10. PREPARATION OF ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND ENVIRONMENTAL MANAGEMENT PLANS (EMP) FOR MINES

10.1 PREFACE

The concept of "EIA" was pioneered in USA with the formulation of National Environmental Policy (NEP) in 1969. EIA has been defined by Jain et al (1977) as "a study of probable changes in various socio-economic and bio physical characteristics of the environment which may result from a proposed or impending action". Yet another precise definition by Heer and Hagerty (1977), states "it is to be an activity that aims at establishing quantitative values for selected parameters which indicate quality of environment before, during and after an action". EIA has come to be recognised as an important management tool for ensuring optimal use of natural resources for sustainable development, and was introduced in India initially for River Valley Projects in 1978-79. The scope of the EIA has been enhanced to cover other developmental sectors such as industries, mining schemes, energy, etc. To facilitate project proponents in collection of environmental data and formulation of environmental management plans, it is now mandatory under the Environment (Protection) Act, 1986, for 29 categories of developmental activities involving investment beyond certain thresholds.

The notification was issued by MOEF on 27th January 1994 and was amended latest on 13th June 2002 on the environmental impact assessment of development projects. This, it is hoped would provide an opportunity both for the project proponents and Government to assess the impact of the concerned project on the environment before it actually comes into play.

Environment means the whole complex of physical, social, cultural, economic and aesthetic factors, which effect individually as well as the communities. Environmental impact means any alteration of environmental conditions or creation of new set of conditions, adverse or beneficial, caused by human activity, such as mining. The purpose of EIA is to identify and evaluate the potential impacts (beneficial and adverse) of development projects on the environmental system. It is a useful aid for decision making based on understanding of the environmental implications including social, cultural and aesthetic concerns which could be integrated with the analysis of the project costs and benefits. This exercise should be undertaken early enough at the planning stage of projects for selection of environmentally compatible sites, process technologies and such other environmental safeguards.

There are a number of environmental parameters such as land, air, water, solid wastes, noise pollution, plant & animal life, social & cultural life of people, etc., which may get affected due to mineral development activity. The EIA should be an assessment of the impacts of different developmental activities/actions, which may act upon various environmental parameters. Therefore, the first task of the EIA is to identify all the relevant parameters, which are likely to be affected by the above activity and assess the qualitative and quantitative changes in them. Thus, the evaluation of EIA enables the decision maker either to approve the proposed project or to make some suggestions for alterations in the project or to completely disapprove the project. In this process, the promoters of the project will get the chance of either to eliminate some of the activities which cause most severe impact or at the best to mitigate their undesirable effects on the environment that would arise from the contemplated actions. This in fact reflects that many of the types of environmental damages can be avoided by remedial measures provided that they are identified well in advance.

While all industrial projects may have some environmental impacts, all of them may not be significant enough to warrant elaborate assessment procedures. The need for such exercises will have to be decided after initial evaluation of the possible implications of a particular project and its location. The projects which could be taken up for detailed Environmental Impact Assessment include:

(i) Those which can significantly alter the landscape, land use pattern and lead to concentration of working and service population
(ii) Those which need upstream development activity like assured mineral and forest products supply or downstream industrial process development
(iii) Those involving manufacture, handling and use of hazardous materials
(iv) Those which are sited near ecologically sensitive areas, urban centres, hill resorts, places of scientific and religious importance
(v) Industrial estates with constituent units of various types which could cumulatively cause significant environmental damage.

EIA also helps in identifying alternatives to siting of projects (except mining projects which are location specific), choice of technology and alternatives to the proposed development projects. While EIAs do not always yield precise quantitative optima on all environmental issues, they do focus attention on major ones, which enable examination of options for choosing an acceptable course of action. In recognition of the role that EIA could play, Government approval for investment decisions and selection of sites for projects in various sectors is accorded on the basis EIA and clearance thereof.

10.2 COMPONENTS OF EIA

The difference between Comprehensive EIA and Rapid EIA is in the time-scale of the data supplied. Rapid EIA is for speedier appraisal process. While both types of EIA require inclusion/coverage of all significant environmental impacts and their mitigation, Rapid EIA achieves this through the collection of 'one season' (other than monsoon) data only to reduce the time required. This is acceptable if it does not compromise on the quality of decision-making. The review of Rapid EIA submissions will show whether a comprehensive EIA is warranted or not.

It is, therefore, clear that the submission of a professionally prepared Comprehensive EIA in the first instance would generally be the more efficient approach. Depending on nature, location and scale of the project, EIA report should contain all or some of the following components.

- Monitoring the site-specific meteorological data, viz. wind speed and direction, humidity, ambient temperature and environmental lapse rate
- Air Environment
- Noise Environment
- Water Environment
- Biological Environment
- Land Environment
- Socio-economic and Health Environment
- Risk Assessment
- Preparation of an on site and off site (project affected area) Disaster Management Plan
- Environment Management Plan

The list of instruments required for environmental analysis for both field investigation and laboratory purpose is shown in the following Table:

List of Instruments required for Environmental Investigations

Category	Field Investigation	Laboratory
I) Air Pollution	a) High Volume Air Sampler b) Respirable Dust Sampler c) Personal Air Sampler	a) Hot Air Oven
	a) Stack Monitoring Kit	b) Muffle Furnace
	b) Anemometer	
	c) Hygrometer	OPTIONAL : a) (Ultraviolet visible) Spectrophotometer
	d) Personal Air Sampler	b) Smoke meter
	e) Dust Fall Apparatus f) Max. & Min. Thermometer	c) Portable Gas Chromotograph (for gas analysis)
	g) Wind Monitoring System	
II) Water Pollution	a) Portable Water Analyser Kit	a) Distilled Water Plant (all glass)
	b) pH meter (Pocket)	b) pH meter (Lab.)
	c) Conductivity Meter (Pocket)	c) Conductivity Meter (Lab.)
	d) Portable Dissolve Oxygen Meter e) Bacteriological Test kit f) Portable Colorimeter g) Turbidity meter	d) Magnetic stirer e) Autoclave f) Mercury Analyser g) Water Deionizer Equipment h) Waterbath i) BOD Incubater OPTIONAL : a) Flame photometer
		b) Atomic Absorption Spectrophotometer
		c) Ion Selective Electrode d) Hexavalent Colorimeter for chromium test
III) Noise Pollution	Noise Level Meter (i) Sound level meter (ii) Integrating Sound level meter	
IV) Ground Vibration	Blasting Seismograph (Optional) Blastmate, Minimate, etc.	

10.3 THE PROCESS OF EIA

There are four fundamental steps involved in carrying out an EIA which include :

- Step 1 : Complete understanding of the proposed action including men and material, time frame of each activity and a list of activities which start when the project commences.
- Step 2 : To find out the environmental parameter while would be impacted or changed by the action.
- Step 3 : The proposed action is projected into future and possible changes on various environmental parameters determined.
- Step 4 : Results of the analysis are brought out for a comprehensive picture of environmental impacts for decision making.

10.4 DIFFERENT METHODOLOGIES ADOPTED FOR THE REPARATION OF EIA & THEIR LIMITATIONS

A number of methods have been developed for preparing EIAs. Most of them, however, suffer from excessive dependence on subjective judgements and are weak in predicting and quantifying the impact of the project on the environment.

- ***Adhoc Method :*** It is an old and crude method which can only bring out broad impacts on forests, human population, etc. Secondary impacts are rarely addressed.

- ***Check Lists*** : A Check list is a list of environmental parameters in which an adverse, beneficial or no effect is time marked. They are usually very large and subjective and is of little use in decision making.

- ***Matrix Method :*** This is attributed to Leopold et al (1971). A matrix format is used to relate project actions with environmental parameters. The column of the matrix consists of 100 project actions cells (could be reduced as per requirement) and the rows of the matrix consist of 88 environmental components, which too could be suitably altered depending upon the requirements of the project. If any of the project affects an environmental component, the appropriate project action cell is assigned a score depending on the magnitude and importance of the impact. A = (+) or (-) is also put to designate harmful or beneficial impact.

  Row totals of the matrix reflect the cumulative impact of all project actions on one environmental component while the column totals reflect the impact of the project activity on all the components of the environment. The matrix total gives the total environmental impact.

  One of the drawbacks of the matrix method is that it does not consider the assessment of secondary impacts. Besides it is a non mathematical matrix in which true algebraic operations cannot be performed. The CMPDI, Ranchi, has used a matrix method for assessment of environmental impacts of mining projects in India on an arbitrary scale using 1 for appreciable impact and 4 for severe impact.

- ***Mathematical Matrices :*** Two such matrices have been developed namely, the Peterson's Matrix and Component Interaction Matrix in the year 1974. The later was developed by Ross.

The Peterson's matrix is constructed to evaluate the effects of environmental action on various components of the environment on a scale of +3 and –3. Another matrix is constructed to evaluate the effects of the impacted physical components on human environment matrices as developed in the earlier two steps are then multiplied to produce a third matrix which brings out the effect of project activities or actions on the human environment. The production matrix is operated by a vector of relative weight of human environment. The production matrix is operated by a vector of relative weight of human impacts to yield a weighted vector of human impacts. The weighted vectors are then summed up to arrive at the total value of the impact of the project.

The Component Interaction Matrix was developed to assess major impacts of five alternative sites for transhipment of number of a estuary. The following steps are involved :

(i) Construction of a matrix with environmental components on each and identifying first order dependencies.
(ii) The matrix is powered to determine all higher order dependencies.
(iii) A disruption matrix is then constructed to score impacts of each project alternatives on primary dependencies.

Mathematical matrices suffer from too much of mathematical aggregation, tends to be unwieldy and basic inputs are still subjective.

- ***Network Approach :*** The objective of such a method is to bring out in an easily understood format, the intermediary links between projects and its ultimate impacts. Since the environmental system is dynamic, an action or activity impacting any particular environmental parameter is capable of causing a series of impacts on a number of other environmental parameters. The network method defines a set of possible networks and the user can identify the impact by tracing it to appropriate project actions.

  If there are n branches in an impact tree and pi is the probability that impacts a : score for a given branches I to occur i

  Also if M(x) = magnitude of impact x on branches.

  And if I (x) = importance rating of the impact x

  Then the impact score for a given branch i = M(x) I(x)

  Environmental impact for all the branches is project as a whole is given by

$$EI = \sum_{i=1}^{n} p_i \text{ (impact score for branch I)}$$

This approach is very good for measuring higher order impacts although quantification of impacts is still essentially subjective in nature.

- ***Battlelle Environmental Evaluation System :*** This is one of most comprehensive methods of EIA. It visualises 78 environmental parameters divided into four major categories of ecology, environmental pollution, aesthetic and human interest. This method involves :

(i) transformation of parametric estimates into an environmental quality (EQ) scale which ranges from 0 to 1, 0 denoting extremely load quality and 1 very good quality. This is done using value function curves.
(ii) EQ values are then multiplied with their respective parameter importance unit (PIU) values to obtain environmental impact units (EIU) for each parameter.

(iii) EIU values are then aggregated as follows for a composite score :

EI = (Vi)1 wi - (Vi)2 wi

Where,

EI	=	Environmental Impact
(Vi)1	=	value in environmental quality of parameter i with project
(Vi)2	=	value in environmental quality of parameter I without project
Wi	=	relative weight of parameter I
M	=	total number of parameters

Total environmental impact is calculated by evaluating expected future environmental quality with and without project. NEERI, Nagpur has used a modified version of this system for EIAs of some mining projects in India.

- ***Computer Aided EIA*** **:** Of late, computer aided EIA methods have been developed. One such system has been developed by the US Army Construction Engineering Research Laboratory for predicting environmental impacts of army construction activities.

  Luhar and Khanna (1988) have proposed a computer aided rapid environmental impact assessment system using predictive models for a number of environmental parameters. The method divides the environment into six broad environmental components (i) namely, Air, Water, Land, Biological, Socio-economic and Noise. Each environmental component above is further divided into associated risks and control costs (j) and each risk further divided into measurable environmental parameters and predictors (k). Value function curves have been developed to convert measured values of environmental parameters into environmental quality on a scale between 0 and 1 like the BEES. The overall environmental impact is aggregated using an aggregate index. A notable highlight of this method is the use of air, water and noise models for prediction of environmental parameters on computer based systems.

10.5 ENVIRONMENTAL IMPACT MATRIX DEVELOPED BY MINING RESEARCH CELL OF IBM

Many studies for the use of matrices for the environmental impact studies for different industries were undertaken. They differ from each other and there is no uniformity in their approach, or agreement upon the objectives in an impact analysis. Further in mining industry not much of quantified work has been done to identify more or less a uniform matrix. Hence attempts have been made by M.R. Cell of IBM, to develop a uniform and generalised matrix, covering almost all the environmental parameters, which are likely to be affected due to different actions from the mining industry (especially from the metalliferous mines). The main objective of evolving this matrix is to serve as a guide for many people who are faced with the evaluation and preparation of environmental impact study report connected with mining.

The EIA analysis requires the definition of two aspects of each action, which may have an impact on the environment. The first is the definition of the magnitude of impact upon the specific sector of the environment. The term magnitude is used in the sense of degree, extensiveness or scale. The second is a weighing of the degree of importance i.e. the significance of the particular action on the environmental factor in the specific instance under analysis. Unlike magnitude of impact, which can be more readily evaluated on the basis of facts, evaluation of the importance of impact generally will be based on the value judgement of the evaluator. The numerical values of magnitude and importance of impact reflect the best estimates of pertinence of each action. The EIA matrix should, therefore, consist of three basic items:

- A listing of the effects on the environment, which would be covered by the proposed development and an estimation of the magnitude of each.
- Evaluation of the importance of each of these effects.
- Combining the magnitude and importance estimates in terms of summary evaluation.

The analysis covered by the above three items is made with a matrix, called the environmental impact matrix, before implementation of mitigation measures, by including the actions of the projects which may affect the environment, along horizontal axis and the existing environmental parameters, that might be affected, along the vertical column. This provides a format for comprehensive review to remind the investigator of the variety of interactions that might be involved. For every action, the concerned environmental parameters are assigned to two different numerical values, one for importance factor and the other for its magnitude.

Procedure adopted in developing the matrix :

As the first step in the construction of this matrix, a list of environmental parameters that might be affected due to mining operations are tabled along the vertical column. These parameters are grouped under six logical sets as Land, Water, Air, Noise, Human Environment and Eco-system. Under each of these sets, sub-sets are made, showing the specific topics involved under each set. For example, land degradation can be due to the alteration in relief, soil erosion, deforestation, change in land pattern, land slides and so on. After listing these topics, ratings are assigned to each of these topics in numerical values showing the relative weightage of these sets. These weights are attached by distributing 1000 parameter importance units/points among these topics, based on their priorities and effects.

Since mining causes almost equal damage to land as well as water quality and resources, equal weightage of 275 points each, are given to the above two sets. Amongst the set, land degradation, and in fact even amongst all other sets also, the deforestation is the major environmental damage caused by mining activity especially by surface mining. Hence, the highest weightage point of 100 is assigned to the deforestation and the balance 175 weightage points are equally distributed amongst the other topics in land degradation each weighing 25 points. In the second set, that is water, it is divided into two subsets water quality and water resources. In mining activity the more environmental impact effect is on the quality of water by getting dissolved with toxic substances and carrying suspended solids, rather than the use or depletion of natural water resources. Therefore, a weightage of 200 points is assigned to the quality of water, both for surface as well as underground. Since the dissolved toxic elements create more havoc than the solid suspensions in the water, more weightage is given for toxic substances present both in surface as well as the ground waters qualities, by giving a weightage of 75 points each. The balance of 50 points is assigned to the solid suspensions. Further, 75 points are attached to water resources, distributed equally amongst the surface water, ground water & aquatic life. As existence of aquatic life also depends upon the surface water resources, this topic is also included under this subset.

India is a developing country and mining is the backbone for any industrial growth. Further, it solves the unemployment problems and creates avenues for medical and other infrastructure and social facilities, as most of the mines in India, are located in interior and backward areas. Hence a total weightage of 175 important points is assigned to different topics under the set – Human Environment. Of course, most of the topics under this set are beneficial to humanity.

Except the dust nuisance, there may not be any other significant air pollution caused by the mining activity. Therefore, it finds the third place in the weightage assignment, having weightage assigned as 125 points. These points are distributed amongst the topics as dust generation and liberation of noxious gases as that from the blasting fumes or the exhaust from machinery/equipment, etc. In the matrix the next place is given to the Eco-system of the area, having weightage assigned as 100 points. This set consists of wild life, rare species found in the area, disturbance to food chain and other microorganisms of flora and fauna. The weightage point of 100 is equally distributed amongst all these four topics, each rating at 25 points. The last weightage is given for noise. Since almost all the mines are located in isolated areas, uninhabited, a weightage of 50 points only is assigned to this set and this is equally distributed under the items nuisance to inhabitants and scaring away of the wild life existing if any. Thus, 1000 parameters importance-points distributed amongst the above six sets.

After listing out the environmental parameters under the vertical column of matrix and assigning their weightage importance points as above, the different operations involved under mining activity are tabled under the horizontal axis. They include ore/mineral excavation, drilling and blasting, loading and transport, solid waste disposal, surface facilities, ore treatment, construction of tailing dams, etc. Items like liquid &gaseous effluent discharges, energy generation, waste-recycling and accidents are also included under the table, as these items result from mining activity, though they are not actual mining operations. Thus the number of total actions listed horizontally is 113, and the vertical list of environmental parameter topics contain 27 items which gives a total of 351 possible interactions. The items listed here represent most of the basic actions and most environmental parameters likely to be involved in full range of mineral development activity. However, it may not be necessary that all would apply to every project.

After tabulating these items the next step is to make interaction between mining activity and environmental parameters. The places of interactions are marked on the matrix by judgement and numerical score values for impact assessment ranging from 1 to 5 are marked at these places, '5' represents the highest magnitude of impact and '1' the minimum. Positive or negative signs are assigned to these score values to denote beneficial or adverse effects. It must be emphasised here that the significance of high or low values for any item only indicate the degree of impact of one type of action on the particular environmental parameter.

Assignment of numerical weights to the magnitude should be to the extent possible, based on factual data rather than preference. Thus, the use of this rating scheme discourages purely subjective opinion and requires the author of an environmental impact statement to attempt to quantify his judgement of probable impacts. The overall rating allows the readers to follow the originator's line of reasoning and will aid in identifying points of agreements and disagreements.

The most efficient way to use the matrix is to check each action on the top horizontal list, which is likely to be involved in the proposal project. Each of these actions thus checked is evaluated in terms of magnitu.'e of the effect on the environmental characteristics on the vertical axis and a mark is placed across each item, which represent significant interaction. In marking this matrix, it is important to remember that actions may have major short-term impact i.e. major impacts only during the initial years of starting the project the impact of which may gradually decrease in a few years and thus form only minor or negligible importance in a long-term frame. An example of this is the construction of building and other land development activities involved in a mining project. Conversely, other actions with lesser initial impact may produce more significant and persistent effect and therefore may have major impact in a long-term frame. An example of this is the erosion from a solid waste dump located near a valley or a stream. In marking these items, unnecessary duplication can be avoided by concentrating on first order effects of specific actions. For example, ore dressing operations would not have direct effect on aquatic life, even if the tailings were toxic in aquatic environment. The aquatic impact would be covered under disposal of tailings/solid wastes, which may lead to direct degradation of the aquatic habitat. After marking, each mark is assigned with the value of relative magnitude of impact ranging from 1 to 5 and with a positive or negative sign as explained earlier. The value of the arithmetical sum of the values of magnitude of impact multiplied by the weightage points assigned to each environmental parameter/topics is enlisted in the last column of this table. This gives the individual score value for each topic. After getting all these individual score values, their arithmetic sum is arrived which gives the cumulative score value of EIA of the project. This value can be compared to the significance of score values to judge the overall impact of the proposed mining activity on the environment.

This cumulative score thus obtained will be compared with the significance of score values in order to judge whether the project is environmentally feasible or not and also to know that type of mitigation measures are required. To evaluate the significance of score values, a highest value of (+) 1000 which is the sum of the parameter importance units/points that are assigned is taken, where there will not be any appreciable impact on environment by the project. The minimum score value at which a permanent irreversible impact could occur is taken at the score value of (-) 5000 and below and the project at that stage will be environmentally not feasible. This is the product of sum of the parameter importance units/points assigned multiplied by the value of severe magnitude of impact i.e. (-) 5. In between the above two score values, based on the experience and judgement four stages are assigned at which different levels of mitigation measures/control measures are to be taken.

The text should accompany the completed matrix. This text should be primarily a discussion on the reasoning behind the assignment of numerical values assigned for the magnitude of impact and their relative importance and should include a discussion of the action which have significant impact and should not be diluted by discussion of obviously trivial side issues. The matrix should in fact be the abstract of the text that is accompanied.

The impact matrix described so far relate to the environmental impact assessment of the project before the implementation of any mitigation measures. In fact this reflects the mitigation/control measures that are to be taken under different environmental parameters. Based on this an Environment Management Plan will be prepared depicting therein the mitigation/control measures that will be taken up. In order to assess the efficacy of these mitigation/control measures, it is also necessary to prepare another environmental impact matrix after the implementation of the proposed mitigation measures. In fact this matrix will be an abstract of the text on the proposed environmental control measures.

This matrix constructed after the implementation of the mitigation measures is almost similar to the earlier matrix before implementation of any mitigation measures either in the body or in the procedure adopted. The only difference will be that in the horizontal axis in place of different mining operations, the different mitigation/control measured that will be adopted are introduced. Hence, a set of control measures going to be adopted are land reclamation and back filling, stacking and reuse of the top soil, erosion control afforestation after care and monitoring, etc. A total of 11 numbers of activities covering almost all the control measures that are required under mining activity are tabled. Here, under this horizontal axis, in addition to the above items on control measures and their total score, two more items are also introduced. They are the score arrived before implementation of mitigation measures and the net score after implementation of mitigation measures. The score before the implementation of mitigation measures for different environmental parameters as assessed earlier under the environmental impact matrix, before implementation of mitigation measures, are entered in this column. The last column i.e. net score is the arithmetical difference of the total score after implementation of mitigation measures and the score before implementation of mitigation measures. This finds out the net score after the implementation of mitigation measures for all the environmental parameters. A positive value of this net score indicates that the total proposed mitigation/control measures are effective to control the net environmental degradation caused by the implementation of the project.

This net score, thus obtained, will be compared with the significance of score values in order to judge whether the mitigation measures proposed are environmentally sound or not. To evaluate the significance of score values a lowest value of (-) 1000, which is the sum of the parameter importance units/points that are assigned, is taken, where the mitigation measures proposed will be grossly inadequate and a revision of entire EMP is required. The maximum score value at which mitigation measures are quite adequate and no changes in environmental impacts are visualized at least for the next 5 years period of mining, the auditing of which can be taken at 5 year intervals. In between the above two score values, based on the experience and judgement four stages are assigned at which different levels of environmental auditing are required.

10.6 PREPARATION OF ENVIRONMENTAL MANAGEMENT PLANS (EMPs)

Once the impacts of the proposed mining activities are known, an EMP should be prepared incorporating adequate safeguards or abatement measures for preventing/mitigating the likely damage to the environment. Environmental management is a process of natural resource optimisation for short and long term human welfare. In other words, mineral resources need to be extracted and converted into goods and services for the present generation but other resources like bio diversity and genetic material contribute to human welfare through conservation. There is a term delicate balance, which has to be maintained to ensure that the benefits are available on a long-term basis. The key success factors of an EMP are:

- Set out clear achievable targets & quantitative indicators on level of environmental management required
- Specify realistic institutional responsibilities for implementation, taking into account the local conditions
- It should be able to modify & shape the project in the light of monitoring results

- Address costs of implementation & resolve the issues of how these costs are to be met with
- Create effective accountability for implementation & for monitoring its success

The management plan should consists of the following aspects:

- General Considerations: Anticipated pollution specific to mine site, ore dressing plants and waste dumps.
- Storage & Reuse of Topsoil: Design of storage piles and improvement in quality for reuse.
- Land Restoration / Reclamation
- Design of solid waste dumps - Selection of areas, heights and slopes of the dumps and provision of intermittent berms.
- Design of retaining Walls - Their shape, width, height, and size of foundation and material for construction.
- Back-filling - Old & worked-out portions.
- Design of tailing dams - Tailing is the residue of ore processing and represent a significant component of mineral waste. Tailings are commonly deposited as slurry containing 45-80% water, depending upon the de-watering measures taken at the mill. Though tailing is chemically similar to its parent ore but the presence of milling reagents, evaporation of free water, etc., can be the properties. Tailings include a variety of heavy metals, radioisotopes, cyanide, hydrocarbons, salts etc. Such constituents can leach from the tailings and enter surface and ground water. They can be disseminated through wind and water erosions. They can even migrate upward via capillary action and diffusion to contaminate the soil placed over the tailing surface to support vegetation, they can be absorbed by plants and introduced into food chain. The major environmental problem associated with mining is the tailing disposal, which includes, site selection, erection of dams, method of disposal, settling of slimes, decantation, reuse of water, etc. The primary requirement of a tailing pond is to prevent the discharge of substantial amount of solids into the receiving watercourses. In many instances, it is built to provide a large degree of chemical treatment to the liquid waste within the pond. Thus, a typical pond may be required to perform some or all of the following functions:

    a. Removal of tailing solids by sedimentation
    b. Acid neutralisation
    c. Formation of heavy metal precipitates
    d. Retention of settled tailings
    e. Stabilisation of oxidizable constituents
    f. Storm water storage and flow balancing
    g. Water treatment facility for recycling the water to the mill

Following deposition in the tailing dam, a large portion of the water is removed by sedimentation and decantation, but additional water must be removed prior to reclamation. Most de-watering operations rely on evaporation. When this de-watering can not remove sufficient water to allow the access for machinery and subsequent reclamation, special measures may be needed.

- Prevention of spread of pollutants in the surrounding of the affected areas through green belts.

- Improvements of land use in the virgin areas - Conversion into cultivated lands, forestlands, picnic spots, etc.

- Avenue plantations in other areas like colony, other buildings, etc.

- Protection from landslides and back filling of worked out portions

- Afforestation Programme : this should include :

    1. Mulching and artificial soil formation on the waste dump and reclaimed surfaces.
    2. Initial reclamation crop - To improve soil quality.
    3. Economic utilisation of the area through commercial crops and through transplantation of trees.
    4. Provision of infrastructure facilities required for the afforestation work
    5. Provision of Green Barriers Estimation of their widths and species selection for dust and noise control.

- Drainage Control & Hydrologic Balance: It should include :
    1. Protection of surface drainage system.
    2. Design of garland drain.
    3. Design of check dams.
    4. Hydrological Balance and recharge of ground water.
    5. Water Harvesting Systems

- Liquid Effluent Treatment : It should include :
    1. Treatment of mine and plant drainage water.
    2. Design of settling tanks and water treatment plants.
    3. Design of sewage treatment plants and grease traps.

- Treatment of drinking water including filtration and chlorination of drinking water.

- Control on Soil Erosions: Design of drainage structures, spread of mulches and growth of vegetation.

- Control on Fall of Scree & Flyrocks: Modification of the blasting parameters if required to control the spread of fly-rocks.

- Control on Air Quality: This should include :
    1. Noxious Gases: Measures to control emissions at source in the plants and within the mines through scrubbers, traps and stacks.
    2. Dust Control: Measures to control emissions at plants, mines and mine roadways, through filters, scrubbers, water sprays and green barriers.

- Control on Noise, Vibrations & Subsidence:
    1. Noise Level: Design of noise abutment structures and green barriers.
    2. Ground Vibrations & Subsidence: Controlled-blasting technique/Alterations to conventional blasting systems, to protect surface features and migration of wild life. Measures adopted to protect the ground from subsidence, subsidence surveys, etc.

- Wild Life Protection : Promotion of congenial environment for immigration of wild life.

- Human Environment: Preparation of practicable rehabilitation plans.

- Management on Socio-economic Fabric : Provision of new avenues for jobs, adoption of surrounding villages, rural development programmes, health care systems and preparation of cost-benefit analysis.

- Post-plantation Care: Permanent irrigation facilities and other post plantation care for the revegetated areas.

- Monitoring System : A feedback mechanism that the mitigation measures function efficiently. Locations of monitoring stations and analytical procedures to be adopted.

- Equipment for Restoration the Plan: Machinery and equipment required for soil preparation, afforestation, chemical analysis, meteorological data and erection of pollution control structures.

- Manpower Organisation : Expert facility required and the requirement of other staff, technical persons and workers.

10.7 EMP REQUIRED UNDER THE MINING PLAN

An EMP which is to be incorporated in a 'Mining Plan' required to be submitted under MCR 1960 (as amended) in case of fresh grant or renewals of mining leases and under MCDR, 1988 in respect of existing mining leases should conform to the following outline and it consists of three parts, Baseline Information, Environmental Impact Statement & Environmental Management Plan.

Baseline Information

Reliable baseline data is generally not available particularly for small mines. However, considering the limited resources of such mine owners, the IBM has issued a simplified guidelines for such small opencast mines (without any beneficiation plants) for submission of mining plans including aspects pertaining to environment management plans.

However, the Chief Controller of Mines, IBM, Nagpur has issued Circulars to all RQPs in the country prescribing certain minimum standards to be achieved in the EMPs which are incorporated in the mining plans submitted to the IBM as mentioned earlier. Circulars No.3/92 dated 16-10-92 have spelt out in great detail the requirements of an elaborate baseline information including the manner of sample collection, selection of sampling stations, seasons to be covered, number of samples to be collected per station and the parameters to be tested, etc. in respect of all mechanised mines or mechanised mining projects in non forest areas. It also spells out the aspects to be covered in the EIAs. The circular has also brought out the need for periodical monitoring of baseline data as one of the main purposes of collecting baseline information is to monitor changes in the environmental parameters consequent to mining. It was followed by yet another Circular No.2/92 issued on 11th February, 1993, which requires collection of (a) dust fall or precipitation rate and (b) respirable free silica under "Air Quality".

Environmental Assessment Report :

A environmental assessment report should include the following :

1. Executive summary: It is a summarised account of all salient findings and recommended actions
2. Environmental regulations
3. Project description

4. Baseline data
5. Analysis of alternatives
6. Environmental impacts
7. Mitigation plan
8. Monitoring plan
9. Appendices

There are a number of consultants both in public and private sectors who undertake generation of environmental baseline data. Necessary information about the preparation of EIA and EMP have been furnished in Annexure-14. The Indian Bureau of Mines also undertake such assignments on payment of charges and for which enquiries may be addressed to the Controller General, Indian Bureau of Mines, Indira Bhawan, Civil Lines, Nagpur – 440 001.

10.8 ENVIRONMENTAL CONDITIONS THAT ARE OBSERVED TO BE NOT COMMONLY COMPLIED WITH

- Simultaneous reclamation of pits and quarries is not undertaken by most of the mines. Para 4.42 of National Forest Policy is reproduced below – Beneficiary mine owners should undertake reclamation of mines in accordance with established forestry practices as directed above.
- Proper demarcation of safety zone and its regeneration.
- Installation of effluent treatment plants.
- Opening of fuel wood depot in project areas.
- Planting of dwarf tree under transmission lines.
- Canal side planting.
- Mutation of compensatory afforestation land in favour of Forest Department.
- Roadside plantation.

The underground mining helps in reducing surface land degradation to certain extent and air pollution, it leads to subsidence, which is equally harmful to the flora and fauna. The water from these mines is pumped out constantly to avoid any accident and flooding in the underground mine. Discharge of mine water into streams leads to contamination of surface water. This must be rectified immediately.

In opencast mining, the ambient air quality is poor with high values of suspended particulate matter due to the plying of heavy trucks, dumpers and dozers. In addition, the blasting in the area, though controlled, leads to clouds of dust in the vicinity. Water sprinklers are essential in these areas to minimise dust pollution. Such facilities, however, are provided at a few areas. The major problem observed in opencast mines is an improper management of overburden dumps. One of the conditions of the clearance letter specifies maintenance of overburden dump below 28° slope. But due to non-availability of space at the sites or due to other reasons, the OB dumps go beyond 40° slope in certain mines. During heavy rains leaching from these dumps are polluting watercourses in the vicinity as the dumps have not been provided with garland drains. The topsoil removed is not properly managed or spread on top of the overburden dumps to raise plantations as prescribed in the environmental clearance. This must be strictly adhered to and rectified immediately.

The abandoned old underground mines in the fragile hilly region, especially in the eastern region, are causing great environmental concern, as there is a scope that these may collapse at any time due to subsidence or other natural disasters such as an earthquake.

Immediate efforts are to be made now to sand stove the abandoned mines to prevent any catastrophe. A strategy must be elicited and implemented to ward off this degradation.

The project authorities are required to develop green belt of sufficient width and density in the mining and plant areas. Even though plantation was done in a few mines, the success was not satisfactory due to poor soil quality, inadequate protection and improper selection of plant species.

Periodic collection of environmental data, sampling and analysis have to be carried out by the project authorities to assess the ambient air quality and quality of mine & plant effluent water. This is required under the provisions of environmental auditing. For this purpose, the project authorities are also required to establish an Environmental Management Cell to collect and analysis the data as well as monitor the implementation of environmental safeguards in the area. Persons working under Environment Management Cell are usually drawn from different departments. Qualified personnel with sufficient training in ecology/environment need to be recruited to look into environmental management. It is necessary to see that such environmental auditing reports prepared internally are unbiased. At present, sampling and analysis of air and water quality in most of the projects are given to consultants and sampling is done at quarterly intervals. The data procured is inadequate in most cases to elicit any conclusion on the status of air and water pollution. Even in underground mining projects, detailed analysis is to be carried out on various environmental parameters and subsidence. It is also required to study the status of health of the workers in the mines.

The project authorities are required to allocate sufficient funds to implement the environmental safeguards while executing the project. But due to non-availability of funds in time, effluent treatment and plantation activities in the areas could not be taken up to get better success. Hence, funds should be made available to take up the activity in time for achieving better success of the mitigation measures adopted and rate of plantation undertaken. It is observed that in majority of cases, the environmental safeguards are not taken up simultaneously during the project construction. The planning is not made ahead to raise plantations since the project authorities are mostly concerned to achieve production targets. Due to personal interest and initiative taken by some of the project officers, in a few projects, good plantations have come up. This is due to timely release of money by internal adjustment of available funds. All user agencies must follow this meticulously.

Rehabilitation of land oustees as well as homestead oustees is major problem in mining projects. Either the oustees are not satisfied with the compensation or the project authorities are not able to rehabilitate the oustees as per specific time schedule. This has to be sorted out in a time bound manner.

In the areas, where mines are located in cluster, the Ministry of Environment & Forest has stipulated for carrying out a Regional Planning Study. An integrated plan may be worked out for the whole mining area. The State Departments of Mines should take up all necessary steps for successful operation of this aspect. Besides the Environment Management Cell at the project level, a Regional Environmental Management Committee for all such areas is required to be constituted to implement the environmental safeguard of the area as a whole, in a time bound programme. Such independent committees will be more effective in implementing the conditions, which will be complementary to the small cells operating individually at the mine site. Implementation of EMP conditions by project authorities is being monitored periodically by the Government agencies and the project authorities are being informed about the achievements made by them as per EIA/EMP conditions.

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