Annex 2. Guidelines and formats for Final Mines Feasibility Study (Section 28)

Part II Guidelines for preparation of Environmental Management Plan for mining projects.

The purpose of these guidelines is to assist the applicant to provide all information relating to environment in a standard format to the government for it to assess the environmental impacts and protection measures. The EMP in general should have the following chapters.

1. **Introduction, location, project setting and project profile summary**

This chapter will summarise the reason(s) for setting up the proposed mining project, its target production capacity, market for the product, location of the proposed mine and its accessibility, land requirement and status of land acquisition and proposed investment and project funding requirements. This chapter should also attach a location map of the project site in a Survey of Bhutan topographical map having a scale of 1:50000 or larger scale) showing the roads, settlements, other neighbouring mines and industries, water courses, forests and other environmentally significant features.

2. Summary of geology, reserves and mining method

This chapter should cover a brief description of the exploration carried out to define the reserve and quality of the mineral and the geology of the area and that of the deposit. A geological map and one or more geological cross sections should be included in the EMP. The stripping ratio and the nature, type and quantity of overburden or interburden likely to be generated during mining should be given. The mining method proposed to extract the given quantity of mineral along with the height of benches, method of stripping top soil and overburden, list of major equipment to be deployed should be described. The phasing of production of mineral and overburden/waste material should be explained. A pit plan and a typical section or sections through the working pit and overburden/waste dumps should be included.

3. Base line environmental scenario

To understand the likely adverse impacts due to mining operation and to plan remedial measures in advance, a detailed study of the pre-mining environmental scenario is essential. While the lease area of a mining project (or the core zone) is most affected by mining activity, the adverse environmental impacts spreads to a lesser extent in the surrounding areas also i.e. the buffer zone. Hence the base line study should be carried out in the core as well as in the buffer zone. In absence of a stipulation for a buffer zone, an area falling within a distance of two kilometre from the leasehold boundary can be considered as the buffer zone.

The physiography and land use status of the area, air, water and soil quality, noise level, availability and utilization of surface and sub-surface water resource, climate and drainage, evidences of landslides, if any, rainfall, list of flora and fauna found in the area, with specific mention of presence or absence of any endangered species should be covered in this chapter. The socio-economic environment covering population density, literacy level, occupational structure, communication, education and health care facilities should also be included in the base line study.

4. Environmental impact assessment

Environmental impact assessment is essential to evaluate the beneficial and adverse effects of a planned activity on the environmental system. Whereas the two previous chapters have described what is impacting (the mining activity) and what is being impacted upon (the base line environmental condition), in this chapter the direct physical impact of the mining activity on each of the environmental parameters should be identified.

The items to be covered are impacts on topography (e.g a hill can be chopped down or an overburden dump may be created or an excavation appears on the ground etc.), land use pattern (will change progressively with mining, trees may be cut from forest area and in some cases the area will be excavated, and on the other hand new plantation areas may be added to forest cover at later stage of mining), airborne particulate matter (concentration may go up due to mining), water quality (the surface water may have more TSS, oil and grease and in some cases may have increased acidity and concentration of heavy metals), soil quality (may change due to flow of mine effluent, dust deposition and solid waste disposal), noise level (may go up due to operation of mining and transport equipment), availability of surface and sub-surface water (mining may cause stoppage of flow in some springs due to destruction of recharge zone, lowering of ground water table and additional withdrawal to meet the water needs of the mine. On the other hand, the pumped out water from the mine may be conveniently available for agricultural and other uses), climate and rainfall (unlikely to be affected by the scale of mining being carried out in Bhutan), drainage pattern (sometimes small streams are diverted or blocked for disposal of tailings, and change of topography may also affect the drainage pattern), land slides, (heavy blasting or road cutting may trigger new slides), flora and fauna (affected if habitat or migration routes are disturbed, and blasting and high noise level may drive the wild animals away).

The greatest socio-economic impact due to mining takes place when people are involuntarily displaced or their land acquired for mining purpose. The impact, if happening in a project, must be discussed in great detail giving the number of project-affected families and project affected persons as well as those persons having to be resettled and rehabilitated and those who will be given employment in the project. Another negative impact of a mining project is the increase in vehicular traffic in the area and the introduction of danger from fly rock and ground vibration from blasting operation, both factors introducing new risk elements in the area, especially if villages occur near the mining project. The beneficial impact of creation of new jobs, communication, education and health facilities in the area are of great importance and should be covered in the chapter.

There are various techniques of evaluating the environmental impacts- from simple to highly complicated ones and all suffer from varying degrees of subjectivity in evaluation. Battelle Environmental Evaluation System (BEES), coupled with application of value function curves has less element of subjectivity than most other evaluation methods. However, at the present stage of mineral development in Bhutan, even application of simple matrix method may be accepted. In the matrix method, the various activities being carried out in a mine are listed in columns and the various environmental parameters are listed in the rows. The environmental attributes are given weights in terms of relative importance and the impact due to each mining activity is judged in a six-point scale of 0 to 5 impact value. Positive and negative signs are assigned to the impact value to show

beneficial or an adverse impact due to the proposed activity. The impact score obtained without and with environmental protection measures (to be described in the next chapter) would show to what extent the project would have adverse and beneficial impact on the environment.

5. Environmental Protection Measures

In this chapter corrective measures for all identified adverse impacts should be spelled out. Two of the major adverse impacts of mining are on landform and deforestation of land. By proper back filling, dozing, top soil spreading and soil amelioration, the land can be prepared for biological reclamation. As far as possible, back filling and land reclamation work should be carried on concurrently with mining. The vacant land in the mine leasehold should be utilized for tree plantation and a green belt created around the mine workings would be aesthetically pleasant and act as dust and noise filters.

The top-soil, wherever extracted should be used immediately for plantation work, and where it can't be used immediately, should be stacked separately, to be used later for rehabilitating mined out areas and dumps. The overburden dumps should not be created on steep hill slopes but on plain or moderately sloping ground and should be created in layers of moderate thickness of say 8 to 10 m, and each upper layer should be formed leaving a terrace at the outer edge of the lower layer. The individual layers may have slopes at angle of repose of the dump material but the overall angle of slope by this method of formation in layers would come down to around 28°, making it easier for erosion control and revegetation of the dumps. Construction of check dams in gullies and rivulets will help in checking erosion and down wash of silt. If overburden dumps slopes cannot be avoided, application of geotextiles would help the revegetation process. Water accumulated in mine sump or obtained from vehicle wash in the workshop or from seepage from OB dump should be treated for excess of suspended solid and oil and grease and should be reused in the mine as far as possible for dust suppression and plantation work. If toxic material is encountered in the ore body or overburden, the effluent water should be treated for the same before discharge to area outside of the lease hold. Dust suppression measures such as surfacing of roads, applications of fixed point water sprays, mobile water sprinklers, avenue plantation, covering of trucks during transport, early reclamation of overburden dump etc. should be incorporated. If places of cultural heritage or habitations exist near the mine, blasting should be carried out in such a way that houses are not damaged due to ground vibration nor are the people affected by fly rock. For this a control on the total charge weight per delay has to be kept and at intervals ground vibration monitoring has to be carried out.

If the mining project involves involuntary displacement of persons, a suitable scheme for compensating the families for their land and homestead should be made and a proper resettlement and rehabilitation scheme prepared after due consultation with the persons being displaced. Rehabilitation scheme for other project-affected persons should also be prepared. As many as possible of the jobs created in the project should be given to the local population. If necessary, proper training scheme should be organized to improve the employability of the local pollution. The benefits of infrastructure, health care and education facilities developed for the mining project or its personnel should be extended amongst the local population also.

6. Mine Restoration Plan/mine closure

Unless proper care is taken, a mine may continue to adversely impact the environment even many years after its closure. Hence a Mine Restoration Plan is a great necessity. This should cover

a) Post mining land use (should be prepared in consultation with the people of the surrounding villages)
b) reclamation and revegetation process- The steep slopes of mine benches may be blasted and dozed to give gentler slopes at the end of mining. Similarly the dumps may be dozed before spreading of topsoil, and revegetation done by planting seedlings or by broadcasting seeds. For steep slopes, the revegetation process may need construction of contour bunds or creation of terraces and in extremely difficult cases application of coir matting or geotextiles.
c) time schedule for the Reclamation Process

It is best to carry out land reclamation concurrently with mining. Then the pit being dug for mining gets progressively filled with overburden or waste material. Large external OB dumps gets created if in-pit dumping is delayed. In mining hill top deposits, the reclamation process is generally done after the end of mining, but it can be carried out even before the end of mining if a part of the deposit is worked down to the planned level first. After mine closure, the reclamation process should be completed quickly say within one or two years of the end of mining.

7. Environmental monitoring Scheme, environmental auditing

As a check on the environmental protection measures adopted in a mine, a system of regular monitoring of environmental quality parameters - air, water, and noise level should be put in place. These may also be needed to meet the statutory requirements. A system of annual environmental audit will similarly permit a systematic, documented, periodic and objective evaluation of the environmental management system and bring out deficiencies, if any. In large mining projects, creation of an environment management cell with provision for simple monitoring equipment would be desirable.

8. Budgetary allocation

Sufficient funds for carrying out the environmental protection measures enumerated in the EMP shall be provided for. A list of equipment needed for environmental management and their cost as well as the cost of rehabilitation of the project-affected people should be prepared and provision made for capital expenditure on this account. Simultaneously, the recurring expenditure per year for environmental protection work such as tree plantation, dozing of dump surface, environmental monitoring, water spraying, effluent treatment, erosion control etc. should be estimated. Expenditure for environmental protection measures in terms of percentage of total project cost and revenue cost should be calculated.

9. Miscellaneous and Conclusion

Based on the earlier chapters, the proponent should conclude on the desirability of setting up of the project from the environmental angle. Any other matter, which the proponent thinks is relevant but not covered in the earlier chapters may be stated here.