A Progressive Mine Closure Plan for a Semi-mechanized Quarry of Dolomite

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ABSTRACT

All major mining activities from prospecting to exploitation and beneficiation contribute the problem of pollution directly or indirectly. Therefore, a comprehensive environmental study is required for sustainable development of any mining area that requires planning of mine closure activity from the commencement of the mining operations to its final closure. The main aim of closure planning is to return the mine site in an ecological sustainable and suitable state for future land use. The study focuses on the various aspects of progressive mine closure plan of the Tulsidamar opencast dolomite mine of Steel Authority of India Limited. The mine is producing about 0.3 Million Tones of dolomite per year and will be closed after depletion of the reserve keeping in view the present market scenario. Premature and unplanned mine closures can result adverse impacts to the environment and the community, and therefore, must be managed appropriately. This paper analyses the progressive mine closure planning as a part of mining plan or mining scheme while mining operations are going on.

INTRODUCTION

Mining is one of the major core sector industries which play a crucial role in the process of country's economic development with, of course, some unavoidable environmental impacts. Enhancement of production capacity of mineral resources has threatened the natural capacity of self sustainability of the environment. It destroys the flora and fauna and also alters the demographic picture of the region. Since human have to live within their environment, the process of development should be sustainable, so that environmental quality is maintained within safe limits. Mine closure encompasses rehabilitation process as an ongoing program designed to restore physical, chemical and biological quality disturbed by the mining to a level acceptable to all concerned. It aims at leaving the area in such a way that rehabilitation does not become a burden to the society after mining operation is over. It also aims to create as self-sustained ecosystem. In India, mineral deposits are located in remote and tribal areas of the country, where the primary means of livelihood is agriculture and forest produce. It is therefore necessary for the mine management to consider that mine closure and rehabilitation of community must be essential parts of the overall project plan. (Dhar, 2005)

Mineral Conservation and Development Rules, 2003 provide for two types of Mine Closure Plan namely a Progressive Mine Closure Plan; and a Final Mine Closure Plan. Progressive mine closure plan as a component of mining plan is to be submitted in case of fresh grant or renewal of mining lease (section 23B, MCDR, 2003) and Final Mine Closure Plan as a component of mining plan is to be submitted one year prior to the proposed closure of the mine (section 23C, MCDR, 2003). Bitley (2003) has outlined the following major objectives of a mine closure plan.

- To safeguard health and safety of the public
- Land after closure shall not be affected and shall ensure sustainability in long term.
- Environmental resources in the area shall not be degraded in any form.
- Minimize adverse socio-economic impacts.
- Develop potential for communities future prospect in respect of economic and social life.

Mine closure operation is a continuous series of activities starting from day one of the initiation of mining project therefore mine closure plan is an additional chapter in the present Mine Plan and will be reviewed every five years in the Scheme of Mining. (GSR 329 (E), 2003, GSR 330 (E), 2003) Final mine closure plan as per statute, shall be considered to have its approval at least nine months before the date of proposed closure of mine. This period of nine months is reckoned as preparatory period for final mine closure operations. The chief goal of closure planning is to return the mine site in an ecological sustainable and suitable state for future land use (Kumar et al 2003, Trivedi et. al., 2008). Keeping the essential considerations of the mine closure, it should be the goal of mining companies to integrate the closure plan with the mining plan in a cohesive manner (Jayanthu and Gupta, 2005). Fourie and Brent (2006) have proposed a project-based Mine Closure Model (MCM) for sustainable asset life cycle management. Mine Closure Model (MCM) is based on project management principles, including risk management and concurrent engineering for the management of the closure process and assists the governing bodies with the effective evaluation of closures and the issuance of certificates. Mine closure or rehabilitation objectives can be achieved whilst managing the resources of the mining industry optimally and aligning the closure process to meet the end requirements of stakeholder groups.

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The factors that must be considered with mine rehabilitation are physical and chemical stability of mine waste dumps and open-pits, maintenance of water quality, safe disposal of infrastructure, development of sustainable ecosystems, meeting community expectations (Taylor, 2004). Hancock(2004) used landscape evolution models in mining rehabilitation design. Rathke and Bröring(2005) have studied the rehabilitation and colonization of post-mining landscapes and found that the relative abundance of all species is significantly higher in undisturbed sites as compared to disturbed mining sites. Rao and Pathak (2005) have studied the Socio-economic impacts of mine closure in Raniganj Coalfields using remote sensing and satellite imagery. Ghosh et. al, 2003 have highlighted rehabilitation and revegetation strategy for mine closure. Dutta et. al. (2003) have focused on challenges for post mine closure environment management in Kakum coal field, Assam.

There is growing awareness of the environmental legacy of mining activities that have been undertaken with little concern for the environment. Changes in laws, technologies and attitudes have begun to address some of the most immediate threats posed by mining activities, but there remain many areas of mining practices and regulations that need to be addressed. Sengupta and Biswas (2003) have underlined the importance of Mine closure planning in changing environmental arena. The mining of non-renewable resources has various known impacts on the natural environment throughout the life cycle. Re-contouring of pit walls and waste dumps, covering of reactive tailings dumps, de-commissioning of roads, dismantling of buildings, re-seeding or plantation of disturbed areas, ongoing monitoring and possible water quality treatment are the key issues that are to be properly addressed while planning for Final Mine Closure.

Premature and unplanned mine closures results in significant adverse impacts on the environment and community. Mine closure may be planned but most commonly, it is premature, occurring before ore reserves are exhausted. The reasons why mines close are diverse and include economic, geological, geotechnical, regulatory, community and other pressures. There seems to be a misalignment between the mining industry and the various government authorities pertaining to the issue of mine closure, rehabilitation of implementation of environment management plan. The main reasons for this are unclear and unformulated approaches to mine closures. This *implies the successful implementation of Environmental Management Plan EMP is the most essential thing.*

The study focuses on the various aspects of progressive mine closure plan of the Tulsidamar opencast dolomite mine of Steel Authority of India Limited. The mine is producing about 0.3 Million Tones of dolomite per year and the quantum of waste generated is 0.1 Million m^3.per year. The lease of Tulsidamar Dolomite Mine is situated in the Garhwa district of Jharkhand. The deposit is covered on Survey of India topo sheet No. 63 P/11 of 1982. The Latitudes and longitudes of the area fall in between 24°-15' N to 24°-20' and 83°-30' E to 83°-35' E, respectively. The mine will be closed after depletion of the reserve keeping in view the present market scenario.

FIELD SETTINGS AT TULSIDAMAR OPENCAST DOLOMITE MINE

Geology & Reserves

The leasehold presents a complex geological structure, and forms part of the Western Chhotanagpu area. The basal rocks in the area consist of Archeans and older Metamorphics. The latter are considered equivalent to Lower Dharwars. The Pre-cambrian rocks comprise a group of metamorphosed pelitic, calcareous and psaminitic sediments, and are called older Metamorphics. A major part of the area is composed of gneisses with intrusive granites at places. The dolomite formations occur as roof-pendants of granitc batholiths. These are intruded by granites. The granitic intrusions are both concordant as well as discordant. The dolomitc formations are generally medium-to-coarsely crystalline. Their colour varies from milky white to bluish grey with a pinkish tint. The size of crystal varies from 0.2 mm to a few mm. Basic intrusions are also not uncommon in this area.The strike of dolomite bands is generally NE-SW and amount of dip varies from 60° to 75°. The area appears to have undergone complex tectonic movements in different phases resulting in refolding of primary folded beds giving effects of dome shaped structures. The dolomitic bands are well defined as anti forms and conforms to a fold axis.

Net mineable reserve as on 1st April, 2008 of dolomite is 12.48 Million Tonnes. Since w the mine is to be planned for annual production rate of 0.3 MT of dolomite. Therefore life of the mine will be 41 years and 7 months approximately With Ultimate pit limit of 260 m RL.

Mine Description

Mining is being done by the method of semi-mechanised open cast method. Drilling is done by 105 mm wagon Drills *and Crawler drills of Ingersol Rand. Drilling parameters are-burden of 2.5 m, spacing of 3 m and the depth of 6.5 m.* Due to associated waste, drill hole depth varies from 3 m to 6.5 m. Blasting is carried out at mine between 12.00 AM and 2.00 PM during interval of rest. As the P.W.D. road passes through the mining lease area. Proper care is

taken to block the road with barriers at both ends of the mine entrance. Adequate eleactric siren is mounted on the explosive van for warning. All the labours are evacuated away from the danger zone of 500 mm holes are charged. Use of primer is approx 20% including secondary blasting by plaster shooting.

Review of implementation of Environment Management Plan

Table 1: Afforestation during 2001-02 to 2007-08

Year	Planned numbers	Actual	Remarks
2001-02	500-1000	5,000	Intervening plantation over waste dump
2002-03	500-1000	2,000	Intervening plantation over waste dump
2003-04	500-1000	NIL	Dry Monsoon and very poor rain in the area
2004-05	500-1000	Nil	Dry Monsoon and very poor rain in the area
2005-06	500-1000	100	Intervening plantation over waste dump
2006-07	500-1000	150	Intervening plantation over waste dump
2007-08	500-1000	150	Intervening plantation over waste dump

PROGRESSIVE MINE CLOSURE PLAN

Mined out Land

Although reclamation of mined out area was not planned during this scheme period, an area of about one Hectare, adjacent to PWD road near the western boundary of lease, has been backfilled. In this area dolomite occurrence was only upto 302 mRL. Backfilling was done only after extracting all mineable dolomite. Backfilling of the mined out area has already been started from previous mining scheme. A total area of around 5 Hectare will be backfilled by the waste materials generated during the mining of Tulsidamar. Once the back filled area will be stabilized, afforestation will be done on the backfilled area.

Topsoil management

Most of the area is broken therefore meeting topsoil is very rare, however if the topsoil is encountered will be used for afforestation of the waste dumps.

Afforestation Program

It is proposed to have Afforestation at the rate of 1000 trees per year in mines area.

Post Mining Land Use

Mine out area around PWD road will be backfilled with the waste and will be progressively rehabilitated afforesting. With the available waste, it will be possible to backfill around five-hectare mine out land. Rest of the mined out area will be afforested. Waste dump will be progressively stabilized and rehabilitated through afforestation. The raiyti land will be restored to pasture.

Water Quality Management

The leasehold area is rugged in nature with a broken ridge running predominantly in E-W direction in the northern part. The mine workings are located south of this ridge, on a plateau, which is drained by several small nullahs flowing in the southern direction, into Longa Nadi flowing west-to east. The northern part of the leasehold drains into Pandi Nada flowing west to east 16 km to the north.

Regular monitoring of water quality is being done at Tulsidamar Dolomite Mine by Environment Management Division (EMD) of SAIL. Water quality monitoring and analysis report is annexed at Annexure 4. Water quality monitoring was carried out at various locations near in and around mining lease area. All water samples collected from various ground/surface water locations are reasonably clear. Surface and sub-surface water is mainly alkaline in nature.

Preventive measures are taken to reduce suspended solids in water. The mine has neither any perennial source of water nor any sorts of effluent discharge out of the mine. As such the dischargeable mine water is almost negligible. The effect of the mining operation is negligible on ground as well as surface water regime. This plateau is self-draining and little water collects within the quarries, except for some stagnant pools. Pollution from oil and grease is also very low due to the level of mechanization.

Air Quality Management

Mining area are considered to be dust prone, as dust is generated at various points of operations in the mines. Major sources of dust generations are drilling, blasting, excavation, transportation of materials, loading into trucks etc. Most of the dust generation is fugitive in nature and is normally localized near the generation points. Ambient air quality data generated during the monitoring period for all the three seasons was found to be well within the norms. However the average SPM, SO2 and Nox levels are well within the norms. Within core zone areas at different places, air samples were taken by EMD.

Air quality is regularly monitored in respect of Tulsidamar Mine quarterly and compiled for all the seasons. The air analysis was done for SPM, Nox, SO2. All these generations are within the norms. However preventive measures are adopted to minimize impact on air quality.

1) Approved type of dust extraction system to be fitted with drill m/c, which keeps drill site free from dust nuisance.

2) Secondary blasting to be avoided.
3) Wet drilling system to be adopted.
4) Water to be also sprayed near the rest shelter during working hours.
5) Plantation to be made around mines, dump and rest shelter.
6) Haul roads to be kept wet regular water spraying during working hours.

Waste Management

Generation of waste during the first five years of the plan is as follows:

Table 2:Year-Wise Waste Generation

Year	Waste Volume (m^3)
First Year: 2008-2009	1,03,210
Second Year: 2009-2010	1,06,930
Third Year: 20010-2011	96,670
Fourth Year: 2011-12	94,910
Fifth Year: 2012-13	98,354
Total	**5,00,074**

To prevent wash offs the surface of the dump will be provided with an inward slope and a retaining wall made of boulders will be provided at the toe of the dump. The selection of dump site was made on the following considerations:

- The area is devoid of any good grade of dolomite band.
- Proximity to the working quarry.
- Easily approachable from the working quarry.
- It is beyond the ultimate pit limit and within lease and occupied area.

The height of dump bench is proposed to be about 8m and overall less than 280. The number of benches will not be more than three (3) and the total height from ground would not be more than 24m. Later on, the dump materials can also be dozed down in worked out areas after extraction of minerals for backfilling purpose.

Infrastructure

Since there is not any plan for closure of the mine in this mining scheme period, this para has not been discussed.

Disposal of Mining Machinery

Since there is not any plan for closure of the mine during this mining scheme period, this para has not been discussed.

Disaster Management & Risk assessment

Potential source of mine disaster has been identified as accident related to blasting, fire, etc. In addition to the existing safety and security measures a crisis management procedure has been developed and is placed at Annexure 6

Care & Maintenance during temporary discontinuance

In case of any temporary discontinuance the machineries will be withdrawn to a safer place and deploying adequate numbers of security grards would protect the workings and other facilities.

Financial Assurance

Details of the area taken into account for calculation of Financial assurance is as given in Table 3 and Fig.1.

The total amount towards Financial Assurance for 91.5 hectares @25000/hectare in Rs. 22,87,500/- (Rupees Twenty Two lakhs eighty seven thousand five hundred only). The required amount towards the financial assurance for this mine shall be deposited by SAIL/RMD in the prescribed form in due course of time for the area to be excavated, overburden dump, infrastructure etc. subject to the approval of IBM.

CONCLUSIONS

It can be safely concluded that no significant deterioration in the eco-system is likely to occur due to the Tulsidamar opencast dolomite project under study. On the other hand, the project is to have several benefits like improvement in employment generation and economic growth of the area, by way of improved infrastructure facilities and better socio-economic conditions. The effects of mining on different components of environment have been studied and the mitigative measures to reduce the adverse impacts have been suggested. The progressive mine closure plan has been prepared as per the guideline issued Indian Bureau of Mines. Sustainable management of mining activities can contribute vastly to the economy of the nation, and the livelihoods of society. Hence, the key to successful mining operations that contribute significantly to job creation and economic advancement is 'sustainable development'. Mine closure normally leaves an adverse impact on the environment and society that, if left unattended, may last for years to come.

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Table 3: Details of Broken Area for Calculation Of Financial Assurance
(Area in Hectare)

Sl. No. (a)	Head (b)	Area put on use at start of plan (c)	Addl. Requirement During plan period (d)	Total (e=c+d)	Area considered as fully reclaimed & rehabilitated	Net area considered for calculation g=(e-f)
1	Area to be excavated	62	0	62		62
2	Storage for top soil	0	0	0	0	0
3	Overburden Dump	16.5	3.5	20	0	20
4	Mineral Storage	0	0	0	0	0
5	Infrastructure	3.0	0	3.0		3.0
6	Roads	6.5	0	6.5	0	6.5
7	Railways	0	0	0	0	0
8	Green Belt	4.0	0	4.0	4.0	0
9	Tailing Pond	0	0	0	0	0
10	Effluent treatment plant	0	00	0	0	0
11	Mineral separation plant	0	0	0	0	0
12	Township area	0	0	0	0	0
13	Others 0	0	0	0	0	0
	Total	**92**	**3.5**	**95.5**	**4**	**91.5**

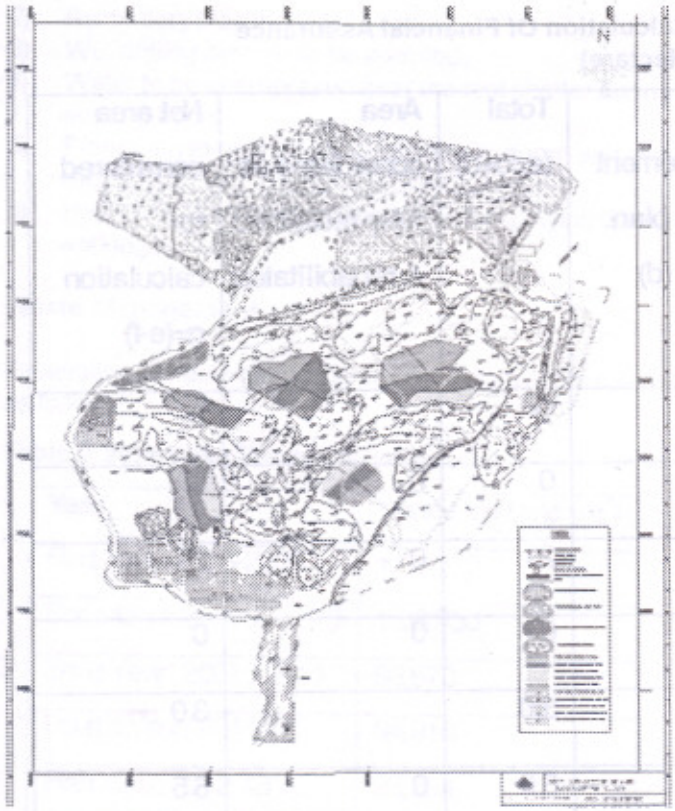

Figure 1 Progressive Mine Closure Plan of Tulsidamar Project

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