poor practice. The void should be filled up as far as possible by overburden and the reclaimed land should be used for forestry, agriculture or grazing. If formation of a water body is unavoidable, then proper infrastructure should be set up for the use of the water either for irrigation or for fishery.

1.5.9 Social impact of mining project

Any mining project will have social impacts during three stages – Pre-operational phase, operational and post operational phase. The key issues associated with these stages are described below:

i. Pre-Operational Stage: This is a very important stage for most projects as it is associated with displacement and therefore loss of livelihood. Displacement completely changes the lives of affected people as they lose their livelihood and are completely uprooted from their home. In such cases, rehabilitation and resettlement plans have to be developed and implemented in a way so as to minimise the negativity associated with displacement. This can be done by compensating affected people with land, employment, money or housing facilities and other benefits

ii. Operational Stage: During the operational stage, the pollution that is generated from the activity at the project site affects the environment and people residing in and around the area. This could be in the form of pollution, scarcity of natural resources such as water, nuisance due to noise and vibration, increased safety risk and pressure on the existing roads due to increased transportation, and other diseases associated with pollution, etc. It is necessary to initiate and incorporate certain plans for mitigating these impacts. There would also be positive impacts such as direct and indirect employment generation, infrastructure development and better facilities for health and education.

iii. Post-closure stage: The post closure is also significant as a closing down of the mine or a big quarry would have impact on the local community as it would directly or indirectly affect their livelihood. It is therefore important to plan an alternative for such scenario. Once the mine is closed, the existing building or infrastructure including waste storage site may have to be reclaimed. Post closure is especially important for mining projects where the minerals are exhausted after a certain period. In such situations, it is crucial to restore the ecological balance and also address the social concerns that such situations tend to generate.
Scoping

2.1 Introduction

The primary function of scoping, also referred to as setting the Terms of Reference (ToR) of an EIA, is to establish the environmental priorities and set the boundaries for the study. The objective of the ToR is to avoid creating a voluminous report and make the assessment process concise and focused. The ToR acts as a benchmark used by the appraisal committee to decide whether the EIA report has been complied meeting all the requirements or not.

There are various tools that can be used for scoping, such as questionnaire checklists, network method, comparison with other similar projects, matrix and ad-hoc methods, etc. The selection of scoping tools largely depends on the size of the project and the existing environmental and social characteristics of the project area. A site visit is advisable before framing the ToR, as the impacts of mining depend on site-specific characteristics to a large extent.

The ToR given below is a generic one and can be framed as per the project requirements; ground realities and peculiarities of the project, applicable laws, rules, guidelines, policies as well applicability need to be considered before framing ToR for EIA study. There may be a possibility that some of the ToR is not applicable for a given project. The generic ToR is also applicable for quarries, but the size of the quarry, location sensitivity and relevance of questions needs to be carefully examined before framing ToR for a quarry project.

2.2 Terms of Reference (ToR) for mining projects

The ToR should include the following conditions, details and components:

2.2.1 General information

- Executive summary of the project, which summarises the project characteristics, environmental and social issues, and the proposed mitigation measures.
- Information about the project proponent with following details (a) Name of the project (b) Name of the applicant (c) Present mailing address including telephone number, fax, and email (if any) (d) Name of the environmental focal person (e) Telephone number of focal person
• Justification of the project highlighting its benefits to surrounding areas and for the economic development of the country as a whole.
• Description on proposed mineral usage and purpose of mining (i.e. captive mine or stand-alone mine)
• Project financial statement and the project activity schedule.
• Name of the organization/consultant preparing the EIA report, qualifications and experience of experts involved in the EIA report preparation.
• List of complains/litigations against the particular project, if any.
• List of all regulatory approvals and No Objection certificate (NOC) required for the project and the status of these approvals.

2.2.2 Map (cartographic) representations
• A map specifying the location of the project. Also, mention the latitude and longitude details.
• Area map of the core and buffer zones indicating features such as the drainage patterns, locations of human settlements and major constructions, roads, any industries/mines and other polluting sources.
• A map specifying the mine lease area.
• A map specifying the forest cover in mine lease as well surrounding area up to 5km radius with details on district and geog boundaries, if applicable, and marking the presence of migratory corridors, water bodies, occurrence of any endangered/threatened flora and fauna species and/or plants and animals of economic/ecological importance.
• A cross-sectional map of the geology and deposit characteristics of the mine lease area.
• A contour map along with the site plan of the mine, showing the various proposed operations such as quarry area, overburden (OB) dumps and buildings such as mine offices, workshops, stockyards and townships/colonies (if applicable).
• A map clearly delineating the locations of various monitoring stations (for ambient air, water, noise and soil).
• A map indicating the detailed land use pattern of the core and buffer zones separately.
• A detailed map of the lease area showing the proposed mine closure both progressive and final.
• Applicable in case of big mine (i.e. capacity of mine equal or greater than 1 million tonnes per annum) - satellite imagery of the study area (core and buffer zones), indicating the land use pattern with explanatory notes. Besides these, the ToR should also put a condition to submit satellite imagery of the study area every five years for the entire life of the mine and the satellite imagery of the study area once the mine is officially closed down.
Note 1: Depending upon the type, size and location sensitivity, NEC can decide the study area and recommend appropriate scale for Environmental Assessment.

2.2.3 Project description

A. Information on existing land use pattern of the study area

- Land use pattern of area acquired for mining and existing land use pattern of study area.
- Land ownership pattern of acquired land.
- Distance of the project from key infrastructure installations, if applicable.
- Catchment area characteristics of the study area, such as water recharge potential and drainage pattern.
- Identification of areas vulnerable to erosion in the core area and buffer area separately.
- If forest land or agricultural land are likely to be diverted, the impact on the availability of fodder, fuel, food and livelihoods, if applicable.

B. Information on sensitive receptors at project site and in the study area, if any:

- Distance of forest areas, wildlife sanctuaries, national parks, biological corridors, archaeological sites, critical water-shed areas, settlements, important installations and sites of religious importance and others from the mine lease area.

C. Areas of forest land diverted, if any.

- Discuss, if the project site or adjoining areas (such as the buffer zone) support any unique habitat, endemic, threatened or declining species or species of high economic/ecological value.
- List of flora and fauna in the project area, duly authenticated by a government approved organization or independent body such as a university. The findings should be annexed with the report.
- Presence of any wildlife corridors or locations favored by migratory birds, animals at the project site or in the buffer zone, if any.

D. Information on the geological setting, mineral resource and mining plan

- Mineral reserves (indicated, inferred, proven) in the mine lease area.
- Characteristics of the mineral deposit (physical and chemical characterization)
• Geological characteristics of the mining area. The project should undertake detailed geological investigation and highlight the technical and environmental issues arising from this investigation.
• Details of the mine excavation plan
• Details including the working depth, final working depth, and mineral recovery potential and progressive stage-wise working scheme until the end of mine life.
• Details of mineral production schedule
• Details of waste generation (overburden, topsoil), as per the calendar plan as well as during the entire life of the mine. Overburden dump heights and terracing should be based on slope stability studies. The EIA should discuss the dumps section (in both longitudinal as well as cross section) with relation to the adjacent area.

2.2.4 Information on technologies and resource requirement

• Description on type of mining, technology to be adopted, including details of equipments to be used and their potential impacts. The project should also examine the possibility of use of other technologies, which are environmental friendly.
• The EIA should justify the selection of the mining technology and mining method with reference to mine safety, productivity and environment.
• Details on method of mining (manual, semi-mechanized, mechanized) and mode of transportation (dumper, conveyer, ropeways, etc.)
Resource requirement:

- Details of water balance of the entire mine under following heading See Table 2.1.

**Table 2.1: Water requirement (m³/day)**

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Avg. Demand</th>
<th>Peak Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. MINE SITE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Mine operation</td>
<td></td>
<td></td>
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<tr>
<td>2. Land reclamation</td>
<td></td>
<td></td>
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<tr>
<td>3. Dust suppression</td>
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<td></td>
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<tr>
<td>4. Drinking</td>
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<td></td>
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<tr>
<td>5. Green Belt</td>
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</tr>
<tr>
<td>6. Fire Service</td>
<td></td>
<td></td>
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<tr>
<td>7. Community supply</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Others (specify)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. TOWNSHIP (if applicable)</strong></td>
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<td></td>
</tr>
<tr>
<td>1. Green Belt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Domestic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Other (specify)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Details of the workforce (administrative, production and environment and safety) to be employed in the project under following heading See Table 2.2 and the operating hours;

**Table 2.2: Workers employed by the project**

<table>
<thead>
<tr>
<th>Type of Labour Skills Required</th>
<th>Numbers</th>
<th>Nationality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Construction Period</strong></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Project Operation Stage</strong></td>
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</tbody>
</table>

- Provide following details (i) the quantity of explosives that the mine will require per day or per annum (ii) type of blasting techniques that the project intends to adopt
- Fuel, oil and electricity requirements.
2.2.5 Baseline data

- Surface and surface water characteristics in core and buffer areas.
- Characteristics of topsoil and its thickness.
- Characteristics of overburden with respect to pollution potential.
- Baseline data on ambient air quality (PM10, SOx, NOx, CO) and generation of site-specific information on existing meteorological conditions such as temperature, humidity, rainfall, and wind speed, wind direction, wherever it is applicable.
- Generation of ambient noise data by considering noise-prone areas and sensitive receptors.
- Inventory on tress to be cut down.
- The EIA report should provide an overview of the existing hydro-geological setting of the study area, describing the aquifers, hydraulic characteristics, groundwater quality and the interaction of surface water, if applicable.
- Information on number and distances of water-bodies such as rivers, lakes, streams, springs, wells, etc. present in core and buffer zones.
- Existing socio-economic status of the population (demographic characteristics and local amenities, livelihood patterns, income levels, literacy and the presence of indigenous and vulnerable groups) in the study area.
- Data on the health status of local communities and common diseases prevailing in the area, if applicable.

2.2.6 Impact assessment

Impact on land and water resources

- Impacts on biodiversity.
- Potential activities/operations likely to cause impacts on land.
- Impact of mining operation on social and economic setting of an area
- The impact of modification of natural drainage and diversion of existing water courses flowing through the mine lease (rivers, streams, springs, drains, etc) or important water resources originating in the mine and adjoining areas on local hydrology, if applicable.
- The impact of run-off due to mining and associated activities (as from the stockyard and waste storage areas, etc.) on water bodies, forest and agricultural land.
- If applicable, the impact of mining on the groundwater regime due to mine seepage within the study area. Hydrological and rock characteristic data should be collected and a hydrological model should be prepared for predicting the cone
of depression at various stages of mine life. The EIA should provide the impact of the area of influence of draw down caused by mine seepage (that is, the impact on shallow, deep wells and surface water bodies). Also, mention the total population likely to be affected by the fall in the groundwater level.

- If the mine proposes to discharge effluents into the water body (a river, natural drains etc.), then, the impacts of the mine discharge on that water body.
- Acid Mine Drainage (AMD) potential and identification of areas which might get affected by AMD, applicable for coal mine only.

**Information on impact on ambient air quality**

- Impact of mining and allied activities on air quality by using any well established models like ISCSTS or Aeromod, Fugitive Dust Model (FDM), etc. The report should include assumptions used for the model and input and output data of modeling.

**Noise and vibration**

- EIA should assess the impact of noise due to mining and allied activities such as transportation, crushing, loading and unloading on the local community and provide detailed mitigation measures for the same in the EMP.
- Impact of ground vibration on local habitation.

**Traffic**

- Mode of transportation for the mineral and waste materials and its impact on existing traffic scenario and infrastructure.

**Socio-economic impacts**

- Socio-economic of project including impact on visual aesthetics and health, wherever applicable

**Risk**

- EIA should assess the potential risks associated with various mining operations (such as risk during drilling, slope failure, fly rock and vibration due to blasting, storage of explosives, toxic fumes from blasting, slope destabilization, transportation, etc.) including natural calamities
2.2.7 Mitigation and Environmental Management Plan (EMP)

The EMP should discuss the mitigation measures to be taken against each impact, the timeline for completion, the responsible departments for implementation, the budget for the EMP, post monitoring provisions and reporting to the concerned regulatory authority.

Note: The mitigation measures given below is a generic one for all types of mines; ground realities and peculiarities of the project as well applicability need to be considered before preparing EMP for EIA study. There may be a possibility that some of the given mitigation measures are not applicable.

The generic mitigation measures are also applicable for quarries, but the size of the quarry, location sensitivity and its relevance needs to be carefully examined before framing EMP plan for quarry project. For small mines and quarries (i.e. less than 3 hectare or up to 5 hectare), the environmental clearance should be given after carefully examining the EMP.

EMP and mitigation for land

- A mine closure plan including year-wise backfilling programme and final land use. The EMP shall discuss the financial requirements for the detailed activities proposed to achieve final mine closure. It should also discuss the benefit sharing and ownership of the reclaimed lease area.
- A detailed management plan, with explanatory notes, for overburden. This should include provisions to control run-off and erosion from overburden dump sites and the impact on ambient air and water.
- Mitigation measures for control of erosion and run-off from the mine lease area and open pit, especially if there is a river or agricultural land adjoining the mines.
- Management plan for topsoil utilisation and conservation.
- Progressive year-wise green belt development inside and outside the lease area.

EMP and mitigation for water

- Proposed mitigation measures to reduce drainage diversion within the mine lease area, if any.
- Detailed mitigation measures for local catchement area improvement.
- If possibility of AMD has been identified, then detailed long-term plans to mitigate the same.
• Details of sewage treatment plant (STP) in the colony and effluent treatment plant (ETP) in the mine. The EMP should also mention the treatment technology, layout plan and final disposal of treated wastewater.
• Information on design and dimensions of settling/sedimentation pond for handling run-off and mine seepage, if applicable.
• Detailed mitigation measures for the areas affected due to draw down, if applicable.
• A water assistance plan for the local community, if affected by water scarcity due to the mine’s operation. The project developer should form a monitoring committee to oversee the execution of this plan.
• The EMP should discuss the disposal or usage of mine seepage water in detail, if applicable.

EMP and mitigation for air quality

• Management plan to reduce fugitive emissions during material handling, excavation, loading/unloading, transportation, and storage. The project should also discuss the level of mechanisation incorporated in mine management.
• A mitigation plan for controlling dust during drilling and blasting.
• A mitigation plan for controlling dust during transportation outside the lease area and for minimizing the impacts on people.

EMP and mitigation for socio-economic impacts

• Preparation of a Resettlement and Rehabilitation plan (R&R), if displacement is involved. The plan should include details of the compensation provided, including land-for-land compensation, employment or money; provisions at the resettlement colony (such as basic amenities including housing, educational facilities, infrastructure and alternate livelihood potential); a clear timeline for implementation; responsibility; budgets; grievance mechanism, etc.
• The R&R plan should analyze and take into consideration the impact of displacement on women and vulnerable communities such as landless labourers, etc., and prepare a detailed management plan to improve their status.
• A detailed compensation package for the community likely to lose their livelihood due to diversion of forest or agricultural land.
• A detailed mitigation plan for improving and enhancing socio-economic condition in and around the project site and discuss the budgetary provision for the same.
• A management plan for occupational health and safety of the workers and nearby local community.
• The EMP should also discuss the provision for compensation in case damage to building and infrastructures.
2.2.8 Others

- Mitigation measures for noise abatement from equipments, operations (blasting and drilling) and transportation of mineral and wastes.
- A detailed mitigation plan for biodiversity protection and conservation (if the project is likely to impact biodiversity).
- Mitigation plan and EMP to reduce the impacts of fly-rock and ground vibrations on human settlements.
- A disaster management plan for explosive warehouse, landslides, flashfloods, cloud-bursts, earthquakes.
- Provisions for various facilities to be provided in terms of parking, rest areas and canteens for workers and drivers.
- Road safety measures planned to reduce road accidents.
- The organisational set-up and requirement of manpower for environmental, health and safety management, including monitoring and clear responsibilities.
- The frequency of training and awareness programmes on mine safety, and the annual budget allocated for them.
- Provision for annual environment and social audit of the project, including status of compliance with different statutes.
- EMP should also discuss the Corporate Social Responsibility (CSR) and annual budget for CSR.
CHAPTER 3

Impact Assessment

3.1 Introduction

The scientific and technical reliability of an EIA study depends on the skills of the EIA practitioners/reviewers, who estimate and review the nature and magnitude of the environmental change that the proposed project may entail. Impact prediction and evaluation is a vital exercise for assessing impacts, deciding alternatives, setting down mitigation measures and developing an environmental management plan. Predicting the magnitude of impacts and evaluating their significance is the core exercise of impact assessment. This process is also known as impact analysis and can be broadly broken down into three overlapping phases:

- **Identification**: To specify the impacts associated with each phase of the project and the activities undertaken
- **Prediction**: To forecast the nature, magnitude, extent and duration of the main impacts; and
- **Evaluation**: To determine the significance of residual impacts after taking into account how mitigation will reduce a predicted impact.

In assessing environmental impacts and their significance, some key concerns have to be kept in mind:

- Identity who or what is affected
- Description of how they are affected
- Evaluation against a set of consistent assessment criteria

Normally, in impact assessment, potential impacts can be categorised into various parameters ranging from its type and nature to magnitude and reversibility, each signifying its importance in impact prediction and decision making (See Table 3.1: Parameters which determine impact characteristics).

In the EA of a mining or quarry project, the potential impacts are globally well documented, and do not normally require extensive impact identification (Refer Chapter 1, Section 1.5: Environmental and Social impact of mining project). Many of the environmental and social repercussions of mining project can be managed by selecting an appropriate site at the planning stage. However, there are some impacts such as displacement, loss of livelihoods, influence of topography and meteorology on water and air pollution, feasibility with respect to land use, geological characteristics, other sensitive
receptors such as forest/biodiversity etc., which are site-specific and can only be identified once the data on them is available or generated. There are various tools that can be used for impact identification, such as questionnaires, checklists, network method, comparison with other similar projects, matrix and ad-hoc methods.

To ensure effective impact identification, one should always opt for a simple, logical and systematic approach. As a good practice in EA, it is always recommended to consider all potential project impacts and their interactions. At the same time, it is important to ensure that indirect and cumulative effects which may be potentially significant are not unintentionally omitted. All the identified impacts may not require a detailed analysis and evaluation – the level of detailing should match the scale, sensitivity and complexity of the impact Refer Table 3.1: Parameters which determine impact characteristics. The choice of the chosen methodologies should reflect these criteria.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Positive or negative</td>
</tr>
<tr>
<td>Nature</td>
<td>Direct, indirect, cumulative</td>
</tr>
<tr>
<td>Magnitude or severity</td>
<td>Low, moderate, high</td>
</tr>
<tr>
<td>Timing</td>
<td>Short term, long term, intermittent, continuous</td>
</tr>
<tr>
<td>Duration</td>
<td>Temporary/permanent</td>
</tr>
<tr>
<td>Reversibility</td>
<td>Reversible/irreversible</td>
</tr>
<tr>
<td>Significance</td>
<td>Local, regional or global</td>
</tr>
</tbody>
</table>


3.2 Impact prediction

Predictions of impacts are normally based on commonly used qualitative and quantitative methods and models. Expert judgment and comparison with similar projects can also be used for impact prediction. While there are a number of models for predicting impacts on physical environment (air, water and noise), modeling socio-economic and cultural impacts is difficult and is generally done through qualitative assessment or economic analysis. A model can be effective only if the input data is correctly inserted. The use of models, therefore, should be done with care and prudence considering factors like availability and reliability of data.

The sophistication of the prediction methods to be used should be kept in proportion to the ‘scope’ of the EIA. For instance, a complete mathematical model of atmospheric dispersion should not be used if only a small amount of relatively harmless pollutants is emitted. However, if the project has a very high air pollution potential – as in the case of a large open-cast mine — then all possible modeling exercises should be done to predict the impact on ambient air quality. All prediction techniques involve assumptions and uncertainties. While quantifying and stating an impact, these assumptions should be clearly identified. Also, uncertainty of prediction in terms of probability and the margins
of error should be mentioned. Table 3.2 gives the list of general prediction models/methods used for predicting the impact of mining project.

**Note:** The models can be used in case of large mine preferably more than 0.5 million tonnes per annum but the focus of impact assessment should be more on time bound and action oriented mitigation measures and EMP.

Table 3.2: General models/methods for impact prediction

<table>
<thead>
<tr>
<th>Impact</th>
<th>Assessment method/model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air quality</td>
<td>Air dispersion model:</td>
</tr>
<tr>
<td></td>
<td>- Fugitive dust model (FDM)</td>
</tr>
<tr>
<td></td>
<td>- Industrial source complex short term (ISCST3) model</td>
</tr>
<tr>
<td></td>
<td>- AERMOD modelling system</td>
</tr>
<tr>
<td>Soil erosion, sedimentation and water pollution, if applicable</td>
<td>- Universal soil loss equation</td>
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<tr>
<td></td>
<td>- SED2D-WES Sediment transport model</td>
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<td></td>
<td>- Mixing zone model</td>
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<tr>
<td></td>
<td>- QUAL-IIE: widely used water quality simulation model</td>
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<tr>
<td></td>
<td>- DOSAG-3, USEPA: water quality simulation model for streams and canal</td>
</tr>
<tr>
<td></td>
<td>- Explore –I, USEPA - A river basin water quality model</td>
</tr>
<tr>
<td></td>
<td>- RECEIVE-II, USEPA - A general dynamic planning model for water quality management</td>
</tr>
<tr>
<td>Surface subsidence (if applicable)</td>
<td>- Subsidence prediction based on either of the following models</td>
</tr>
<tr>
<td></td>
<td>- 3-D numerical modelling</td>
</tr>
<tr>
<td></td>
<td>- Profile function modelling</td>
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<tr>
<td></td>
<td><em>Note: Comparison with similar project can also be done.</em></td>
</tr>
<tr>
<td>Ground water, (if applicable)</td>
<td>- Models based on Darcy’s law</td>
</tr>
<tr>
<td></td>
<td>- Numerical groundwater model using processing MODFLOW</td>
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<tr>
<td></td>
<td><em>Note: Comparison with similar project can also be done.</em></td>
</tr>
<tr>
<td>Biological environment</td>
<td>- <strong>Flora</strong></td>
</tr>
<tr>
<td></td>
<td>a) Sample plot methods – relevance (<em>Density and relative density, Density and relative dominance, Frequency and relative frequency importance value</em>)</td>
</tr>
<tr>
<td></td>
<td>b) Transects &amp; line intercepts methods</td>
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<tr>
<td></td>
<td>c) Plot-less sampling methods</td>
</tr>
<tr>
<td></td>
<td>- <strong>Fauna</strong></td>
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<tr>
<td></td>
<td>a) Species list methods</td>
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<td></td>
<td>b) Direct Contact Methods</td>
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<tr>
<td></td>
<td>c) Count indices methods (Roadside and aerial count methods)</td>
</tr>
<tr>
<td></td>
<td>- Comparative evaluation of conservation value</td>
</tr>
<tr>
<td></td>
<td>- Expert opinion</td>
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</tbody>
</table>
| Land use, if applicable | • Digital Analysis Techniques - Provides land use / land cover distribution
• Ranking analysis for soil suitability criteria – Provides suitability criteria for developmental conversation activities |
| Noise, if applicable | • Dhwanit: Developed by NEERI, Nagpur (India) for prediction of impacts due to multiple noise sources
• Sound PLAN: Noise and air pollution planning and mapping software |
| Traffic | Traffic generation and flow models |
| Socio-economic | • Cost-benefit analysis
• Metaphors and analogies: Experience gained in similar kind of project is used to predict the socio-economic impacts
• Extrapolative methods: Prediction based on the linear extrapolation of current trends
Normative methods: Desired socio-economic goals are specified and an attempt is made to assess the social environment based on historical data in the present context. This would help in examining whether existing or planned resources and environmental programmes are adequate to meet the goals. |
| Aesthetics | • Judgmental assessment |
| Risk | • Risk assessment |

### 3.3 Impact evaluation

In impact evaluation, the predicted adverse impacts are judged for their significance. Therefore, the criteria for evaluating the significance of impacts and their effects should be set in advance (See Box 2: Impact evaluation criteria). The criteria for evaluating the significance should be based on local standards wherever possible. Where local standards are not available, acceptable international standards should be used (e.g. IFC, WHO or USEPA standards and guidelines of others countries, etc.). In all cases, the choice of the appropriate standard must be robust, defensible and relevant to the local situation.

**Box 2: Impact evaluation criteria**

- Comparison with laws, regulations or accepted national or international standards.
- Consistency with international conventions or protocols.
- Reference to pre-set criteria such as conservation or protected status of a site, features or species.
- Consistency with government policy objectives.
- Comparison with best practices
- Existing environmental and social stress in the area.
- Extent of impact on biodiversity.
- Acceptability to local community or general public.
As a good practice in impact evaluation, it is better to use established procedures or guidelines, or relevant criteria which are comparable. While doing impact evaluation, it is equally important to understand the nature and characteristics of impacts on potential target areas, such as air, water, land, human beings, etc. to understand the significance, importance and intensity (See Box 3: Possible evaluation criteria for determining impact significance). It is also essential to find out the answers to the following three questions:

- Are there residual environmental impacts?
- If yes, are these likely to be significant?
- If yes, are these significant effects likely to occur? Is the probability high, moderate or low?

An unbiased impact evaluation requires sector-specific criteria or standards against which impacts can be compared. See Table 3.3: Criteria / standards for impact evaluation, describes some of the criteria for mining projects in Bhutan against which impacts may be evaluated.

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Criteria / standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wastewater discharge from mine</td>
<td>• Industrial Effluent Discharge Standards (September 2010)</td>
</tr>
<tr>
<td>Sewage discharge from mine’s colony and township</td>
<td>• Standard for final effluent from Sewerage Treatment Plant (STP), NEC Bhutan 2010</td>
</tr>
<tr>
<td>Impact of noise and ground vibration</td>
<td>• National Standards for Ambient Noise for Bhutan Refer link <a href="http://www.nec.gov.bt/Documents/Standards/Bhutan-Airstandards-">http://www.nec.gov.bt/Documents/Standards/Bhutan-Airstandards-</a></td>
</tr>
</tbody>
</table>
Refer World Health Organisation (WHO) Guidelines on noise

Ground vibration: If local standard for permissible standards of ground vibration is not available, then reviewer can refer permissible standards of ground vibration practiced in India, Australia and other countries. In India as per Director General of Mines safety, the permissible standards of ground vibration is given in table. Depending on the type of structures and the dominant excitation frequency, the peak particle velocity (ppv) on the ground adjacent to the structures should not exceed the values given below in the table as per the Director General of Mines Safety (DGMS) guidelines. The permissible standards of ground vibration due to blasting as per guidelines of DGMS, Dhanbad, India are as follows.

<table>
<thead>
<tr>
<th>TYPE OF STRUCTURE</th>
<th>DOMINANT EXCITATION FREQUENCY, HZ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;8 HZ</td>
</tr>
<tr>
<td>A. Buildings/Structures not belong to the owner</td>
<td></td>
</tr>
<tr>
<td>Domestic houses/structures (kuchha, Brick and cement)</td>
<td>5</td>
</tr>
<tr>
<td>Industrial buildings (RRC, &amp; Framed structures)</td>
<td>10</td>
</tr>
<tr>
<td>Objectives of historical importance &amp; sensitive structures.</td>
<td>2</td>
</tr>
<tr>
<td>B. Buildings belonging to owner with limited span of life</td>
<td></td>
</tr>
<tr>
<td>Domestic houses/structures (Kuchha, brick and cement)</td>
<td>10</td>
</tr>
<tr>
<td>Industrial buildings (RRC, Framed structures)</td>
<td>15</td>
</tr>
</tbody>
</table>

Source: DGMS Tech Circular No. 7 of 1997, India

Impact on water resource: Ambient water quality criteria of Bhutan, NEC Bhutan 2010

Impact on catchment area: Evaluation of project can be done as per the provision laid in Water Act, 2011

Land use: Evaluation of project can be done as per the provision laid in Land Act, 2007

Forest/Biodiversity and conservation: Evaluation of project can be done as per the provision laid in the Forest and Nature Conservation Act of Bhutan, 1995 and Biodiversity Act of Bhutan, 2003, IUCN Red Data Book

Transportation: Carrying capacity of existing roads

Health and safety: Refer International Labour Organization (ILO) and others guidelines
CHAPTER 4

Mitigation and Environmental Management Plan (EMP)

4.1 Introduction

Mitigation is the process of providing solutions to prevent impacts, or reduce them to acceptable levels.

The objectives of mitigation are:

- To enhance the environmental and social benefits of a proposal;
- To avoid, minimize or remediate the adverse impacts; and to ensure that the residual adverse impacts are kept within acceptable levels.

A good mining project should incorporate environmental and social alternatives at the initial stages of project development. However, there are some which can be managed only after impact identification and prediction.

Mitigation measures can be classified into structural and non-structural measures.

- **Structural measures** include design or location changes, engineering modifications and construction changes, landscape or site treatment, mechanization and automation, etc.

- **Non-structural measures** include economic incentives, legal, institutional and policy instruments, provision of community services and training and capacity building. Non-structural measures are increasingly being used now. They can be applied to reinforce or supplement structural measures or to address specific impacts.

An Environmental Management Plan (EMP) is a framework for the implementation and execution of mitigation measures and alternatives. It usually covers all phases of the project, from pre-construction to the decommissioning of the mine. The plan outlines mitigation measures that will be undertaken to ensure compliance with environmental laws and regulations and to eliminate adverse impacts. The objectives of an EMP, thus, are:

- To ensure that mitigation measures are implemented;
- To establish systems and procedures for this purpose;
To monitor the effectiveness of mitigation measures; and
To take any necessary action when unforeseen impacts occur.

The EMP outlines:

- The technical work schedule to carry out the mitigation, including details of the required tasks and reports, and the necessary staff skills and equipment;
- The detailed accounting of the estimated costs to implement the mitigation plan;
- A plan for operation or implementation of the mitigation plan, including a staffing chart and proposed schedules of participation by the members of the project team, and activities and inputs from various government agencies.

The EMP should also address the formation of a monitoring committee, with the objective of finding out whether different pollution-related issues and social development programmes related to health, education, roads, infrastructure, employment etc., are keeping to the time schedule or not. In case of delays, the reasons for the delays need to be identified and suggestions made for removing them.

**EMP and post-project monitoring**

A good EMP should contain the following

- A summary of all potential impacts
- A detailed description of recommended mitigation measures
- A time-line for implementation of mitigation measures
- Resource allocation and responsibilities for implementation
- A programme for surveillance, monitoring and auditing
- A statement of compliance with relevant standards
- A contingency plan when the impacts are greater than expected

The programme for surveillance, monitoring and auditing should clearly identify the following:

- Parameters for monitoring all significant impacts, including socio-economic impacts and post mine closure impacts.
- Monitoring locations, including sample surveys, to assess the socio-economic impacts
- Frequency of monitoring
- Reporting frequency to the regulatory agency
- Provision for annual environmental and social audit of the project
4.2 Mitigation measures and best environment practices for mine and quarry management

4.2.1 Mitigation measures to reduce impact on land

Topsoil management

The best practices for topsoil management are as follows:

- Scrap the topsoil prior to drilling and blasting.
- Scraped topsoil should be used immediately for plantation/agriculture.
- If it is not possible to use the topsoil immediately, then it should be stacked at a designated area. The location of the storage site should ensure that it does not lead to erosion. The probability of erosion is high if the storage site is proposed at an elevated area.
- The topsoil heap’s height should not exceed more than 6 meters. Storage must be done in a pyramidal form, with garland drains all around.
- If the topsoil is to be stored for a long duration, it should have a vegetal cover of, preferably, leguminous species (grasses and shrubs). If biological reclamation is not done in time, leaching will drain away the nutrients and impair the nutrient cycle, thereby making the soil unproductive.

4.2.2 Overburden management

Overburden disposal and its stabilisation are crucial both from the environment and aesthetics point of view. The decision on ultimate disposal is entirely dependent on the quantity of the overlying earth material over the reserve and in between the seams of deposit. The best management practice is simultaneous backfilling of mined out areas, followed by plantation.

However, if an external overburden dump is unavoidable, then it should be stabilised with biological reclamation. Putting vegetation over the waste dump reduces pollution, ensures long-term dump stability, attracts wild animals and improves aesthetic view. This can be achieved by a combination of engineering and biological reclamation. The engineering reclamation involves work like surface grading, construction of drains, lateral slope drains, jute netting over slopes, gully plugging/check dams, gabions, toe walls, etc. The biological reclamation involves growing of grasses and planting trees.

Best practices for overburden management include the following:

- Excavation from a new pit should begin after an existing pit has been exhausted. This would ensure that the overburden and interburden generated is used for backfilling the exhausted pit, instead of being dumped elsewhere.
• Till a pit is exhausted, the overburden should be compacted and stacked in specified locations or non-mineralised zones within the lease area.
• Vegetation should be planted over the dump slopes as early as possible.
• The height and slope of the overburden dumps should be maintained to prevent slope failure.
• Sedimentation tanks or siltation pond should be constructed to treat run-off from external overburden dumps.
• For external overburden dumps, the bench height and final dump height should optimum and should be decided after consultation with competent authority. The storage of fresh waste should be done in layers and the overall slope angle should be low to avoid material slide. Usually, the slope should not exceed 28 degrees.

4.2.3 Mitigation measures for conservation and protection of water resources

In Bhutan, seeing the terrain, it is inevitable that mining will affect water resources significantly. The impacts cannot be completely eliminated, but sound mine planning and timely implementation of the mine plan can reduce the impacts considerably. The best practices for protection of water resources are as follows:

Water conservation and management

• Plan the surface layout of open-cast mines in such a way that the impact on water bodies as well the surface drainage system remain minimal.
• Natural drains or streams should be disturbed as little as possible. However, in case of diversion, re-alignment should be made by constructing artificial drains.
• Constructing check dams to check the silt or runoff from the mine
• Garland drains should be constructed all around the periphery of the quarry. These drains should be connected to the natural drain or routed to water bodies after treatment in a settling pond.
• Non-mineral zones, external waste dumps, haul roads, etc., should be improved by vegetal cover. Higher vegetative cover in the mine areas will reduce siltation and increase the groundwater recharge.
• To assess the impact on local water levels in time and space coordinates, a monitoring network of dug-wells in the zone of influence should be established and the water levels should be monitored. A location for a piezometer should be selected in consultation with the regulatory authority, if applicable.

Water pollution

• If applicable, treated mine seepage water should be utilised as far as possible to meet the needs of the mining operation, the township, as well as the local
community, wherever applicable. Mine water should be used for domestic purposes only after an assessment of its quality.

- Gabion walls (loose boulders packed in wired crates) should be provided at the toe of active dumps and across the water course with filter pads to check the silt from escaping into the water body.
- Peripheral bunds should be created on the outer edge of abandoned benches before reclamation, so as to minimise any surface run-off by storm water.
- Stockpiled, overburden or topsoil materials should be protected by silt arrestors such as garlands, so that the loose material does not flow away or escape. At the same time, vegetation needs to be grown to stop the erosion of soil and improve aesthetic value.
- A water gradient should be kept at every bench, towards the inside, to prevent the formation of gullies in the bench slopes; these gullies can cause serious erosion.
- Stockpiles, overburden and topsoil should be selectively placed in a stable area which is less prone to erosion. This would, in turn, reduce the silt load on water bodies.
- Effluents from the colony and the workshop should be treated.
- Mine seepage water should be treated in a treatment plant and discharged into the water bodies as per the standards, or supplied to local communities free of cost for agricultural activities. Physical and chemical characterisation of the water is advisable prior to its reuse for agricultural purposes.
- If the mine has AMD, then all the water coming out of the mine should be properly treated for acidity and heavy metal pollution (if present).

4.2.4 Air pollution mitigation measures

An air pollution mitigation and management plan includes management of those activities (drilling, blasting), products (mineral and overburden) and services (transportation) that have the potential to generate air pollution. A good management plan should ensure that the impact of air pollution does not exceed statutory limits or cause undesirable effects on human health See Table 4.1 Best Practices for fugitive dust control in mine.

<table>
<thead>
<tr>
<th>Activities</th>
<th>Best practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling</td>
<td>• Drills should be provided with dust extractors (dry or wet system)</td>
</tr>
<tr>
<td>Blasting</td>
<td>• Water spray before blasting</td>
</tr>
<tr>
<td></td>
<td>• Water spray on blasted material prior to transportation</td>
</tr>
<tr>
<td></td>
<td>• Use of controlled blasting technique</td>
</tr>
<tr>
<td>Transportation of mined material</td>
<td>• Covering of the trucks/dumpers to avoid spillage</td>
</tr>
<tr>
<td></td>
<td>• Compacted haul road</td>
</tr>
<tr>
<td></td>
<td>• Speed control on vehicles</td>
</tr>
</tbody>
</table>
(Note: speed control on vehicles has an approximately linear effect on dust emissions; speed reduction from 30km/hr to 15km/hr will achieve about a 50 per cent reduction in dust emission).

Provision for fixed or automatic water sprinklers on permanent haul roads
- Provision for mobile water sprinklers on non-permanent haul roads

(Note: wet sprinklers can achieve dust emission reduction of about 70 per cent or more, and this can be increased by up to 95 per cent through the use of chemical stabilization)
- Provisions for wheel washing
- Development of a green belt of suitable width on both sides of road, which acts as wind break and traps fugitive dust

| Crusher | • Covered unloading point  
| Transportation from crusher to storage yard | • Closed conveyor transportation from crusher to stockpile  
| | • Minimum drop height at the transfer point  
| | • Regular clean-up of spillage around the transfer points so that the material cannot be picked up by the wind  
| | • Covered transfer points with dust extraction system  
| Stockpile | • Covered storage yard  
| | • In the case of open stockpiles, limit the height and slope of the stockpiles. For example, a flat shallow stockpile will be subject to less wind turbulence than one with a tall conical shape. However, while designing the stockpile due consideration should be given to the effect of other site features - the most prominent being wind direction. Some of the measures to reduce dust impact from the material stockpile are:  
| | • Limiting drop height from conveyors  
| | • Use of windbreaks: wind speed near the pile surface is the primary factor affecting particle uptake from stockpiles. The windbreaks can be constructed by planting trees.  
| | • Sprinklers  
| | • Hood to cover the discharge point

Source: Centre for Science and Environment, New Delhi, India

**Dust control measures in quarry:** Refer to Table 4.2 for various dust control measures that can be adopted in quarry operations.
### Table 4.2: Dust control measures in quarry

<table>
<thead>
<tr>
<th>Operation or source</th>
<th>Control options</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mining Operations</strong></td>
<td></td>
</tr>
<tr>
<td>i) Drilling</td>
<td>• Liquid injection (water or water plus a wetting agent).</td>
</tr>
<tr>
<td></td>
<td>• Capturing and venting emissions to a control device.</td>
</tr>
<tr>
<td>ii) Blasting</td>
<td>• Water spray before blasting</td>
</tr>
<tr>
<td></td>
<td>• Water spray on blasted material prior to transportation</td>
</tr>
<tr>
<td></td>
<td>• Use of controlled blasting technique</td>
</tr>
<tr>
<td>iii) Loading</td>
<td>• Water spray</td>
</tr>
<tr>
<td>iv) Hauling (emissions from roads)</td>
<td>• Water spray, treatment with surface agents, Soil stabilization, paving, traffic control</td>
</tr>
<tr>
<td><strong>Plant Operations</strong></td>
<td></td>
</tr>
<tr>
<td>i) Crushing</td>
<td>• Wet-dust suppression systems, capturing and venting emissions to a control device.</td>
</tr>
<tr>
<td>ii) Screening</td>
<td>• Same as for crushing</td>
</tr>
<tr>
<td>iii) Conveying (transfer points)</td>
<td>• Same as for crushing</td>
</tr>
<tr>
<td><strong>Fugitive dust sources</strong></td>
<td></td>
</tr>
<tr>
<td>i) Stockpiling</td>
<td>• Water sprays at conveyor discharge</td>
</tr>
<tr>
<td>ii) Conveying</td>
<td>• Covering, wet dust-suppression</td>
</tr>
<tr>
<td>iii) Windblown dust from stockpiles</td>
<td>• Water wetting, surface active agents, covering, and windbreaks.</td>
</tr>
<tr>
<td>iv) Windblown dust from roads</td>
<td>• Oiling, surface active agents, soil stabilization, paving, sweeping</td>
</tr>
</tbody>
</table>

Trees can act as efficient biological filters. In fact, a green belt is a proven technology for waste dump stabilisation and restoration of a mined out area. Systematic and planned green belt development reduces fugitive dust and checks run-off, besides improving the aesthetic beauty of an area. Planning for green belt development should be done at the inception.

Green belt of adequate width should be raised by planting native species around the mine lease area, along both sides of haul roads, near material handling plants, on external dumps, backfilled quarries, undisturbed areas and inside the colony. It has been observed that some plant species have a proven efficiency in reducing dust emissions. While granting the clearance letter, afforestation and tree density should be set as conditions – the density of trees should be around 2,500 plants per hectare. As a good management practice, crushing of minerals should be done at the mine followed by conveyor transportation to the storage yard.

### 4.2.5 Biodiversity mitigation measures

Impact on biodiversity is inevitable if a project is located in a sensitive area. There is nothing called ‘best practice’ for biodiversity mitigation. The mitigation measures are
site- and species-specific, and have to be designed and implemented considering the ground realities.

In mining projects, the option of a site alternative is not applicable. If a site is unavoidable, the option is to look for alternatives in the form of technologies or processes that have lower or minimal impact on biodiversity. However, if the mining activity still exercises high adverse impacts, then ‘No Mining’ is the best alternative. Compensation should always be considered as the last option of mitigation (See Figure 4.1: The hierarchy of biodiversity mitigation measures).

**Figure 4.1: Hierarchy of biodiversity mitigation measures**

If impact

The mitigation measures for biodiversity include a Biodiversity Action Plan (BAP) for biodiversity conservation, Species Action Plans (SAPs) where the mitigation is targeted for the protection of a specific species, and Habitat Action Plans (HAPs) to protect the habitats of rare and endangered species.
4.2.6 Mitigation of noise and vibration

The best practices in noise and vibration abatement include:

- use of controlled and advanced blasting techniques like shock tube technology;
- conducting blasting only during the day time, as per a predetermined time schedule;
- use of hydraulic drills;
- provision of sound-insulated chambers for workers deployed on machines producing higher levels of noise like bulldozers, drills, etc.
- enclosing crusher units in covered buildings to minimise sound propagation;
- providing silencers or enclosures for noise generating machines such DG sets, compressors, etc.
- creating a green belt around potential noise-prone areas
- provision of protective devices like earmuffs/earplugs to workers, who are continuously exposed to high levels of noise; and
- reducing the exposure time of workers by practising work rotation.

4.2.7 Mine closure

The fundamental principle of mine management is that if a mine cannot be closed/reclaimed properly, then it should not be opened. The ultimate goal of mine closure/reclamation is to reinstate the landscape, as closely as possible, to its previous physical and biological state. If that cannot be done, then it should be converted into productive assets for local communities.

A good mine closure plan should include the following:

- A detailed final closure plan to create productive and sustainable land use of the mined area after cessation of mining operations. The plan must be accepted by mine owners, regulating agencies, and local communities
- Year-wise progressive reclamation plans
- A plan to protect the health and safety of the surrounding habitat
- A plan to eliminate/contain all possible sources of pollution post-mining
- A plan to conserve valuable attributes and aesthetics of the surrounding area
- A plan to minimise and overcome adverse socio-economic impacts on the people dependent on the mine after cessation of mining operations

4.2.8 Mitigation of occupational health and safety issues

Mitigation measures to reduce occupational and safety risks are given in Table 4.3.
### Table 4.3 Mitigation for occupational health and safety

<table>
<thead>
<tr>
<th>Activity</th>
<th>Mitigation measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Excavation</td>
<td>• Planned excavation, avoid haphazard mining</td>
</tr>
<tr>
<td>• Drilling and blasting</td>
<td>• Driller should be equipped with a closed cabin to reduce exposure to noise and dust. In addition, the operators and other workers should be provided with masks, helmets, gloves and earplugs.</td>
</tr>
<tr>
<td>• Safety zone</td>
<td>• Provisions for a buffer zone between the local habitation and the mine lease in the form of a green belt of suitable width. Restricted entry, use of sirens and cordoning of the lasting area are some of the good practices to avoid accidents.</td>
</tr>
<tr>
<td>• Overburden stabilization</td>
<td>• Accidents are known to happen due to overburden collapse. Therefore, slope stabilization and dump stability are critical issues for safety and environment.</td>
</tr>
<tr>
<td>Worker’s health surveillance</td>
<td>• Health survey programmes for workers and local community</td>
</tr>
<tr>
<td></td>
<td>• Regular training and awareness of employees to be conducted to meet health and safety objectives</td>
</tr>
</tbody>
</table>

### 4.2.9 Resettlement and rehabilitation

The best practices in land acquisition and R&R are as follows:

- Land should not be acquired without the consent of the majority of the project-affected population (PAP). The project proponent should receive ‘free, prior and informed consent’ from the PAP.
- The PAP should include not only landholders but also people dependent on land for livelihood like share-croppers, landless labourers, etc.
- The R&R plan should be a comprehensive framework within which compensation, benefit sharing and community development plans are integrated and the roles of local communities, governments and mining companies are clearly delineated.
- Compensation for land should be based on the current market price.
- The R&R plan should be framed in consultation with the PAP.
- The PAP should have a say in the selection of the resettlement site and design of the housing and other infrastructure facilities.
- Attempt should be made to resettle the displaced people as near as possible to the project sites, so that they can obtain access to facilities as well as economic benefits generated from the project. The R&R plan should recognise not only landholders, but also those dependent on land for livelihood like share-croppers and landless labourers, etc. Compensation should also be provided to them.
- There should be a provision for a life-time monthly pension for the old, disabled and widows (who have no alternate livelihoods).
• Basic amenities should be provided at the new resettlement site. This should include roads, safe drinking water, sanitation facilities, educational and health facilities, markets, community centers, playgrounds, etc.
• There should be a provision for employment to at least one family member from each project affected household. All unskilled and semi-skilled direct employment created in the project should ideally go to the PAPs.
• Financial assistance and training for self-employment should be provided to the PAPs.
• There should be a provision for land-for-land compensation for indigenous communities.
• No physical displacement should be resorted to till the complete R&R package has been implemented.
• Instead of acquiring the land, options should be explored to take the land on lease from the PAP by paying an annual lease rent. The compensation plan should explore the option for benefit-sharing with the PAP.
• Displacement should be used as an opportunity for development. A good resettlement and Rehabilitation (R&R) plan should have components as listed in Table 4.4.

Table 4.4 Recommended outlines for R&R plan

<table>
<thead>
<tr>
<th>Topic</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope of land acquisition and resettlement</td>
<td>• Describe, with the use of maps, the scope of land acquisition and why it is necessary for the investment project.</td>
</tr>
<tr>
<td></td>
<td>• Describe alternative options that can be considered to minimize land acquisition and its effects, and why the remaining effects are unavoidable.</td>
</tr>
<tr>
<td></td>
<td>• Summarize key effects in terms of land acquired, assets lost, and people displaced from homes or livelihoods.</td>
</tr>
<tr>
<td></td>
<td>• Specify role and responsibilities for land acquisition and resettlement.</td>
</tr>
<tr>
<td>Socio-economic information</td>
<td>• Define, identify and provide details of the people to be affected.</td>
</tr>
<tr>
<td></td>
<td>• Describe likely impacts of land acquisition on affected people, taking into account social, cultural, and economic parameters.</td>
</tr>
<tr>
<td></td>
<td>• Identify all losses for the people affected by land acquisition.</td>
</tr>
<tr>
<td></td>
<td>• Details inventory of common property resources, which are going to be affected.</td>
</tr>
<tr>
<td></td>
<td>• Specify how the project will impact the poor, indigenous people, ethnic minorities, and other vulnerable groups, including women, and any special measures needed to restore fully, or enhance, their economic and social base.</td>
</tr>
<tr>
<td>Objectives, policy framework, and consultation</td>
<td>• Describe the purposes and objectives of land acquisition and resettlement.</td>
</tr>
<tr>
<td></td>
<td>• Describe the key national and local policies, laws, and guidelines that apply R&amp;R.</td>
</tr>
<tr>
<td></td>
<td>• Prepare an eligibility policy and entitlement matrix for all categories of loss, including compensation rates.</td>
</tr>
<tr>
<td>Consultation, and</td>
<td>• Identify project stakeholders.</td>
</tr>
</tbody>
</table>
| **grievance redress** | • Describe mechanisms for stakeholder participation in planning, management, monitoring, and evaluation.  
• Identify local institutions or organizations to support the affected people.  
• Review potential role of non-government organizations (NGOs) and community-based organizations (CBOs).  
• Establish procedures for addressing the grievances of the affected people. |
| **Relocation of housing and settlements** | • Identify options for relocation of housing and other structures, including replacement housing, replacement cash compensation, and self-selection.  
• Specify measures to assist with transfer and establishment at new sites.  
• Review options for developing relocation sites, if required, in terms of location, quality of site, and development needs.  
• Provide a plan for layout, design and social infrastructure for each site.  
• Specify means for safeguarding income and livelihoods.  
• Identify special measures for addressing gender issues and those related to vulnerable groups.  
• Identify any environmental risks and show how these will be managed and monitored. |
| **Income restoration strategy** | • Identify livelihoods at risk.  
• Develop an income restoration strategy with options to restore all types of livelihoods.  
• Specify job opportunities in a job creation plan, including provisions for income substitution, retraining, self-employment and pensions, where required.  
• Prepare a plan to relocate and restore businesses, including income substitution, where required.  
• Identify any environmental risks and show how these will be managed and monitored. |
| **Institutional framework** | • Identify main tasks and responsibilities in planning, negotiating, approving, coordinating, implementing, financing, monitoring and evaluating land acquisition and resettlement.  
• Review the mandate of the land acquisition and resettlement agencies and their capacity to plan and manage these tasks.  
• Provide for capacity building, including technical assistance, if required.  
• Specify the role of NGOs, if involved, and that of organizations of affected populations in resettlement planning and management. |
| **Resettlement budget and financing** | • Identify land acquisition and resettlement costs.  
• Prepare an annual budget and specify timing for release of funds.  
• Specify sources of funding for all land acquisition and resettlement activities. |
| **Implementation schedule** | • Provide a time schedule showing start and finish dates for major resettlement tasks.  
• Show how the affected people will be provided for before demolition begins. |
| **Monitoring and evaluation** | • Prepare a plan for internal monitoring of resettlement targets, specifying key indicators of progress, mechanisms for reporting, and resource requirements.  
• Prepare an evaluation plan, with provision for external, independent evaluation of extent to which policy objectives have been achieved.  
• Specify participation for people. |
CHAPTER 5

Review of an EIA report for a mine and quarry project

5.1 Introduction

The purpose of reviewing an EIA report is to take decisions with respect to the following:

• Should the project be cleared in the form proposed by the project proponent?
• Should the project be modified to reduce the impacts and then cleared?
• Is the ‘No project’ option justified, considering the social and environmental costs?
• If the project is cleared, then, what conditions may be prescribed for compliance during design, construction and operation of the project?

5.2 Composition of the EIA review team

To ensure a proper review of the EIA report, the reviewing or project appraisal committee should include experts from diverse fields with a good understanding of the process and potential impact areas. The reviewers should be technically sound and competent enough to review the report. They should be able to make valuable suggestions/recommendations to the project proponent for taking corrective action. Ideally, in the case of a large mining project, the team should comprise of the following experts.

• A mining expert/mine planner/engineer who is well versed with the process and technology, planning and potential impacts of mining project
• An environmental scientist/engineer to overview the adequacy of mitigation options suggested for air, water and waste management and mine reclamation
• A groundwater expert/hydrologist to review the impacts of mining on water resources
• A social science expert/anthropologist to review the social issues and the resettlement and rehabilitation plan
• A biodiversity expert/botanist who can review the biodiversity issues, biodiversity conservation and afforestation plan
• A meteorological expert who can review the meteorological parameters and adequacy and compatibility of air pollution models
• A geologist to review the geological risks and associated impacts
• A safety engineer and occupational health expert who can review the levels of safety, mechanisation, disaster management plans, occupational hazards and
mitigation strategies to combat these hazards at the planning and operational stages

- Nominees of the regulatory agency

5.3 Reviewing an EIA report for a mining project

While reviewing the EIA report, the following key aspects needs to be carefully examined:

- Has the EIA report evaluated the beneficial and adverse impacts of the project properly and clearly?
- Which are the unavoidable adverse impacts? Are they acceptable?
- Is the proposed mitigation plan sufficient to manage and control all adverse impacts?
- What kinds of safeguards need to be incorporated to ensure that the mitigation plan is implemented effectively? In case of mining projects, the implementation of the final mine closure plan needs to be ensured.
- What are the parameters which need to be monitored during project construction and operation so that the state of the environment can be studied throughout the project life?
- Is the project acceptable to the local communities?
- Are the concerns of the local communities genuine and has the EIA report adequately addressed these concerns?
- Will the project improve the socio-economic status of the local communities?

Guidelines for using the reviewer checklist:

By using the reviewer checklist for a mining and quarry project, the reviewer will be able to gauge the acceptability of the EIA report. This can eventually assist in determining the environmental feasibility of the project being assessed.

Scorecard approach: The checklist is designed to follow a “scorecard” approach, using a possible scoring range of 0-10. Scores for each relevant item in the checklist are totaled, and a calculation of the percentage of the total possible score is made.

Relevance: The checklist is a generic checklist for mining and quarry projects. Not all questions may be relevant to all the mining and quarry projects. Therefore, the first step is to determine the relevance of each question, for the specific project being considered. For each question that is relevant, “1” is entered in the box under Column “A” of the checklist, “Is question relevant for this project?” Because the number of relevant parameters varies from project to project, the possible total score for each EIA report will vary accordingly.
**Adequacy:** It is then necessary to determine the adequacy of the EIA report in answering only those questions that are judged to be relevant. Under the “adequacy” heading (Column “B”), the reviewer is asked to assign a numeric score from 0-10. The numeric scoring for the various elements of the EIA report, based on their level of completeness, clarity, and quality, is as follows:

9-10: **Excellent:** Information provided is clear, comprehensive and detailed, with no gaps or weaknesses.

7-8: **Good:** Information provided is comprehensive, has only very minor weaknesses which are not of importance to the decision-making process.

5-6: **Adequate:** Information provided has some minor weaknesses, but the deficiencies do not strongly compromise the decision process; no further work is needed to add to the environmental information.

3-4: **Weak:** Information provided has gaps and weaknesses which will hinder the decision process; some additional work is needed to complete the information.

1-2: **Very poor:** Information provided has major gaps or weaknesses which would prevent the decision process from moving ahead; major work is required to rectify.

0: **Absent:** Information needed for decision-making is not included in the report, and needs to be provided in its entirety.

**Importance:** It is also necessary to determine the importance. In many cases, some of the issues are relevant for the project but is not very important or significant in impact assessment. For instance; name of project, project schedule is relevant for the project but it has not much importance in environmental and social impact assessment. Therefore, while assigning the value for importance, reviewer should always keep in his/her mind the level of importance, a) relevant but least important, b) relevant but average important, c) relevant but most important.

In addition, for each relevant item, the reviewer is instructed to fill in comments for each relevant item. This should be made a mandatory procedure, so that the justification for assigning a specific value for adequacy as well as importance is well documented. For those items where the information provided in the EIA report is not adequate, it should be indicated in the far-right column what types of information are still required, in order to adequately address the question.

As a rule of thumb, an EIA report achieving a score in the range of 50-60% or higher should be considered acceptable. Borderline scores, or scores much lower than this limit, indicate that the EIA report is likely not acceptable. It should be noted, that while this
design (i.e., using a numeric scorecard, and requiring reviewers to provide comments and justifications for their itemized determinations) is intended to minimize subjectivity, this “semi-quantitative” approach cannot totally eliminate all subjectivity from the review process, because the assignment of numeric scores is itself, by nature, a subjective process.

At the end of each section of the checklist, space is left for “other questions.” The space provided here may be used to elaborate on the listed questions in each section (referencing the question number), or to add questions that may have specific relevance for the project being reviewed.

**Overall Evaluation:** There are six components that need to be evaluated to give the total score.

1. Applicant Information
2. Project Description
3. Baseline information
4. Impact Assessment
5. Mitigation and Environmental Management Plan (EMP)
6. Other Requirements

The final section of the checklist provides a framework for giving an overall evaluation of the EIA report. Each topic covered in the checklist is assigned a score, from 1-10, according to the same system used in the main section of the checklist. The resulting value provides a further basis for determining whether or not the environmental information presented is adequate (“acceptable” or “not acceptable”) for making an informed determination about the quality of the EIA report. This is simply a way to cross-check the results that were obtained through a detailed itemized review of the EIA report (Refer reviewer checklist).