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# Chapter 1

# INTRODUCTION

## 1.1 Preamble

The Government of Andhra Pradesh having around 600 million tonnes of bauxite deposits with major reserves in the tribal areas of eastern ghats has decided to give an impetus to the mineral based industry in order to address the primary objective of upgrading the employment and income levels of the surrounding tribals. The GoAP has declared Andhra Pradesh Mineral Development Corporation Ltd. (APMDC) located at Hyderabad, as a nodal agency to exploit the mineral reserves. In order to meet the demand of bauxite, APMDC proposes to acquire mining leases for bauxite and supply 1.0 MTPA Alumina and 2.5 Lakh tonne to Aluminium Smelter in Andhra Pradesh to be set up by RAS-AL-KHIMAH (United Arab Emirates). APMDC proposes to exploit the minerals at the four bauxite deposits located at Blocks I, II, III and VIII at Jerrila, near Chintapalle, in G.K. Veedhi Mandal of Vishakhapatnam district which has a total reserve of 224.60 million tonnes.

The bauxite reserves in the mines in the first phase are planned to be exploited for the period of five years during 2008-09 to 2012-13. The Jerrila Block I bauxite reserve deposit is explored in detail by exploration agencies like GSI, MECL. The total lease area for mining is 85 ha. The exploitable reserves of bauxite at Jerrila Block I are estimated at around 6.8 million tonnes. M/s. APMDC now proposes to produce around 0.5 million tonne per year with opencast mechanized operations. The ore is suitable for extraction of alumina and manufacture of aluminium metal.

In order to seek environmental clearance for the above mining activity M/s. APMDC has appointed the Indian Council of Forestry Research and Education (ICFRE), Dehradun to undertake the “Environmental Impact Assessment of 0.5 MTPA Bauxite Mining at Jerrila Block-I Bauxite Deposit, Jerrila Village, G.K. Veedhi Mandal, Vishakhapatnam District, Andhra Pradesh”. The report presents the EIA study undertaken for above mining activity.

The location of Jerrila Bauxite mines is at **Figure 1.1**. and the project details are summarised at **Table 1.1.**

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**Figure 1.1: Location Map of Jerrila Block I Bauxite Mines**

**Table 1.1: Details of Proposed Mines**

| S. No | Project details | Jerrila |
|---|---|---|
| 1 | Mining lease Area (ha) | 85 ha |
| 2 | Total Reserves | |
| | Proven | 6.8 Million tonnes |
| | Indicated | |
| | Inferred | |
| | Exploited | |
| 3 | Capacity of Mine (MT/Year) | 0.5 MTPA |
| 4 | Water Requirement($m^3$/year) | |
| 5 | Type and method of mining | Opencast |
| 6 | Work force (No.) | 129 |

## 1.2 The Location

The bauxite deposit is located in Chintapalli reserve forest of Chintapalli and G.K. Veedhi Mandals, Visakhapatnam district, Andhra Pradesh. There are no settlements in the proposed mine lease area. The mine lease area occurs at maximum altitude of 1100 m above msl with a relief of 250 m (Plate-1). The mine deposit is situated about 17 Km away from Chintapalli, a Mandal headquarters, which is on the State Highway connecting Visakhapatnam with Sileru. The nearest village is Kondrupalli, which is situated on the northern side of the foot hill of the mining area. Kondrupalli is 17 km from Chintapalli and the latter is 140 Km from Visakhapatnam district head quarters, passing through Narsipatnam which is connected to National Highway No. 5 at Tallapalem, 32 km away. Sileru is over 70 km to the northwest of Chintapalli. No place of historical importance or archaeological importance exists in the study area. The **Figure 1.1** depicts the mining location along the proposed other features.

**Details of the area**

| | |
|---|---|
| District & State | Visakhapatnam, Andhra Pradesh |
| Mandal | G.K. Veedhi |
| Village | Kondrupalli |
| Mine Lease Area | 85 Ha. |
| Nature of the Area | Reserve Forest |
| Survey of India Toposheet No. | 65 K/5 |
| Latitude | N 17°57’45” – 17°58’00” |
| Longitude | E 82°17’15” – 82°18’00” |
| **General Climatic Conditions** | |
| Maximum Temperature | 35°C - 40°C (Summer) |
| Minimum Temperature | 9°C - 12°C (Winter) |
| Mean Annual Rainfall | 1200 -1400 mm |
| Wind pattern – predominant wind direction | Southeast followed by South |
| **Accessibility** | |
| Road Connectivity | Chintapalli is on the Visakhapatnam – Narsipatnam-Sileru state Highway. Chintapalli to Jerrila 12 km. metal road. Jerrila to Block-I is 5 km. |
| Rail Connectivity | Narsipatnam Road railway station on Vijayawada-Visakhapatnam section of South Central Railway |
| **Historical/Important Places** | |
| Archaeologically/Historically/Sanctuaries/National Parks/Sensitive Places | Nil |
| Water bodies | Budugedda rivulet in Northwest |
| Tourist Spots | Nil |
| Air Port/Sea Port | Visakhapatnam (157 km) |

### Physiography

The area under consideration forms a part of the eastern ghats hilly region and is, therefore characterized by an extremely rugged topography. The overall trend of the hills is NE-SW, consistent with the regional “Eastern Ghats” trend. The whole region is marked by a deeply dissected topography with high hills interspersed with narrow valleys. Jerrila village is located in one such narrow valley. Around Chintapalle and further east, the valleys are broader with extensive cultivation. The tops of the hills are in places, made up of gently undulating plateaus of variable dimensions and shapes. Some of these plateaus are the home of bauxite and laterite deposits. The highest peak, a triangulation point of 1297 m is located north of Jerilla Village. The altitude of the valley floors around Jerrila is on an average 850 m, which gives a maximum relief in the area of around 450 m. in the Block – I Area, the maximum altitude is 1100m. The general slope of the region is towards southeast. The broader valleys, to the southeast, have an average altitude of around 750 m with scattered residual hills rising to over 950 m.

The drainage in the study area is controlled by the hill-streams some of which are perennial. Streams descend from the Block I plateau in all directions giving rise to a radial dendritic pattern. The streams descending from the hills merge with the NE-SW trending valleys forming again an overall dendritic pattern. Towards more mature topographic areas, like in the east and southeast, the drainage assumes a general trellis pattern with prominent streams having NE-SW trend, joined by small streams from the NW and SE directions. The regional drainage is chiefly controlled by the Sileru and Budugedda Rivers that flow in the area to the NW.

**Geology**

The study area as already mentioned forms a part of the Eastern Ghats Mobile Belt - a unique entity in the Indian Geology. It is made up of rocks included in the eastern ghats Supergroup of Archaean age. Comprising a distinctive group of lithounits, the eastern ghats supergroup represents one of the most deep – seated ensemble now exposed at the surface levels. The rocks of both sedimentary and igneous parentage formed in a mobile belt are highly metamorphosed in granulite facies and intensely deformed in multiple diatrophic epidsodes. The Khondalite and its variants of the Khondalite group and the different varieties of charnockite of the charnockite group comprise the predominant rock units. The kondalite, a sedimentary derivative, is quartz- garnet-sillimanite-graphite gneiss with well developed banding defined by the alignment of leucocratic and melanocratic constituent minerals. Charnockite, an igneous derivative, is bluish to gray massive crystalline rock with distinctive mineralogy. Hypersthene is characteristic of the different varieties of Charnockite ranging in composition from basic to acidic. This assemblage of charnockite and khondalite is intruded by the later granites resulting in the formation of mignatite gneisses, banded gneisses etc. the final phase of the igneous activity is represented by the emplacement of quartz and pegmatite veins.

The well developed gneissosity in the rocks has a regional NE-SW strike with steep southeasterly dips. Highly compressed, tight, iso-clinal folds with axes parallel to the foliation are superimposed by broad, open cross-folds. Close spaced fractures and extensive joint development make the rocks porous. Dense vegetation is characteristic of the region, which is almost entirely covered by Reserve Forest of different densities in the valley areas where villages exist with cultivation around.

**Land use**

The land use/landcover within a buffer of 10 km circumscribed with Jerella Block III. The study region's land use / landcover comprises of dense forests, drainage, mines, plantations and in open forests. As per Remote sensing analysis forest constitutes 62.8 % of the land cover in the study region. The land cover percentages of various types of forest are: sparse forest (8.1 %), dense forest (24.1%), open scrub (19.6 %), and medium forest (11 %). Barren lands occupy 4.9 % of the region. Area under rock outcrops is 7.5 %. Cropland and water bodies occupy around 21.2 % and 1.6 % in the area. Settlements cover 0.4 % of the area.

The predominant soil present in valleys of the study area is red ferruginous sandy soil. The study area mostly falls in G. Madugula, GK Veedhi, Chintapalle of Vishakapatnam district and Malkanjgiri of Orissa. The revenue area covering these mandals have 35.68% in Chintapalle 26.98 % in Malkanjgiri, 3.51 % in G. Madugula and 33.82 % under GK Veedhi Mandal. 15.51 % is forest land, irrigated area is only 2.62 % as compared to 43.82 unirrigated land. The cultural waste land is 19.36 % while the land not available for cultivation is 18.45 %. In the 5 km buffer area 72.33 % is covered by villages under G.K Veedhi Mandal.

**Climate**

The study area experiences tropical and humid climate with well-defined three seasons, namely winter followed by summer and rainy season. The weather parameter recorded in the observatory at the Airport in Visakhapatnam town is considered as representative of the meteorological conditions of the study area. The various mean climatological parameters for the period 1951 – 2007 have been taken from the records of IMD.

The wind velocity is generally high over the year varying between 7.2 to 15.4 km/hour. The highest wind speed is observed during monsoon period when the south westerly wind envelops the entire coastal belt. During winter season lower wind speed is observed.

The area receives rain mainly through south-west monsoon wind during June to September which constitutes around 65% of annual rainfall. The north-east monsoon prevails over October to December when around 23% of annual rain occurs. The summer season rain account for 10 of annual rainfall while the winter rain constitute hardly 2% of annual rainfall. The number of rainy days over the year is 52. The highest rains are observed during August & September followed by July & October. It is evident that the rainfall over the area is mainly through monsoon wind between June to October every year.

The analyses of this data indicate following:

- The average annual rainfall of the district is 1200 mm.
- The deviation of rainfall in different years with respect to average is not large. Generally the rainfall in different years remain within 20% from average.
- The rainfall variation over the period observed is more or less uniform. The deficit rainfall was observed in nine years while excess in 16 years and the remaining years have experienced normal rainfall.

The study area experiences pleasant atmospheric conditions marked by gusty winds and intermittent hailstorms. The temperature ranges between 35 to 40 º C maximum and 9º C minimum, and rainfall between 1200 mm. The humidity ranges between a maximum of 70% and a minimum of 30 %.

### Meteorology

The minimum temperature recorded is $8^{o}$ C during December and January, while the maximum temperature recorded is 29 $^{o}$C in Feb.

Maximum relative humidity ranges between (31to 38%). Mean relative humidity was at 23 %. The mean wind speed is 9 km/hr during January and 11 during February. The mean wind direction was at the SE during December.

### Social and economic features

The proposed mining activity, has around sixty-six villages in the study region. The main villages are Jerrila, Viravaram, Mondigedda, Reyyalagedda, Konaruupalli, etc. The population as per census 2001 indicate that there are 3593 households with total population of 16836 people and male-female ratio being 952 female : 1000 men. The ST population is 91 % in the study area. There are 51 primary schools, 3 middle school and 22 other schools. The region has 10 medical facilities. The region has 7 public health centres, 7 sub-centre and 1 other centres. There are 4 locations for bus accessibility and 6 post offices. Water is available in all villages mainly through springs, while four villages have wells, 15 villages have handpumps in and four villages have river access.

## 1.3 The Environmental Impact Assessment

Keeping with the Environmental Impact Assessment notification (1996) under Environmental Protection Act, 1986, and the EIA ACT 2006, APMDC desired to undertake the Environmental Impact Assessment of the proposed mining project. The programme proposes for mining of 6.8 ha mine lease area at Jerrila Village.

The EIA study is designed to provide inputs for ensuring that the project will be designed and operated in accordance with the requirements of the Air Pollution (Prevention and Control) Act 1981, Water Pollution (Prevention and Control) Act 1973, and other applicable rules, notifications and environmentally benign practices. The study envisages assessment of environmental impacts of the mining activity, and preparation of the Environmental Management Plan for implementation. Also, considering the possible risk due to the operations in the habited area, a Disaster Management Plan is drawn up and will be taken up for implementation.

Accordingly, APMDC retained the ICFRE, to conduct the Environmental Impact Assessment of Jerrila Block I Bauxite Mines, and to delineate an Environmental Management Plan. The ICFRE is also to review the risks on the site and prepare a disaster management plan. The scope of EIA study also includes review of project design for various pollution control and environmental management systems such as wastewater and solid waste management systems, air pollution control systems, waste minimization systems, ecological impact minimization systems and acoustic measures and suggest additional measures that are needed for protection of environment.

## 1.4 The Scope of EIA

The scope of the EIA study includes:

- Review of regulatory framework, site and project and set the agenda for Environmental Impact Assessment
- Establish the Baseline environmental situation from secondary data sources and primary data collection
- Monitor and measure the ambient air quality and noise levels
- Establish soil and water quality characteristics
- Establish the characteristics of flora and fauna
- Through the satellite Imagery Analysis and toposheets, establish the land use, hydrological characteristics and vegetation characteristics
- Map all the baseline characteristics on the map of the region
- Quantification of forest patches (vegetation density)
- Understand the environmental impacts, assess their levels and suggest a mitigation and management plan

- Preparation of Environmental Impact Assessment Report outlining Environmental Impacts and a plan for mitigation which could facilitate approach to environmental clearances.

## 1.5 Structure of the Report

Accordingly, ICFRE has conducted the study involving estimates and measurements of emission / discharges / disturbances, evaluate the impacts on the environment and formulate an Environment Management Plan. These studies were conducted during winter season (December 07-February 2008).

The results of the study are reported and the scheme of presentation is as below:

Chapter 2 describes project details, proposed mining activities, and features project setting

Chapter 3, 4 and 5 delineates the present status of the various components of the environment viz. Air, Noise, Water, Soil / Land, Biological and Socio-economic.

In chapter 6, we estimate the impact of the mining activity, and enlist operations with highest impact on the environment (air/noise, water, land and soil and ecology). Our estimations herein are quantitative and qualitative too. The impacts are classified based on the applicable CPCB and SPCB regulatory Standards and MoEF Guidelines. The mitigation measure of the impacts are detailed in this chapter

In chapter 7, we arrive at an Environment Management Plan which will be additional pollution control/prevention measures that APMDC has to undertake inorder to mitigate/minimise the environmental impacts.

Chapters 8, 9, 10, 11, 12 and 13 are on green belt development, landscape management, eco-restoration, afforestation plan, biodiversity conservation plan and solid waste management plans whereas in chapter 14 and 15, social management plan and human health systems plan has been illustrated, respectively.

In chapter 16, we provide the Disaster Management Plan that APMDC has to implement for ensuring effective management of emergencies that can arise due to its operations.

The environmental regulations are appended at the end of the report.

# Chapter 2

# PROJECT ATTRIBUTES

## 2.1 Project background and justification

### 2.1.1 Introduction

Andhra Pradesh Mineral Development Corporation Ltd. (APMDC), located at Hyderabad, is a nodal agency for the exploitation of bauxite mines in Andhra Pradesh. As briefed in Chapter I, the proposed project is to meet the demand of bauxite in the state. APMDC proposes to acquire mining leases and exploit the minerals at the Jerrila Bauxite Reserves, GK Veedhi Mandal, Vishakhapatnam district and supply to the proposed Alumina Plant and aluminum smelter to be set up by RAS-AL-KIMAH, UAE. In view of the proximity to the bauxite reserves, and secondly, considering the accessibility for transportation of raw material, the Alumina plant and aluminum smelter is envisaged at Narsipatnam from the site. The location of the mines is at **Figure 1.1** and detailed layout of the mine site is at **Figure 2.1.**

### 2.1.2 Exploration of Bauxite Reserves

The Geological Survey of India (GSI), as a part of the East Coast Bauxite Project, carried out exploration in this block during 1976-77 involving detailed surveying and geological mapping, surface and subsurface sampling of bauxite capping. Since the potentiality is considered to be low in this block, drilling was not carried out at the time. Fourteen auger holes were drilled, in a sub-block of Block – I where mining is proposed to be initiated. This was aimed at establishing the thickness of the bauxite down to 6 m depth. Since the auger holes offer only highly mixed material, it is considered unwarranted to sample the same. Nevertheless, the presence of bauxite is proved down to 6 m depth, which formed the basis for planning mining operations.

In order to have a comprehensive idea about the potentiality of the entire Block-I it is proposed to carry out drilling all along the deposit down to an average depth of 20 m. initially, it is proposed for the area selected for mining during the first five years. The other areas will be covered in subsequent plan period. It is suggested that the exploration be initiated simultaneously with the commencement of mining operations and cover the entire deposit in two or three periods. In order to help computerised mine planning, deposit modeling and geostatistical evaluation it is necessary to drill holes at 50 M interval, as is being done by NALCO. In all, 114 boreholes are suggested to be drilled proposed works out to be 2280 m. Drilling should be dry so that 100 % recovery is ensured.

The proposed drilling would be done by Edsun vacuum as the number of boreholes and meterage will be almost doubled. The advantage of the vacuum suction method is faster rate of drilling, quick mobility, easy operation with limited manpower and cent percent recovery of material.

The grid will have an orientation of NE-SW (parallel to the length of the deposit) and NW-SE (across the deposit). The depth of each hole is controlled by the end of bauxite zone indicated by the appearance of the partly weathered parent rock with high silica in the form quartz. Therefore, the total meterage suggested may not be entirely achieved.

The borehole cores have to be sampled at a constant one-meter interval within the ore zone. In addition, 6 meter (bench height) composites also may be collected. All the samples need to be analysed for $Al_2O_3$, $SiO_2$, $Fe_2$ $O_3$ , $TiO_2$. and LOI. The reserves may be computed with +2-% alumina and <4 % silica cut-off as the minimum mill-feed grade, according to NALCO, is 32 % Alumina.

The Geological Survey of India estimated a total reserve of 6.8 million tonnes of bauxite for the entire block. A cut-off grade of minimum 40 % alumina and maximum 5 % silica was adopted in the computation of reserves yielding an average grade of 46 % $Al_2O_3$ and 3.02 % $SiO_2$. However, this based only on the scarp sample analyses, which, it is found on experience, always slightly, lower than the samples from the interior of the deposit. Hence, the grade estimate may be considered to be slightly on the conservative side. There is hardly any overburden, except for a few small patches of soil. Intercalated waste, however, will be of the order of 10 % of the run-of-the mine material.

The reserves of the sub-block (where mining are proposed to be commenced) are estimated by the cross section method covering the sections from A-A to I – I, which are drawn at 100 m interval. The bulk density is taken as 2 and that of the intercalated waste down to 6 m depth.

The total insitu geological reserves in the mining block are 2.75 million tonnes with waste generation of about 0.229 million tonnes down to 6 m depth.

Since these estimates are for the bauxite zone which is proved to exist down to 6 m depth by auger holes within the proposed sub-block, the reserves may be included in the ‘proved’ category. Assuming 10 % of the quantity will remain in the barrier zone un-mined and another 5 % losses in course of mining (amount left in the benches) the mineable reserves are of the order of 2.34 million tonnes (2.75 minus 0.41). These figures are expected to change after completion of proposed exploration programme.

The Geological Survey of India while giving the reserve estimates, stated the average grade of bauxite in Block – I to be 46.03 % and 3.02 % $SiO_2$. The estimated grade on the basis of the two scarp section samples is 47.6 % alumina and 4.47 % silica without grade applying any cut-off. The average of all the escarpment samples gives a 43.76 % alumina and 4.82 % silica. On the basis of exploration data of NALCO , it is concluded that a +20 % $Al_2O_3$ and less than 4 % $SiO_2$ is an ideal cut off for the calculation of mineable reserves in the East Coast Bauxite Deposits. Although silica contents are at places very high, the scarp samples show that the alumina percentage always above value of 20. Furthermore, it must be mentioned that the scarp samples always show inferior results compared to those of boreholes from the interior deposit is likely to be having all mineable and mill feed grade ore.

## 2.2 Conceptual Mining Plan

### 2.2.1 Mine Plan

**Period of anticipated life of the mine:**

Mineable reserves of bauxite in Jerrila Block I Deposits are of the order of 5.78 Million tones (Table 2.1). At the rate of production of half a million tonne of bauxite per annum, the mine has life of 12 years (Table 2.2).

**Table 2.1: Details of mineral reserves**

| Sr. | Category | Quantity (in Million tonnes) |
|---|---|---|
| A. | Proven | 5.8 million tonnes |
| B. | Indicated | - |
| C. | Inferred | - |
| D. | Exploited Mineral reserves | - |
| E. | Total | 5.8 million tonnes |

**Section 1.01 Table 2.2: Production of minerals and life of mine**

| Sr. no. | Particulars | Section 1.02 Unit |
|---|---|---|
| 1 | Capacity of mine (Million tonne/annum) | 5.8 MTPA |
| 2 | Life of mine (years) | 12 years |
| 3 | Lease period | 12 Years |
| 4 | Date of expiry of lease (D/M/Y) | |
| 5 | Date of opening of mine | |
| 6 | Average production in the last five years (Million tonnes/annum) | |
| 7 | Average/projected for the next 10 years (Million tonnes/annum) | **5** |
| 8 | Type of mining | Opencast |
| 9 | Method of mining | Semiautomatic |
| 10 | Loading, Transportation and unloading of mineral and water, rocks on surface | Yes |
| | Manual | Yes |
| | Scrapper, shovels, dumpers/trucks. | Yes |
| | Conveyors (belt, chain, etc.) | Yes |
| | Others (specify) | |

**Long term design feature in the mine:**

The life of the mine is too small and hence same method of mining and design is followed for the next 12 years. However, in case the ore zone thickness is found to be more than the existing 6 m then the life of mine would be higher. Mining will have to be tried to make the mine design more effective and efficient. This would give precise grade estimates of the bauxite produced every day besides throwing light on the precise bottom configuration of the ore zone. The proposed drilling at 50 m interval will afford achieve this target. This will be a continuous process until the ore is completely exhausted, that is closed spaced drilling in advance of mining each block. The bauxite will be exploited till the basement rock is reached. Trench method of mining will be adopted. While exploiting bauxite, the ultimate pit limit, overall pit slope are duly considered. Bauxite production is just over 0.5 million tonne per annum. The total production of bauxite for the five year period (2008-09 to 2012-13) is 2.5 million tonnes with the waste generating of 0.21 million tonnes. The waste material will be stacked in waste dump yard and will be used for back filling of mined area.

**Exploration**

It is proposed to carry out drilling in advance of mining during the plan period in the block selected for mining. Fifty one holes with an average depth of 20 m are suggested at 50 m interval. This will give an idea of the bottom configuration of the deposit in addition to refining the reserve figures and grade estimates. The proposed drilling will form the basis for further improving the mine design. Geostatistical evaluation and ore deposit modeling may help in more precise mine development and optimum exploitation.

**Mine development and optimum exploitation**

The mine design, when worked out on the basis of drilling at 50 m interval, will result in more efficient mining and optimum exploitation. This changes mine design should be aimed at reducing the angle of the mine face at the UPL so that less ore remains in the benches resulting in optimum exploitation. Experience has shown that detailed exploration at close intervals (such as 25m/50m) would help in evaluating the bottom configuration of the deposit more precisely. The long term strategy for exploitation is dictated by the principles of mineral conservation, optimum exploitation and environmental attributes. Sustainable development with minimal land degradation and reclamation and rehabilitation form the integral part of mine development. Keeping in view of environmental attributes, long term and short term plans are prepared for exploitation of Bauxite. When once bauxite is fully exploited, back filling of mined out area with waste material will start. Reclaimed land is then subjected to afforestation programme, Eco-friendly mining with Zero Wastage is the new concept.

**Proposed Land use**

The proposed land use for first five year of the lease area is given below (Table 2.3 & 2.4).

**Table 2.3: Proposed land use of lease area**

| S.No | Head | Area put on use at the start of plan (Ha) | Additional requirement during the plan period (Ha) | Total (Ha) | Area considered as fully reclaimed and rehabilitated (Ha) | Net area considered for calculation (Ha) |
|---|---|---|---|---|---|---|
| 1. | Area under mining | 28.50 | - | 28.50 | 6.09 | 22.41 |
| 2 | Storage for top soil | - | 0.12 | 0.12 | 0.12 | - |
| 3 | Overburden / dump | - | 3.00 | 3.00 | 3.00 | - |
| 4 | Mineral storage | 0.25 | - | 0.25 | - | 0.25 |
| 5 | Infrastructure (Workshop, Administrative building etc.) | 0.35 | - | 0.35 | - | 0.35 |
| 6 | Roads | 2.00 | - | 2.00 | - | 2.00 |
| 7 | Railways | - | - | - | - | - |
| 8 | Green belts | - | 1.7 | 1.7 | - | 1.7 |
| 9 | Tailing Pond | - | - | - | - | - |
| 10 | Effluent Treatment Plant | - | - | - | - | - |
| 11 | Mineral Separation Plant | - | - | - | - | - |
| 12 | Township Area | - | - | - | - | - |
| 13 | Others (to be specified) | - | - | - | - | - |
| | | A | B | C=A+B | D | E=C-D |
| 14 | Total Mine Lease area | 31.10 | 4.82 | 35.92 | 9.21 | 26.71 |

**Table 2.4: Township (outside Mine lease)**

| S.no. | River bank | Other water bodies* Sea/creek/lakes/etc. (specify) | | | |
|---|---|---|---|---|---|
| | | Sea | Creek | Lakes | Total |
| Mine lease boundary | - | - | - | - | - |
| Ancillary facilities | - | - | - | - | - |

***From highest flood line /high tide line**

### 2.2.2 Blasting

Because of the usage of ripper-dozzer in mining operations, drilling is minimum. Tractor mounted compressor would be deployed for carrying out the drilling operations. When large boulders are encountered they will be blasted by resorting to shot hole drilling of 0.6 m to 1.20 m deep holes, depending on the size of the boulders. Almost 50 t0 70 shot holes may be required per day in a mine producing 2000 tonnes of ore per day. About 20 to 25 kg of small diameter explosives may be needed to blast the boulders. The actual requirement may be needed to be worked out after trial production is done. One months explosives may be stored n the magazine on the site. A magazine will be constructed for storing explosives and other accessories.

### 2.2.3 Mine Drainage

Three sources lead to the accumulation of water in the mines, viz. water from direct precipitation, run-off water from higher slopes and groundwater seepage. The water collected from direct precipitation may be roughly calculated as 1 million cubic meters over 1 sq. km. area when the average rainfall is 1000 mm annually (in the area under consideration average annual rainfall is around 1200 mm). This works out to be on an average, 1000 cum of water accumulation annually for every pit of 1000 sq.m. area. In the present case the surface area of the pit gradually increases from the first year and in the fifth year it shall be about (900 m length and average of 350 m width) 315,000 sq.m., which may accumulate about 315,000 cum of water by direct precipitation). Since this will be spread over two or three months of monsoon period, per day collection would be so meager that it may safely be neglected. Groundwater seepage is not present in the area as the water table is very deep having not been intersected even in 30 m deep drill holes on the neighbouring plateaus. The third source that is the water draining down the higher slopes may pose serious threat to the stability of benches in the quarry besides being harmful to the water regime in the buffer zone.

The study area is characterized by rolling topography at an elevation of over 1000 m. The highest point 1110 m is in the northeastern part of the plateau whereas the lowest point of about 1002 m is in the southwestern part. The maximum relief is about 108 m. The general slope is in all directions with slopes ranging between 1 in 6 while along the plateau the slope direction changes between south and NE with an average slope of 1 in 25. During the proposed five year period the pit may receive water, during the monsoon period flowing in northerly, northwesterly and westerly directions. This water needs to be diverted and channelised by bundling at suitable locations to prevent the same from entering the working pit. These bunds have to be constantly modified as the pit progresses in a south-easterly direction. The bunds have to be placed on the southwestern side of the pit. The benches may be given a gentle slope to northwest so that the entire water may collect at the edge of the plateau close to the barrier zone. It may be pumped out down the slope to merge with the natural drainage. Before pumping out, however, the water may be allowed to pass through a siltation tank near the barrier zone so that the water going out of the area is desilted. Peripheral drains may be constructed all around the waste and any soil dumps to trap the rainwater washings so that the load of suspended solids in the discharged water is minimized. Sump pits retaining walls, check dams will have to be placed along the main channel ways to arrest siltation for effective trapping of rainwater washings so that the load of suspended solids in the discharged water is minimized. Sump pits retaining walls, check dams will have to be placed along the main channel ways to arrest siltation for effective trapping of rainwater washings and to ensure clear water is discharged into the surrounding natural streams.

### 2.2.4 Disposal of Waste

The waste material includes laterite, ferruginous laterite and intercalated, Khondalite lenses or lenticles and other ferruginous and siliceous material. It is expected that generation of waste material in exploitation of Jerrila Block I bauxite deposit will be .5 million tonnes.

The topsoil from the very few patches, very thin and rare lateritic overburden, partly altered patches of country rock as well as some laterite and clay patches occurring as intercalcations within the ore zone constitute waste. The topsoil is not strictly waste, as it will be periodically utilized in the plantation programme. In the proposed mining sub-block for the first five years, a total of 1000 cum of soil may be generated. The total waste generation during the five years is likely to be of the order of 0.21 million tonnes.

A 300 m x 100 m area on the western slope is chosen for dumping the waste generated in course of mining during the plan period. The RLs in the site range here from 1080 m at the top to 1056 m at the bottom. The slope is 1 in 7. The 1000 cu m of soil will be preserved in a heap of top of the plateau close to the road, opposite the site services. It has a base of 1200 sq. m. It is purely temporary as the soil, as generated will be used in the plantation programme regularly.
With a base area of 300 m x 100 m sq. m. the dump will reach a maximum height of 10 m at the end of the V year. The dump will be built progressively upwards and by the end of the V year with all the 0.21 million tonnes waste it will reach a maximum height of 10 m. The dumping will be done in such a manner as to maintain a $10^{o}$ to $20^{o}$ slope to the west. The road can reach the top of the dump every year to spread the waste material generated every day. The average length parallel to the edge of plateau shall be 300 m. The dump has to be stabilized following the principles of slope stabilization. A section of the waste dump after it evolves and design of retaining wall at the toe of dump.

### 2.2.5 Use of Mineral

Jerrila Block I bauxite is of metallurgical grade and is suitable for extraction of alumina. The feed grade of ore for alumina recovery plant of M/s NALCO at Damanjodi, Koraput district Orissa contains 32 % alumina and 4 % silica. So APMDC can send bauxite from this deposit, after crushing to 150 mm size, directly to the alumina plant of RAS-AL-KHIMAH tentatively proposed to be constructed near Narasipatnam, Vishakapatnam district via the central stacking yard to be located at Jerrila. This mine, along with others, will form captive mine for this plant to be installed by private sector.

### 2.2.6 Mineral Beneficiation

Apart from crushing the ore to 150 mm size no other beneficiation is required for the bauxite produced from the mines of Block I. A crushing plant is to be set up at the mine head to crush the run-of-mine ore to the required size. The crushing unit consists of ROM stack yard, crushing section includes receiving hopper, feeder, stationary grizzly and crusher. The hopper has a size of 2000 mm x 7500 mm. the stationary grizzly is of 2000 mm x 4000 mm size. The crusher is of toothed double roll of 1700 mm diameter and 2000 mm width. The belt conveyor transports 150 mm sized crushed ore to the central stacking yard to be located near Jerrila village by conveyor. An inpit mobile crusher unit with an operating capacity of 600 to 700 tonnes per hour is suggested, as the annual production is 500,000 tonnes on an average. The crushed ore may be transported by conveyor belt to the Central stacking yard and there after, to the plant site by tippers and trucks.

## 2.3 Implementation of Mining Operations

### 2.3.1 Proposed Mining Schedule

The scheme of mining operations include a stripping phase – an upper layer of bauxite to be removed by blasting and a lower layer of bauxite to be removed by using backhoe-shovel. The sterile overburden is stripped off by ripper – dozer. Blast holes are used for loosening the lower layer. This is worked by backhoe from the bottom level. The ore is carried by front-wheel loaders up to the dumpers / tipper for transportation to the ore stack yard.

NALCO has introduced “trench Mining Method” in their working mines in Orissa. In the present case this method may be adopted if found suitable. However, the basic method to be adopted for mining bauxite from Block – I is the conventional one described below. It is proposed to produce about 0.5 million tonne per year during the

5 year plan period. Accordingly, an area measuring 1000 m x 500 m is chosen for the commencement of mining operations in the subject area.

**Yearwise Development for the first five years**

A few thin (10 cm max) soil patches occur on the Block I plateau. Before the commencement of mining, these will be cleared and the soil heaped separately for reuse later in green belt programme and for plantation at the site services, on dumps etc. The soil generation, however, will be limited. There is hardly any overburden on bauxite deposit. In course of mining bauxite, however, about 10 % waste material such as laterite, or partly altered parent rock and clay/lithomarge may be generated.

The sub-block proposed for mining during the first five years (during the mining period) have 14 auger holes done to prove the existence of bauxite down to 6 m depth. It measures 1000m x 500 m. Mining operations will be carried out from edge to edge of the plateau (leaving the barrier zone) as bauxite occurs all along. The ultimate pit limit is defined by the barrier zone of 7.5 m width all around the plateau. A retaining wall of one-meter height may have to be constructed along the edges of the plateau, within the zone proposed for mining.

Mining will be done along the transverse sections. A trench parallel to the length of the plateau, connecting auger holes with a convenient width will be made. The walls will have a slope of $45^o$ which will be maintained through out the mining operations. The height of the walls will be 6 m, which is same as the height of the proposed working benches. The bench width or berm will be maintained at 6 to 8 m for the maneuverable. The benches will be pushed to the north, south and west top expand the quarry to achieve the planned production.

**Yearwise production for the first five years**

It is proposed to quarry about 0.5 million tonnes on average per annum. The proposed production for the first five years is shown below. The average bulk density of the bauxite ore is 2 and that of the intercalated waste as 1.5 m in the computations. As already mentioned, 10% of the run-of-mine material is expected to be waste. The total extraction of bauxite during the first five years shall be about 2.5 million tonnes with the expected waste generation of 0.208 million tonnes.

**Proposed rate of production when the mine is fully developed**

The production will on an average be 0.5 million tonnes when the mine is fully developed. Since the total reserve available in this block is only about 6.8 million tonnes , no further augmentation of annual production is possible.

**Mineable Reserves and Anticipated life of the Mine**

The Geological Survey of India has estimated a total reserve of 6.8 million tonnes based on preliminary exploration. Assuming that a quantity of 10 % will be left behind in the barrier zone and benches and another 5 % mining losses, the mineable reserve for the entire block is of the order of 5.68 million tonnes. Working at the rate of 0.5 million tonnes per annum the reserve may last for 11.5 years or say 12 years. However, the possibility of an increase in the production still exists.

**Summary of Production of Bauxite for the period 2008-09 to 2012-13**

| Year | Period | Production of Bauxite (Tonnes) | Production of waste Material (Tonnes) |
|---|---|---|---|
| I | 2008-09 | 452,070 | 37,672 |
| II | 2009-10 | 472,725 | 39,394 |
| III | 2010-11 | 491,175 | 40,931 |
| IV | 2011-12 | 519,975 | 43,331 |
| V | 2012-13 | 571,725 | 47,644 |
| | | 2,507,670 | 208,973 |

### 2.3.2 Mining Process

As already mentioned the deposit being surfacial, is confined to the top few meters of the plateau. The general northerly slope of the ground in the selected sub-block for mining is 1 in 8 or 9 while the ground on the plateau itself is gently undulating with opposing slopes, along the length, of 1 in 12 to 1 in 14. The highest contour in the proposed block is 1092 m going down in the north, to less than 1030 m. open cast working is suited for this deposit.

**Mining Practices:** The main activities for mining of the bauxite reserve would include:

- Mobilisation
- Clearing wherever necessary
- Removal of overburden
- Earthwork and operation
- Material transport and storage

The method of mining is by top slicing and benching either by ripper-dozer. As already mentioned, backhoe will be employed in the lowest bench to extract the bauxite from the irregular depressions as the bottom configuration of the bauxite is not always regular and flat. Although the mineralized plateau is not covered with thick trees to be felled in order to clear the area of mining, thick undergrowth of bushy scrub is characteristic of the bauxite plateaus with subjacent charnockite parent rock. The surface with subjacent Khondalite has hardly any vegetation cover. However, careful consideration and due caution will be employed before felling larger trees, if any.

During the first year of mining benches will be developed towards north, south and west to cover all the area encompassing 250 m long in NE-SW direction with widths ranging between 175 m and 450 m. There is no recovery of soil along this section line. Over 0.45 million tonnes of bauxite and 0.04 million tonnes of waste will be recovered at the end of the year. The RLs covered during the year will be from 1080 m to 1065 m. On the northwestern and southeastern sides the pit will have reached the UPL / barrier zone.

In the second year, pit will be extended towards SW covering the section C-C and D-D. The floor RLs shall be between 1085m,1080, 1075, 1070m, 1065m, 1060m, and 1055m progressively from SE-NW of the pit. The dimensions of the pit excavated in the year will be 350 m in the NE-SW direction and 325m to 450 m in NW-SE direction. Bauxite production in the year shall be 472,725 tonnes with waste generation of 39,394 tonnes.

During the third year the pit will have further expanded towards NW covering the section E-E and F-F with the Floor RLs again ranging from 1080 m and 1060 m. The pit size during the year shall be 225 m (NE-SW) by 450 (Max NW-SE). The entire pit will be of 550 m x 450 m in dimensions. The production of bauxite during the year shall be 491,175 tonnes with 40,931 tonnes of waste generation.

The fourth year will see the pit size grow further southwest up to the section H-H with a production of 519,975 tonnes of bauxite and 43,331 tonnes of intercalcated waste. The pit will be worked between 1075 m and 1035 m RLs. The overall size of the pit will be 725 m x 250 m to 450 m. On the northwestern and southeastern sides of the pit will have reached the UPL.

At the end of the five years the maximum size of the pit will be 900 m (NE-SW) x 250-450 m (NW-SE). The bauxite production in the fifth year will be 571,725 tonnes with waste of 47,644 tonnes. The total production during the five years will be of the order of 2,507,670 tonnes and waste of 208,973 tonnes. The RLs of floor during the fifth year will range between 1070 m and 1035 m.

### 2.3.3 Major Mining Facilities

**Mining Facilities and Mechanization:** The mining operations will be fully mechanized. Ripper dozer will be deployed for top slicing and benching. Ripping is now practiced for mining bauxite in the Panchpatmali mines of Koraput district, Orissa by NALCO.

The equipment required for carrying out mechanized mining operations with their capacities are mentioned in **Table 2.5,** which includes ripper-dozer, hydraulic excavators, heavy tippers / dumpers, tractor mounted bulldozers, Road grader, water tanker etc.

**Table 2.5: Common equipment facility to support the Mining of Bauxite**

| No | Unit | Capacity |
|---|---|---|
| 1 | Ripper Dozer | Nos. 1; 400 t/hr. |
| 2 | Hydraulic Excavator | Nos. 2; 416 t/ hr |
| 3 | Front-end loader | Nos. 2; 4.8 $m^3$ |
| 4 | Tippers/Dumpers | Nos. 7; 35 t payload |
| 5 | Drills | 105 mm crawler mounted; 12 m/hr |
| 6 | Tractor Mounted Bull Dozers | 1 no |
| 7 | Road Grader | 1 no |
| 8 | Water Tankers | 2 no |

- **Ripper – dozer:** Ripping is a process in which a riper (a plough attachment fitted to a crawler tractor is used to loosen the rock. The loosed rock is then piled up by dozer for loading and transportation. Ripability of rock depends upon compressive strength, shear strength, moisture content and refraction seismograph of rock. Techno-economic factors are considered for deploying ripper in mining operation, it is planned that riper will be deployed for overburden removal, stripping thin layer of waste material as well as bauxite production.

  The total production of material required to be considered per annum is half a million tonne. For this it is proposed to deploy ripper driven by 770 HP diesel engines fitted with single shank attachment. Ripper and dozing capacity of this equipment is estimated as 400 tonnes per hour. One ripper-dozer will be sufficient to meet the targeted production of bauxite. The techno-economic survey conducted by NALCO in their mines revealed that this combination has an advantage and efficiency of about 20 % over drilling –blasting method. Mining with riper dozing is also eco-friendly.

  The quantity to be raised each year is about 0.5 million tonnes. A ripper driven by 770 Hp Diesel engine fitted with single shank riper attachment is required. Ripping and dozing is estimated as follows:

| | |
|---|---|
| Speed of Ripping | 2 kmph |
| Speed of dozing | 3 kmph |
| Depth of ripping | 750 mm |
| Spacing between passes | 800 mm |
| Machine efficiency | 0.8 |
| Operator Efficiency | 0.8 |
| Material Factor | 0.8 |
| Visibility factor | 0.8 |

Based on the above assumptions the capacity of machine works out to be 400 tonne per hour. The number of rippers required to meet the annual target of production may be estimated as follows:

| | |
|---|---|
| Annual quantity of bauxite to be ripped and dozed | $0.5 \times 10^{6}$ t |
| Annual operating hours | 2400 |
| Machine capacity | 400 tph |
| Number of rippers required | (500,000/2400x400) =0.52 |

Thus, one ripper dozer will be adequate to raise the targeted material every year.

- **Hydraulic Excavator:** This is to be deployed for loading the dozed material into rear dumpers of 35 t capacity. Considering the mobility, maneuverability and speedy deployment at the work site, front-end loaders are preferred for loading of bauxite ore and overburden into rear-dump trucks for transportation to crusher plant, ore stock-pile and overburden / waste sump site. It is proposed to deploy 3.8 $m^3$ capacity hydraulic excavators and 4.8 $m^3$ capacity front-end loader.

| | |
|---|---|
| Capacity of bucket | 3.8 $m^3$ |
| Bucket fill factor | 0.70 |
| Bulk density of material | 1.5$m^3$ |
| Tonnage handled per bucket | 3.8 x 0.7 x 1.5 = 3.9 |
| Cycle time | 40 seconds |
| Expected operational efficiency | 80% |
| Number of Loading cycles/hr. | (60x60x0.8)/40 = 72.29~72 |
| Tonnage handled by excavator/hr | 72 x 4 = 288 |
| Availability factor | 0.8 |
| Output/hour | 288 x 0.8 = 230 t |
| Average annual production to be handled per hour | 208 t |
| Number of excavators required | 1 |

Accordingly, one hydraulic excavator and one front-end loaders are required. One of the excavators can be converted to a back-hoe as and when required.

- **Tippers/ Dumpers:** The effective lead for transportation of bauxite and overburden/waste material considered within 1 km for estimate purpose. 5 dumpers of 35 t capacity.

**Cycle time per trip**

| | |
|---|---|
| Loading | 6 minutes |
| Spotting near loader | 0.5 minutes |
| Haulage | 5.25 minutes |
| Turning, spotting & dumping | 1.5 minutes |
| Return journey | 4.25 min |
| **Total** | **17.5 min** |
| Expected efficiency | 85 % |
| Number of trips required per hour | (60x0.850/17.5) = 2.9 |
| Pay load of dumpers | 32 t |
| Quantity of material transported by one dumper in one year (300 working days per year and 2 eight hourly shifts per day) | 4800 x 32 = 153600 t |
| Quantity of bauxite to be transported per year | 500,000 t |
| Availability factor | 0.65 |
| Number of dumpers required would be | 500000/153600 = 5 |
| Fleet strength required would be | 5 dumpers of 35 t capacity |

- **Drilling:** Drilling may be necessary to drill some blast holes when the formation encountered is not amenable for ripping and dozing. This is very occasionally used when big boulders are met within the benches.

- **Loading:** The loading of loosened material will be loaded into dumpers / tippers with the help of hydraulic excavators. The soil/waste generated in course of mining will also be loaded into tippers in a similar way.

- **Haulage and transport:** the haulage roads are temporary within the working pit. They have to be laid down on the working benches with certain specifications. They need to be wide enough to accommodate free movement of heavy vehicles with places for crossing and turning. The thumb rule is that the width should be three or four times the width of heavy vehicles (~2.4 m). Thus, the berms should be around 8 or 9 m to have safe haulage. The haulage roads will connect to the semi –permanent transportation road, which allows the material to be transported outside the leasehold to the end user or the nearest rail head. The haulage roads, dumpsites and place for soil heaps are shown in the mine plans while the later are located outside the working area with approach roads. The haulage transportation roads have to be gently sloping with gradients ranging between 1 in 8 and 1 in 16. The outer edges of hairpin bends need to be bulwarked with one meter high parapet walls.

- **Miscellaneous Operations and Machinery:** One road grader necessary for grading the haul roads and bench floors. One wagon drill by jack hammer drills may be required. Water tanker with 28 Kl capacity will be used for sprinkling water on roads, dumps, soil heaps etc. to suppress dust. Maintenance of roads in all seasons and plantation with efforts to achieve high survival rates as also monitoring of the important environmental parameters at regular intervals, form other miscellaneous operations.

**Other equipments:**

| Equipment | Make |
|---|---|
| Ripper dozer | BEML, 770 Hp |
| H-51 Backhoe | Hind motors, Remag, Hydraulic, 3 $m^3$ |
| PC-650 Hydraulic front end loader | BEML 4.8 $m^3$ |
| 325 Hp Hydraulic Rock excavator | L & T, 300 ch, Pochlain, 3 $m^3$ |
| 183 Hp hydraulic Rock Breaker | L & T |
| 72-718 Terex Wheel Loader | Hind Motors 5.7 $m^3$ |
| ADM-01,260 Hp Dumper 35 t/50 t | DJB dumper |
| 130 Hp air compressor | Ingersal IDM-15 |
| Tractor Mounted Bull dozer | |
| Water Tanker 28 Kl | |
| Crushing Unit | Krupp Industries/KCP |
| Wagon drill | Atlas Copco |

- **Water Requirement during the mining**

Water requirement during the mining has been given in the Table 2.6.

**Table 2.6: Water requirement and source of raw water supply** (cums/day)

| Sl. No. | Water requirement (Purpose) | Average required (cums/day) |
|---|---|---|
| 1 | Dust suppression | 135 |
| 2 | Drinking | 2 |
| 3 | Others (please specify) | 5 |
| 4 | | - |
| | Total | 142 |
| | **Source of raw water supply (net)** | |
| 5 | Sea | - |
| 6 | River | - |
| 7 | Groundwater | - |
| 8 | Rainwater harvesting | 142 |
| 9 | Municipal water supply | - |
| 10 | Others (please specify) | **-** |
| | Total | **142** |

***Source:** Guduketta river, Logged rainwater in trench

****Remarks**: During rainy season the requirement of water is very less. Only drinking water will be brought from out of lease area

## 2.4 Bauxite Transportation

The bauxite transportation to the alumina refinery plant is determined by a combination of economic and environmental considerations. The various options available are

- Road Transport
- Rail Transport
- Ropeway System
- Conveyor System
- Pipe slurry system

There is no rail connection from the mines to the plant site and the pipeline slurry system has hitherto not been tried in the country. These two options are therefore ruled out. The ropeway system or the conveyor system involves short distance transport from the mine head to the plant site. However, the environmental and economic considerations have to be worked out. These systems involve passing over a wide forest area.

This, therefore, leaves the road transport system as the most viable method as of now. It involves transportation of about half-a – million tonnes of ore or about 1600 tonnes per day by heavy vehicles. The maximum distance of the refinery is over 85 to 90 km from the mine. The road from the mine to Jerrila and then to Narasipatnam needs to be repaired and maintained so that the to and fro traffic of heavy duty 35 tonne capacity vehicles, carrying ore from the mine, is not impeded. It may have to be doubled in width. The plant is proposed to be located on a 1000 acre site, 15 km east of Narasipatnam. An alternate arrangement would be to transport the crushed ore from the Central Stacking Yard to be established near the Jerrila Village by conveyor. From the stack yard the ore will be moved to the Alumina plant site by trucks.

## 2.5 Site Services

Site services include Administration set up and Services Centre, which include auxiliary facilities namely quality control lab, repair and maintenance shop, stores, training centre, first aid, canteen, transport and communication facilities. Other utility supplies include power and water supply systems.

A training centre will impart will impart vocational training to mining personnel as per Mines Vocational Training Rules, 1966. The administrative set-up accommodates service personnel. A security gate will be located on the access road at its entry point to the deposit. Two check posts will be provided at the entry point of administrative building and service centre. The quality control center is provided with a chemical laboratory for analyzing and quick determination of important radicals, for check samples collected from mine benches and crushing plant. Computer facilities will be provided for data storage, quality control and production planning.

A first aid station will be set-up as per the Mining rules, 1955 to provide first aid to working personnel. Ambulance van also needs to be provided at the site.

A canteen will be set-up to provide refreshments and other eatables to the workers, supervisory staff and office staff at subsidized rates.

Power supply system includes supply of power to work site, crushing plant, administrative building, service centre etc. power will be drawn from the nearest sub-station of AP Transco. A communication network will be established to be able to contact workers and staff at different workstations on the mine site and administrative block.

The owner of the mines is obliged to provide all the essential services to ensure efficient and safe running of the mining operations round the year.

## 2.6 Manpower

The estimated manpower requirement is given below for effective management and successful operation of Jerrila bauxite mining project. The mining project provides both direct and indirect employment opportunities.

The estimated manpower requirements are as follows:

| | | |
|---|---|---|
| General | General Manager | 1 |
| | Secretary or Steno to PM / GM | 1 |
| | Steno & Assistant | 2 |
| | HRD Manager | 1 |
| | Liaison Officer | 1 |
| | Commercial Officer | 1 |
| | Accounts Officer | 1 |
| | Medical Officer | 1 |
| | Compounder | 1 |
| | Nurses & Ayahs | 4 |
| | Sanitary Officer | 1 |
| | Unskilled Labour | 10 |
| Mining | Mining Engineer with Degree in Mining | 1 |
| | Mines Manager | 1 |
| | Asst. Mines Manager | 2 |
| | Mining Foreman | 2 |
| | Sampler | 1 |
| | Mines Supervisor | 4 |
| | Draughtsman | 1 |
| | Mines Surveyor | 1 |
| | Vocational Training Officer | 1 |
| | Chemist | 2 |
| | Lab Assistant | 4 |
| | Clerical Staff | 4 |
| | Record Keepers | 4 |
| Geology | Manager (Geology) | 1 |
| | Geologists | 2 |
| | Assistants | 2 |

| | | |
|---|---|---|
| | Surveyor | 1 |
| | Laboratory Assistant | 1 |
| | Clerical Staff | 1 |
| | Record Keepers | 3 |
| Environmental Management | Manager | 1 |
| | Environment Engineer | 1 |
| | Unskilled Labour | 3 |
| | Office Assistant | 1 |
| Stores & Purchase | Stores & Purchase Officer | 1 |
| | Superintendent | 1 |
| | Store Keeper | 1 |
| | Unskilled Workers | 4 |
| Security | Security Officer | 1 |
| | Security Supervisor | 2 |
| | Security Guards | 12 |
| MIS | Manager | 1 |
| | Asst. Manager | 1 |
| | Assistants | 1 |
| Civil Works | Civil Engineer | 1 |
| | Operators | 2 |
| | Assistants | 4 |
| | Office Assistant | 1 |
| Mechanical Workshop | Automobile Engineer | 2 |
| | Electrical Engineer | 1 |
| | Engineer (Traffic) | 1 |
| | Supervisors (Traffic) | 3 |
| | Foreman | 1 |
| | Electrical Supervisor | 3 |
| | Supervisor (Crushing Plant) | 1 |
| | Foreman (Crushing Plant) | 1 |
| | Mechanics | 3 |
| | Casual Labour | 10 |

## 2.7 Proposed Environmental Management Plan

### 2.7.1 Storage and Preservation of Topsoil

Soils are developed due to complex organic and inorganic processes. In Jerrila area, soils are the products of disintegration and chemical leaching of Khondalite. Preservation and utilization of topsoil is an integral part of dump management. Topsoil in Jerrila Block I deposit will be scrapped by bulldozer and stacked separately for reuse in plantation programme. About 2500 cu m of topsoil will be generated by the time mining ceases in the area. During the proposed plan period, however, 1000 cu m of soil is likely to be collected.

The perimeter of the applied area is 8,750 m and with a 7.5 m wide barrier zone the area for green belt plantation works out to be 65,625 sq. m. or approximately 6.5 ha. Spreading the recovered soil (2500 cu m) all along the barrier zone may result in the increase in thickness of soil by 4 cm. However, the available quantity of soil may judiciously be distributed where it is most need such as the reclaimed degraded, barrier zone etc. In the first five year a barrier zone of length of 2250 m (on either side of the proposed mining block will be subjected to green belt plantation. This works out to be 16,875 sq. m. or 1.7 ha.

### 2.7.2 Land Reclamation

In case of opencast mining, original topography will be disturbed. It is necessary to reclaim the degraded land to its near original topography by back-filling the mined out area with waste material. Restoration, reclamation and rehabilitation of mine-spoiled land would form an integral part of mining operations. The reclamation of land involving back filling of mined out areas, landscaping, soil amelioration and revegetation shall proceed concurrently with mineral extraction as stipulated in the National mineral policy, 1993.

During the Plan period about 28.50 ha area will be spoiled by mining and conceptually, a total area of 82 ha area will be degraded at the end of the operations. Only an area of 2.75 ha will remain unmined due to its very narrow nature represented by the two neck like portions. The total waste generation is likely to be 0.21 million tonnes at the end of the plan period and about 0.58 million tonnes at the end of the mining operations in the area. The available waste at the end of first five years is adequate to refill a small part (6.09 ha) of the pit \where the mining would have been completed in 5 years.

### 2.7.3 Phased plantation

The phased afforestation programme includes green belt plantation along the buffer zone (65,625 m) around the boundary of the applied area, avenue tree plantation on either side of the mine roads, revegetation of reclaimed areas of the pit. The green belt plantation will begin soon after mining is commenced in the area. About 2250m length of perimeter of the applied area bounds the mining block proposed for the first five years green belt plantation. The area works out be 16,875 sq. m or 1.7 ha IWST proposed 30 m wide green belt. Approximately 3000 trees per year may be planted during the five year period. The other areas ready for plantation shall be site services campus where floral plants and fruit bearing tree saplings may be planted. The toe part of the proposed dumpsite, avenue plantation and rehabilitation of the reclaimed part of the pit may also be taken up. In all 5000 saplings are proposed for annual plantation during the five year period.

It is proposed to create green belt along the peripheries of Block I deposit. All measures will be taken to suppress dust and noise baffling generated during mining operation. Also, steps will be taken to reduce unpleasant and visual impacts and prevent soil erosion and possible land slide. It is also proposed to stablise and protect old and new waste dumps by creating green belts and providing garland drains around the waste dumps.

### 2.7.4 Fauna Preservation

During the developmental stage of mine, care will be taken to preserve the endangered species and rehabilitate them to sanctuary.

### 2.7.5 Drainage

Mined out area will be given forest cover and necessary drainage will be provided to prevent soil erosion.

### 2.7.6 Air Pollution Control Measures

Several abatement measures to control air pollution due to mining operations are proposed. In order to prevent dust pollution, dust generation should be suppressed while drilling, blasting, vehicular movement ore crushing and handling etc. The sources of the later are mine faces, loading and unloading points, crusher site, un-surfaced dusty roads, dust blows from dumps, soil heaps and ore stacks.

The following measures will be undertaken.

- Suppression of dust by water-sprinkling at the site of activity in the mine, haul road, waste dumps, crushing plant and any other areas susceptible to dust generation
- Effective provision for dust collection in drills
- Continuous monitoring of air quality and taking appropriate measures to reduce the SPM load in the air
- Enclose loading and unloading points, if possible
- Surface of internal roads with Lateritic gravel.
- Directing exhaust fans of transport vehicles upwards
- Growth of green belt

### 2.7.7 Control of vibration and Noise Pollution

Higher noise levels are possible at the sites of heavy equipment such as shovel dumper, drills and crushing plant. The following measures will be taken to mitigate noise pollution.

- Provide ear-muffs to workers who are exposed to noise-prone equipments
- Provide silencers and mufflers in the exhausts of all equipment and drills
- Regular maintenance of machinery equipments
- Create thick belt of plantation to avoid the possible noise level locations as acoustics barriers

### 2.7.8 Stabilization and vegetation of dumps

The dump accumulated over a period will be progressively used for back filling part of the mined out area. Till such time the material is not used for refilling. The dead part of the dumps will have to be protected from erosion by planting grass on its surface and fast growing trees around the toe of the dump. Garland canals have to be provided at the top and bottom of the dump to prevent the rain water streaming down the dumps and the bottom garland canal will catch the washed dump material and deposit in the siltation tanks through which such silt laden waters will be made silt-free. Similarly, the soil heaps also will be covered with grass.

### 2.7.9 Treatment and disposal of water from the mine

The water draining from the mine will be a major source of adverse impact on the surrounding water regime and agricultural lands. In order to make the run-off water leaving the mine silt free, a number of check dams, gully plugs may be considered across the water courses to reduce the velocity of water flow, so that the silt is deposited before making it much cleaner to flow out into the environment. Simple – design-rock-filter dams erected across the water channels may be very effective in treating the non-toxic turbid water where the direct discharge water from the mine gets filtered through a specifically prepared vertical filter bed embedded into the dam walls made of sized stones. No toxic substances of significant quantities will exist in dissolved state in the water flowing out of the area.

### 2.7.10 Measures for mining adverse effects on the water regime

The run-off waters from the mines carry silt and clay particles in suspended state and toxic metals. If, any, in dissolved state. If left unchecked these pollutants are likely to spoil the surrounding water regime in the buffer zone. The agricultural fields, irrigation canals, the stream beds and surface water bodies, if any, will get silted. The revegetation programme coupled with the construction of check dams across the water discharge courses are considered adequate to ensure discharge of clean water into the surrounding environment.

In addition, providing a gentle gradient to the benches in the mine, garland drains to prevent soil erosion and plantation of eucalyptus trees and shrubs at the point of discharge will also help.

Monitoring and feedback becomes essential to ensure the implementation of the mitigation measures planned. It forms an integral part of the mining operations. An environmental cell may be constituted at the mine level to monitor the various environmental parameters at periodic intervals and to improve upon the mitigation measures where they are found to be inadequate.

### 2.7.11 Water Pollution Control Measures

The Jerrila Block I bauxite project will not generate any waste effluents. In order to reduce suspended solids in water, the following measures will be taken.

- Provide proper gradient and drainage arrangement at the mine benches
- After trapping the suspended solids in check dams / sump pits, the water will be allowed to flow down the hill slopes to join streams
- Plant, trees and shrubs at the point of discharge so that water is absorbed by vegetation
- Provide forest cover and necessary garland drains to prevent soil erosion.

**Figure 2.1: Proposed Layout of Jerrila Block I Mines**
**(Map from DPR)**

# CHAPTER 3

# PHYSICAL ENVIRONMENT

## 3.1 Introduction

The environmental impact assessment study includes identification, prediction and evaluation of potential impacts of the proposed mining activity at Jerrila Block I Bauxite mines on the environment within the study area.

The study area of 10 km radius circumscribing the mine deposit at the centre is considered to establish baseline condition while determining the criteria of pollutants, potential effects, sensitivity of receptors viz. forest flora and fauna, rural settlements, plantations, cultural, aesthetic and recreational features etc. are considered. The study area is depicted at **Figure 2.1**. For the evaluation purpose and to understand the existing environmental scenario in the study area, the baseline setting for the above mentioned environmental components are documented in this chapter. Subsequently, in the next chapter description on the potential impacts during the operational phase, on the said environmental components are identified, predicted and evaluated.

For this EIA study, baseline data is collected for the period during December 07–February 2008. Primary data is collected to establish baseline scenario for the micrometeorology, ambient air quality, noise levels, soil, surface and groundwater quality, flora & fauna and socioeconomic surveys. Secondary data is also collected for the significant environmental components for EIA i.e. land, geology, ecology, climatology, and socio- economic factors.

## 3.2 Water Environment

### 3.2.1 Physiography

The area under consideration forms a part of the Eastern Ghats hilly region and is, therefore characterized by an extremely rugged topography. The overall trend of the hills is NE-SW, consistent with the regional “Eastern Ghats” trend. The whole region is marked by a deeply dissected topography with high hills interspersed with narrow valleys. Jerilla village is located in one such narrow valley. Around Chintapalle and further east, the valleys are broader with extensive cultivation. The tops of the hills are in places, made up of gently undulating plateaus of variable dimensions and shapes. Some of these plateaus are the home of bauxite and laterite deposits. The highest peak, a triangulation point of 1297 m is located north of Jerilla Village. The altitude of the valley floors around Jerilla is on an average 850 m, which gives a maximum relief in the area of around 450 m. in the Block – I Area, the maximum altitude is 1100m. The general slope of the region is towards southeast. The broader valleys, to the southeast, have an average altitude of around 750 m with scattered residual hills rising to over 950 m.

The drainage in the study area is controlled by the hill-streams some of which are perennial. Streams descend from the Block I plateau in all directions giving rise to a radial dendritic pattern. The streams descending from the hills merge with the NE-SW trending valleys forming again an overall dendritic pattern. Towards more mature topographic areas, like in the east and southeast, the drainage assumes a general trellis pattern with prominent streams having NE-SW trend, joined by small streams from the NW and SE directions. The regional drainage is chiefly controlled by the Sileru and Budugedda Rivers that flow in the area to the NW.

### 3.2.2 Drainage

The drainage in the study area is controlled by the hill-streams some of which are perennial. Streams descend from the Block I plateau in all directions giving rise to a radial dendritic pattern. The streams descending from the hills merge with the NE-SW trending valleys forming again an overall dendritic pattern. Towards more mature topographic areas, like in the east and southeast, the drainage assumes a general trellis pattern with prominent streams having NE-SW trend, joined by small streams from the NW and SE directions. The regional drainage is chiefly controlled by the Sileru and Budugedda Rivers that flow in the area to the NW in the Toposheet 65J/4. The study area comprises of upper reaches of the Machkund Reservoir skirting by river Buddugedda, and streams Pala eru and Rurna revu. The Kumulu revy flows in the eastern part of the study area. The river Budugedda traverses north- south in the western part of the study area. The relief of the area is hilly and undulating which covers larger portions of study area and is studded with several small intermountain valleys. General slope of area in is towards southeast. The drainage pattern of the area is quite intricate and complex. Due to the hilly terrain the general drainage pattern is dendritic and occasionally radial. **Figure 3.1** shows the water bodies and drainage in the region.

**Error! No topic specified.**

**Figure 3.1: Water Bodies and Drainage network**

### 3.2.3 Hydrogeology and Ground water

Groundwater resources are tapped through bore wells, and also through some dug wells in the villages. Bore wells are present at very few habitations/village. The water required for the proposed mining activity and maintenance of the green belt plantations etc. would be drawn from the perennial waters.

The area is underlain by eastern ghat tectonic zone of Archaean period and is represented by Khondalite and Charnockite formation. The patches of lateritic soil of sub-recent period occupy the area. The thickness of weathered mantle varies between few maximum 30 m in the study area.

The groundwater in the study area occurs with in secondary porosity of crystalline rocks as well as in the primary porosity of weathered alluvial sediments deposit in the foot hill zones and the intermountain area. The groundwater over the area occurs in phretoric or water table conditions. Nearly 90 % of study area is represented by hilly terrain, while the valley or plain area is represented through intermountain valleys.

Groundwater in the bauxite residum remains in an unconfined state and moves to the contact with the host rock. Aquifer conditions occur in the saturated zone of weathered host rock. There is no possibility of encountering ground water within 30 m from surface on the hill tops. Water table in the valley is steady and shallow as shown by the tube wells drilled near the villages.

### Groundwater occurrence

The hydro-geomorphology controls the occurrence as well as the movement of groundwater in the area. The larger part of the area is represented through hilly terrain constituted by crystalline rocks which are compact and devoid of porosity. Hence the secondary porosity developed in these rock types due to de-formative process are the only place for groundwater occurrence. The secondary porosity is constituted by fractures and cracks as well as weathering. The degree and depth of weathering in these formations varies from place to place. At the hill top maximum thickness of weathered material is around 30 m and that too under favorable land form conditions and similar conditions are observed in Valleys.

The groundwater in weathered zone occurs under unconfined state. The weathered sediment has low to moderate prospects of groundwater occurrence. The dugwell and shallow bore wells are common source for groundwater exploitation.

### 3.2.4 Water Quality Characteristics

Water quality characteristics are mainly recorded for surface water bodies, reservoirs and boreholes. Water quality monitoring studies were carried out for determination of physicochemical characteristics of rivers/ reservoirs and borewells. Four flowing water samples represent the surface water quality. The samples of bore wells, dug wells, and hand pumps at five locations taken from the village represent the ground water quality. The sampling locations are given in **Table 3.1** and **Figure 3.2.** Details of surface water quality assessment carried out in November / December 2007 are presented at **Table 3.2 (a)** to **Table 3.2 (c)** for Physico chemical, Heavy metal and Bacteriological Parameters.

**Table 3.1: Surface and Groundwater Sampling Locations in the Study Region**

| No | Sampling Location | Description |
|---|---|---|
| | **Surface Water** | |
| SW 1 | Bodugedda | River water |
| SW 2 | Kotakonda | Stream Water |
| SW 3 | Mondigedda | Stream Water |
| SW 4 | Jerilla | Stream Water |
| SW5 | Pebbampalli | Stream Water |
| SW6 | Chintalawada | Stream Water |
| SW7 | Charepalle | Stream Water |
| SW8 | Syamagedda | Stream Water |
| SW9 | Bagidikonda | Stream Water |
| | **Ground Water** | |
| GW 1 | Panaspalle | Dug Well water |
| GW 2 | Korukonda | Borewell water |

The water quality assessment is done as per BIS 10500 (potable water quality standards). The drinking water sources are both the groundwater and surface waters. The surface water in major is used for irrigation, plantation, other domestic purposes.

The observations are:

- Color and Turbidity levels of streams are high than the prescribed limits at all the locations.  Accept for three locations, the turbidity is < 5NTU. It is high in Bodu gedda (SW1) river station around 22 NTU and maximum at Mondigedda (SW 3) which is 28 NTU.
- The TDS of the streams is high at most of the locations. It is highest at Bodu Gedda (SW1) 750 mg/l and Jerilla (SW4) it is 720 mg/l.
- Bacteriological analysis reveals that the Total Plate Count (T.P.C) and Most Probable Number (M.P.N) count significantly exceed the prescribed limit, at two

locations, as also the surface water samples collected confirm to presence of E. Coli at Chintalpadu (SW6). This can be attributed to unhygienic conditions prevailing in the surroundings.

- Physico-chemical and bacteriological analysis of the water samples collected in the study region indicates that the water is not fit for drinking purposes.

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**Figure 3.2: Water Sampling Locations- Surface & Ground water Water**

**Table 3.2 (a): Physicochemical characteristics of Surface Water in the Study Region**

| S. No. | Parameter | Unit | Limits | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | SW7 | SW8 | SW9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [a] Physical Parameters | | | | | | | | | | | | |
| 1 | Color | Hazen | 5 | 16 | 14 | 10 | 12 | 8 | 8 | 4 | 14 | 10 |
| 2 | Odour | Hazen | UO | UO | UO | UO | UO | UO | UO | UO | UO | UO |
| 3 | Taste | Hazen | Agreeble | Disgreeble | Agreeble | Disgreeble | Agreeble | Agreeble | Disgreeble | Agreeble | Disgreeble | Agreeble |
| 4 | Turbidity | NTU | 5 | 22 | 22 | 28 | 22 | 5 | 15 | 2 | 14 | 2 |
| 5 | PH | H+ | 6.5-8.5 | 6.34 | 6.54 | 6.26 | 7.24 | 6.5 | 7.24 | 6.94 | 6.44 | 6.74 |
| **[b] Chemical Parameters** | | | | | | | | | | | | |
| 6 | Total Hardness | mg/l | 300 | 65 | 65 | 55 | 80 | 55 | 90 | 55 | 56 | 50 |
| 7 | Calcium (as Ca) | mg/l | 75 | 14 | 10 | 14 | 12 | 12 | 18 | 12 | 14 | 12 |
| 8 | Magnesium (as Mg) | mg/l | 30 | 7.2 | 6.2 | 7 | 7.2 | 7 | 9.2 | 7.2 | 7 | 7.2 |
| 9 | Chlorides | mg/l | 250 | 80.5 | 84.5 | 75.5 | 88.5 | 65.5 | 95.5 | 65.5 | 38.5 | 45.5 |
| 10 | Manganese | mg/l | 0.1 | 0.14 | 0.1 | 0.12 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 |
| 11 | Copper | mg/l | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| 12 | Total Alkalinity | mg/l | 200 | 125 | 125 | 18.5 | 135 | 115 | 175 | 135 | 85 | 25 |
| 13 | TDS | mg/l | 500 | 750 | 680 | 680 | 720 | 410 | 680 | 340 | 540 | 440 |
| 14 | Sulphide | Mg/l | NiL | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil |
| 15 | Sulfactants | Mg\l | NiL | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil |
| 16 | Nitrite ($NO_2$) | mg/l | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| 17 | Iron | mg/l | 0.3 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.9 | 0.2 |
| 18 | Fluoride | mg/l | 1 | 1.4 | 1 | 1 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0.4 |
| 19 | Oil & Grease | mg/l | 0.01 | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil |
| 20 | Total Nitrogen | Mg/l | NiL | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil |
| 21 | Phosphate | Mg/l | NiL | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 22 | Sulphate | mg/l | 200 | 26 | 25 | 20 | 48 | 78 | 18 | 68 | 48 | 18 |
| 23 | Aluminium | mg/l | 0.1 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |

**Table 3.2 (b): Heavy metals in Surface Water in the Study Region**

| S. No. | Parameter | Unit | Limits | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | SW7 | SW8 | SW9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [c] Heavy Metals | | | | | | | | | | | | |
| 1 | Chromium (as $Cr^{+6}$) | mg/l | 0.05 | 0.005 | 0.004 | 0.005 | 0.008 | 0.004 | 0.004 | 0.008 | 0.004 | 0.006 |
| 2 | Cyanide | mg/l | 0.05 | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil |
| 3 | Phenolic Compound | mg/l | 0.001 | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil |
| 4 | Free Residual Chlorine | mg/l | 0.2 | 0.04 | 0.04 | 0.04 | 0.04 | 0.08 | 0.04 | 0.04 | 0.06 | 0.05 |
| 5 | Lead | ppm | 0.1 | 0.002 | 0.004 | 0.002 | 0.004 | 0.004 | 0.005 | 0.004 | 0.002 | 0.004 |
| 6 | Arsenic | Ppm | 0.05 | 0.006 | 0.008 | 0.006 | 0.008 | 0.008 | 0.008 | 0.008 | 0.006 | 0.008 |
| 7 | Selinium | ppm | 0.01 | 0.001 | 0.001 | 0.004 | 0.005 | 0.001 | 0.004 | 0.001 | 0.001 | 0.002 |
| 8 | Cadmium | ppm | 0.01 | 0.004 | 0.002 | 0.004 | 0.004 | 0.004 | 0.005 | 0.004 | 0.004 | 0.004 |
| 9 | Mercury | ppm | 0.001 | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil |
| 10 | Zinc | mg/l | 5 | 1 | 1.5 | 1.5 | 1.8 | 1.8 | 2.8 | 3.5 | 1.8 | 1.5 |

**Table 3.2 (c): Bacteriological characteristics of Surface Water in the Study Region**

| S. No. | Parameter | Unit | Limits | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | SW7 | SW8 | SW9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **[d] Bacteriological Parameters** | | | | | | | | | | | | |
| 1 | MPN / 100ml | Index | <10 | 120 | 10 | 102 | 10 | 10 | 20 | 7 | 10 | 9 |
| 2 | E.coli | Cfu/ml | nil | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absen t |
| 3 | Total Plate Count | Cfu/ml | 50 | 46 | 40 | 26 | 38 | 28 | 78 | 22 | 28 | 42 |

Groundwater quality data (for Physico chemical, Heavy metal and Bacteriological Parameters) recorded at various bore-wells and dug-wells meant for domestic and washing purposes are as given in **Table 3.3 (a) to Table 3.3 (c).**

The observations are:

- Color and Turbidity levels of water from the grund water are higher at most of the locations.
- The pH values of water from all hand pumps collected are within the prescribed range i.e. 6.5 – 8.5
- The TDS levels are 1040 mg/l
- Bacteriological analysis reveals that the MPN count exceeds the prescribed limit at most of the locations. The ground water has no contamination of E. Coli. The Total plate count at all locations is within the prescribed limit
- The physico-chemical and bacteriological analysis of the water samples collected in the study region indicates that the water in requires primary treatment.

**Table 3.3 (a): Physicochemical characteristics of Ground Water in the Study Region**

| S. No. | Parameter | Unit | Limits | GW1 | GW2 |
|---|---|---|---|---|---|
| 1 | Color | Hazen | 5 | 28 | 10 |
| 2 | Odour | Hazen | UO | UO | UO |
| 3 | Taste | Hazen | Agreeble | Disgreeble | Disgreeble |
| 4 | Turbidity | NTU | 5 | 35 | 20 |
| 5 | PH | H+ | 6.5-8.5 | 7.24 | 6.34 |
| 6 | Total Hardness | mg/l | 300 | 150 | 58 |
| 7 | Calcium (as Ca) | mg/l | 75 | 32 | 10 |
| 8 | Magnesium (as Mg) | mg/l | 30 | 14.2 | 7.4 |
| 9 | Chlorides | mg/l | 250 | 95.5 | 87.5 |
| 10 | Manganese | mg/l | 0.1 | 0.14 | 0.14 |
| 11 | Copper | mg/l | 0.05 | 0.01 | 0.01 |
| 12 | Total Alkalinity | mg/l | 200 | 225 | 145 |
| 13 | TDS | mg/l | 500 | 1040 | 760 |

| | | | | | |
|---|---|---|---|---|---|
| 14 | Sulphide | Mg/l | NiL | Nil | Nil |
| 15 | Sulfactants | Mg\l | NiL | Nil | Nil |
| 16 | Nitrite ($NO_2$) | mg/l | 0.02 | 0.04 | 0.02 |
| 17 | Iron | mg/l | 0.3 | 0.2 | 0.2 |
| 18 | Fluoride | mg/l | 1 | 1.8 | 1.4 |
| 19 | Oil & Grease | mg/l | 0.01 | Nil | Nil |
| 20 | Total Nitrogen | Mg/l | NiL | Nil | Nil |
| 21 | Phosphate | Mg/l | NiL | 0.2 | 0.2 |
| 22 | Sulphate | mg/l | 200 | 42 | 78 |
| 23 | Aluminium | mg/l | 0.1 | 0.04 | 0.04 |

**Table 3.3 (b): Heavy metals in Ground Water in the Study Region**

| Sl. No. | Parameter | Unit | Limits | GW1 | GW2 |
|---|---|---|---|---|---|
| 1 | Chromium (as $Cr^{+6}$) | mg/l | 0.05 | 0.006 | 0.02 |
| 2 | Cyanide | mg/l | 0.05 | Nil | Nil |
| 3 | Phenolic Compound | mg/l | 0.001 | Nil | Nil |
| 4 | Free Residual Chlorine | mg/l | 0.2 | 0.08 | 0.08 |
| 5 | Lead | ppm | 0.1 | 0.002 | 0.002 |
| 6 | Arsenic | Ppm | 0.05 | 0.008 | 0.008 |
| 7 | Selinium | ppm | 0.01 | 0.004 | 0.002 |
| 8 | Cadmium | ppm | 0.01 | 0.004 | 0.004 |
| 9 | Mercury | ppm | 0.001 | Nil | Nil |
| 10 | Zinc | mg/l | 5 | 1.8 | 1.5 |

**Table 3.3 (c): Bacteriological characteristics of Ground Water in the Study Region**

| S. No. | Parameter | Unit | Limits | GW1 | GW2 |
|---|---|---|---|---|---|
| 1 | MPN / 100ml | Index | <10 | 70 | 10 |
| 2 | E.coli | Cfu/ml | nil | Absent | Absent |
| 3 | Total Plate Count | Cfuml | 50 | 58 | 48 |

### 1.3.1 3.2.5 Water Use at Mine Site during Mining Activity

During the mining activity, continuous use of water is required. The proposed facility for the supply is from the perennial waters of flowing rivers. The daily water supply requirements are in the order of 142 cum/day, which also includes the domestic consumption of about 2 cum/day. There is no public water supply line available to the site, and hence the quality of the water for mining and domestic are the same apart from the water drawn from hand pumps.

The water requirement for each use is as shown in the **Table 3.4**.

**Table 3.4: Water Requirement for Proposed Project Activities (cum/day)**

| Sl. No. | Purpose | Average required |
|---|---|---|
| 1 | Dust suppression | 132 |
| 2 | Drinking | 2 |
| 3 | Others (please specify) | 5 |
| 4 | | |
| Total | | 142 |

## 3.3 Air Environment

### 1.3.2 3.3.1 Micrometeorology

In order to assess the baseline status with respect to the meteorology and climate issues, meteorological stations were setup and primary data was collected. These meteorological measurements were made at Chittanpali. The micrometeorological information collected for the region includes temperature, relative humidity, wind speed, and wind direction. Temporal data for the period is tabulated in **Table 3.5.**

The minimum temperature recorded is $8^{o}$ C during December and January, while the maximum temperature recorded is 29 $^{o}$ C in February. Maximum relative humidity ranges between (31to 38%). Mean relative humidity was at 23 %. The mean wind speed is 9 km/hr during January and 11 during February. The mean wind direction was at the SE during December.  Windrose show wind speed and direction (Figures 3.3 a, b and c).

**Table 3.5: Summary of Micrometeorological Data**

| Month | Temperature ($^{0}$C) | **Relative Humidity (%)** | **Wind Velocity (Km/hr)** | **Mean Wind Direction** |
|---|---|---|---|---|

| | Mean | Max | Min | Mean | Max | Min | Mean Speed | Max Speed | Min Speed | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dec | 17 | 25 | 8 | 22 | 31 | 15 | 9 | 12 | 3 | SE |
| Jan | 17 | 26 | 8 | 23 | 34 | 17 | 10 | 14 | 5 | SE |
| Feb | 19 | 29 | 10 | 28 | 38 | 18 | 11 | 14 | 7 | SE |

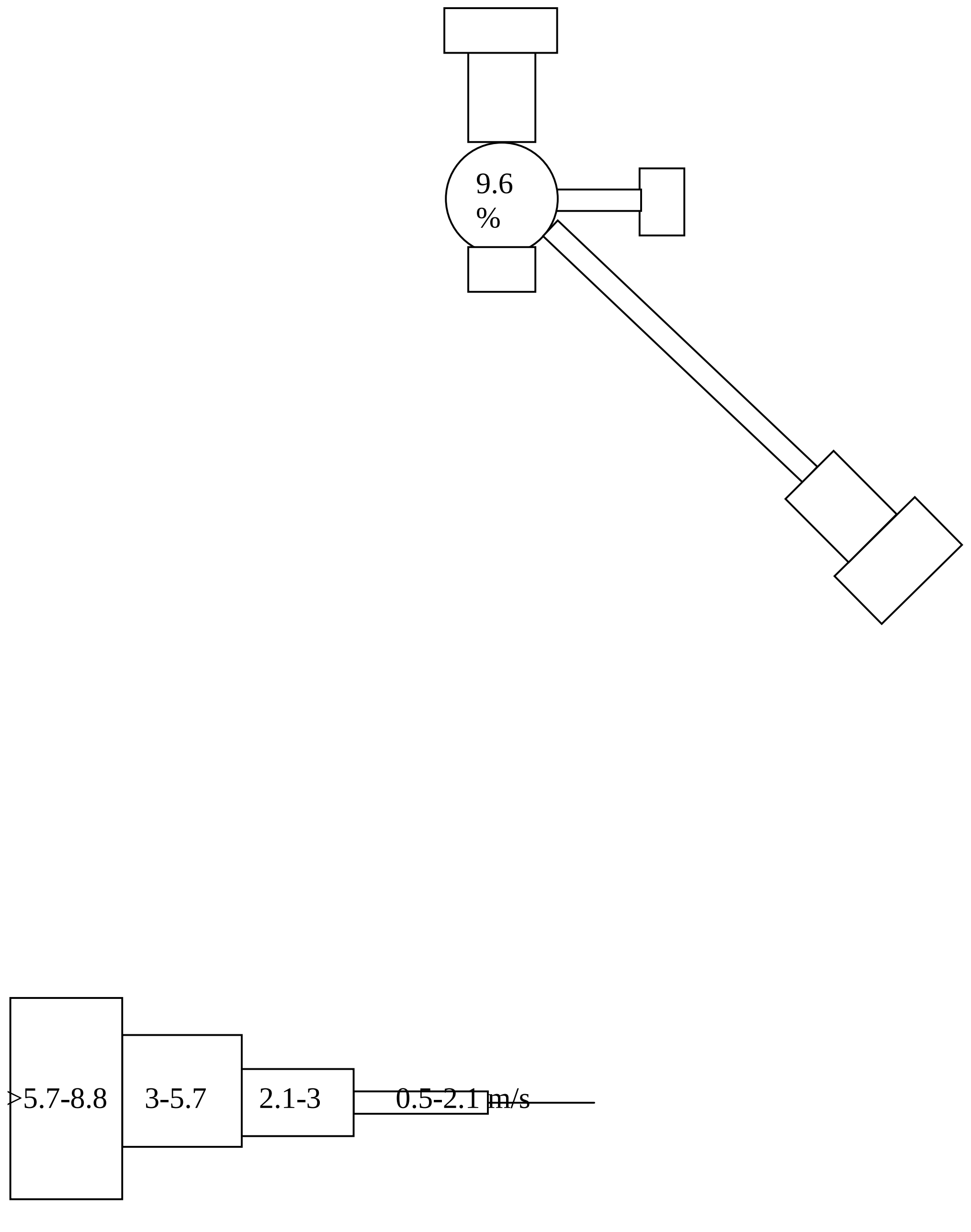


**Figure 3.3 a: Wind Rose depicting wind direction and wind velocity-Dec 07**

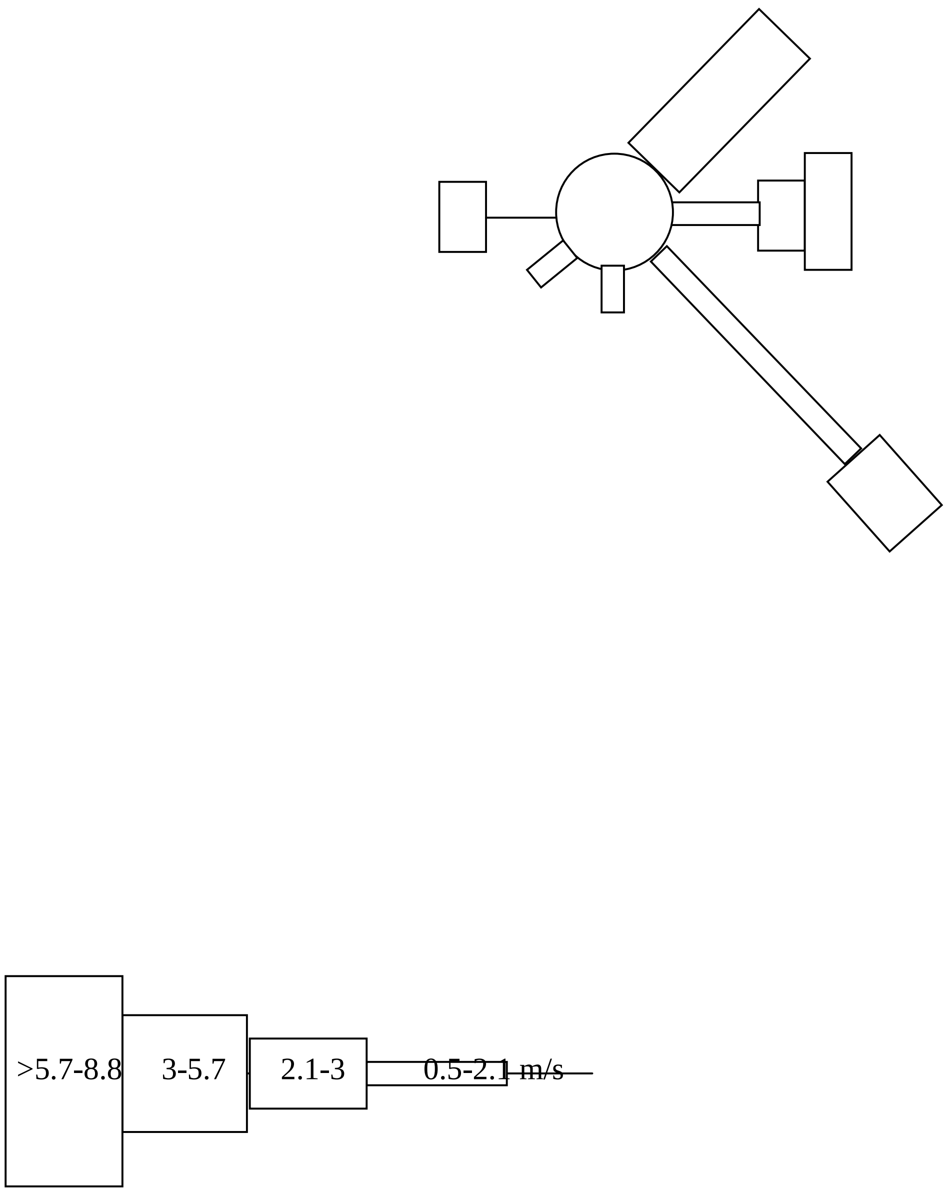
>5.7-8.8
3-5.7
2.1-3
0.5-2.1 m/s

**Figure 3.3 b: Wind Rose depicting wind direction and wind velocity-Jan 08**

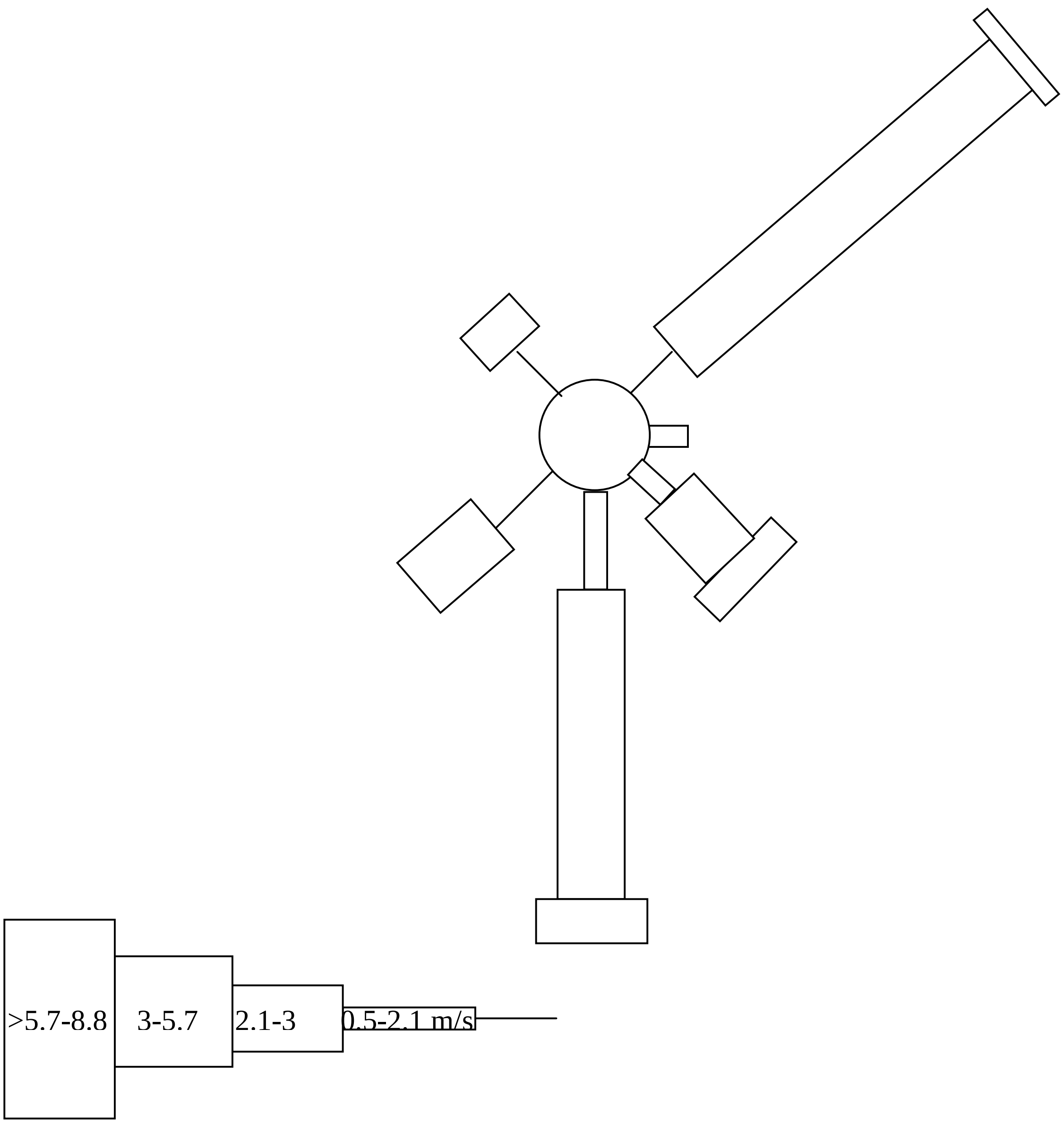

**Figure 3.3c: Wind Rose depicting wind direction and wind velocity Feb 08**

## 3.3.2 Existing Ambient Air Quality

**Ambient Air Quality monitoring Network:** In order to assess the baseline Ambient Air Quality (AAQ) in the study area, monitoring was carried out at nine locations. The nine locations were selected at mining site, the habitation villages keeping in view the predominant wind direction.

**Figure 3.4** shows sampling locations for AAQ. **Table 3.6** gives details of air quality monitoring stations. The monitoring was carried out twice a week during January – March 2007. During each day monitoring was carried out for 24 hrs. The details of AAQ monitoring locations, methodology adopted, and discussions on the AAQ status are presented in the next section.

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**Figure 3.4: Ambient Air Quality Monitoring Stations**

**Table 3.6: Ambient Air Quality Monitoring Stations**

| Sl. No. | Station Code | Location | Ht from Ground level |
|---|---|---|---|
| 1 | AQMS – 1 | Mine Site | 1.5 m |
| 2 | AQMS – 2 | Rallagedda | 1.5 m |

| | | | |
|---|---|---|---|
| 3 | AQMS – 3 | Jerilla | 1.5 m |
| 4 | AQMS – 4 | Mondigedda | 1.5 m |
| 5 | AQMS – 5 | Viravaram | 1.5 m |
| 6 | AQMS – 6 | Chikatipalli | 1.5 m |
| 7 | AQMS – 7 | Lasar | 1.5 m |
| 8 | AQMS – 8 | Godivada | 1.5 m |
| 9 | AQMS – 9 | Konarupalli | 1.5 m |

**Methodology of AAQ Monitoring:** The methodology, code of practice, and the equipments/instruments used for analysis during AAQ monitoring has been presented in **Table 3.7.**

**Table 3.7: Methodology and Instruments for AAQ Monitoring**

| Parameter | Code of Practice | Sampler | Equipment | Methodology |
|---|---|---|---|---|
| SPM | BIS | HVS | Balance, oven desiccators | Gravimetric |
| RSPM | BIS | HVS with cyclone separator | Colorimeter | Gravimetric |
| $SO_2$ | BIS | HVS | Colorimeter | Colorimetric |
| $NO_X$ | BIS | HVS | Colorimeter | Colorimetric |
| CO | BIS | Bladder and Aspirator | Gas chromatograph | Flame ionization detector |

**AAQ monitoring results and discussions:** The concentration of Suspended Particulate Matter (SPM), Respirable Particulate Matter (RSPM), Sulphur-dioxide ($SO_2$), Oxides of Nitrogen (NOx), and Carbon Monoxide (CO) in the ambient air were monitored. The AAQ monitoring results, Cumulative Percentile Values and comparison of 98th percentile values with CPCB Standards for industrial and residential areas are presented in **Table 3.8 a and b.**

The mean ambient air quality levels for the parameters SPM, RSPM, $SO_2$, $NO_X$ and Pb are within the ambient air quality standards at all locations viz., Block I, Rallagedda, Jerilla, Reyallagedda, Chikatpalli, Viravaram, Lasar, Gudiwada, and Konarupalli. The maximum ambient air quality levels are below the standards prescribed for residential and rural areas at all locations. However, the levels at these locations are far below industrial standards.

The SPM levels observed are maximum at Jerilla (30 $\mu$gm/m$^3$) and 19 $\mu$gm/m$^3$ at Konarupalli, 18 $\mu$gm/m$^3$ at Gudiwada, and Chikatpalli. RSPM levels ranged between 4 to 19 $\mu$gm/m$^3$ in the study region. The levels of $SO_2$ and NOx are highest at Jerilla as recorded in the study region. CO levels were below detectable limits even at six locations it is 1 $\mu$gm/m$^3$ in the region**.**

The comparisons of 98th percentile values with industrial and residential standards indicate that the SPM and RSPM values are below the residential and industrial standards. The highest levels of RSPM are observed at Konarupalli and Jerilla.

**Table 3.8 a: Ambient Air Quality during Dec 07 –Feb 2008 (in $\mu$g/m$^3$)**

Suspended Particulate Matter (SPM)

| Code | AQMS | Min | 25th percentile | 50th percentile | 75th percentile | 98th percentile | sd | Max | Avg |
|---|---|---|---|---|---|---|---|---|---|
| AQMS 1 | Mine Site | 8 | 10 | 13 | 15 | 16 | 2.72 | 16 | 13 |
| AQMS 2 | Rallagedda | 9 | 12 | 14 | 15 | 18 | 2.50 | 18 | 14 |
| AQMS 3 | Jerilla | 12 | 22 | 24 | 26 | 29 | 4.35 | 30 | 23 |
| AQMS 4 | Reyyelagedda | 8 | 9 | 12 | 14 | 18 | 3.09 | 20 | 12 |
| AQMS 5 | Viravaram | 7 | 11 | 12 | 15 | 16 | 2.56 | 16 | 13 |
| AQMS 6 | Chikatpalli | 4 | 12 | 13 | 15 | 18 | 3.20 | 18 | 13 |
| AQMS 7 | Lasar | 8 | 11 | 13 | 14 | 16 | 2.42 | 16 | 13 |
| AQMS 8 | Gudivada | 5 | 11 | 12 | 15 | 18 | 3.36 | 18 | 12 |
| AQMS 9 | Konarupalli | 9 | 12 | 14 | 15 | 19 | 2.57 | 19 | 13 |

Respirable Suspended Particulate Matter (RSPM)

| Code | AQMS | Min | 25th percentile | 50th percentile | 75th percentile | 98th percentile | sd | Max | Avg |
|---|---|---|---|---|---|---|---|---|---|
| AQMS 1 | Mine Site | 4 | 8 | 9 | 10 | 14 | 2.52 | 14 | 9 |
| AQMS 2 | Rallagedda | 4 | 8 | 9 | 12 | 13 | 2.58 | 14 | 9 |
| AQMS 3 | Jerilla | 10 | 14 | 15 | 16 | 19 | 2.36 | 19 | 15 |
| AQMS 4 | Reyyelagedda | 5 | 6 | 8 | 10 | 12 | 2.41 | 12 | 8 |
| AQMS 5 | Viravaram | 3 | 6 | 10 | 11 | 12 | 2.81 | 12 | 9 |
| AQMS 6 | Chikatpalli | 4 | 8 | 9 | 12 | 14 | 2.61 | 14 | 10 |
| AQMS 7 | Lasar | 6 | 9 | 10 | 10 | 12 | 1.62 | 12 | 10 |
| AQMS 8 | Gudivada | 3 | 8 | 10 | 10 | 12 | 2.42 | 12 | 9 |
| AQMS 9 | Konarupalli | 6 | 8 | 10 | 12 | 17 | 3.47 | 18 | 10 |

Sulphur-di-Oxide ($SO_2$)

| Code | AQMS | Min | 25th percentile | 50th percentile | 75th percentile | 98th percentile | sd | Max | Avg |
|---|---|---|---|---|---|---|---|---|---|
| AQMS 1 | Mine Site | 2 | 2 | 3 | 3 | 4 | 0.47 | 3.6 | 3 |
| AQMS 2 | Rallagedda | 2 | 2 | 3 | 3 | 4 | 0.62 | 4.2 | 3 |
| AQMS 3 | Jerilla | 2 | 7 | 8 | 9 | 11 | 2.32 | 12 | 8 |
| AQMS 4 | Reyyelagedda | 1 | 2 | 3 | 3 | 4 | 0.57 | 4 | 3 |
| AQMS 5 | Viravaram | 1 | 2 | 3 | 3 | 4 | 0.61 | 3.8 | 3 |
| AQMS 6 | Chikatpalli | 2 | 2 | 3 | 3 | 5 | 0.75 | 5.4 | 3 |
| AQMS 7 | Lasar | 2 | 2 | 3 | 3 | 4 | 0.40 | 3.6 | 3 |
| AQMS 8 | Gudivada | 1 | 2 | 3 | 3 | 4 | 0.80 | 4.5 | 3 |
| AQMS 9 | Konarupalli | 1 | 2 | 3 | 3 | 4 | 0.58 | 3.6 | 3 |

Oxide of Nitrogen (NOx)

| Code | AQMS | Min | 25th percentile | 50th percentile | 75th percentile | 98th percentile | sd | Max | Avg |
|---|---|---|---|---|---|---|---|---|---|
| AQMS 1 | Mine Site | 1 | 2 | 2 | 2 | 3 | 0.42 | 3 | 2 |
| AQMS 2 | Rallagedda | 1 | 2 | 2 | 3 | 3 | 0.46 | 3.4 | 2 |
| AQMS 3 | Jerilla | 1 | 5 | 7 | 8 | 9 | 2.39 | 9 | 6 |
| AQMS 4 | Reyyelagedda | 1 | 2 | 2 | 2 | 3 | 0.39 | 2.6 | 2 |
| AQMS 5 | Viravaram | 1 | 2 | 2 | 2 | 3 | 0.46 | 2.9 | 2 |
| AQMS 6 | Chikatpalli | 1 | 2 | 2 | 3 | 4 | 0.62 | 4.2 | 2 |
| AQMS 7 | Lasar | 1 | 2 | 2 | 3 | 3 | 0.41 | 3 | 2 |
| AQMS 8 | Gudivada | 1 | 2 | 2 | 3 | 4 | 0.62 | 3.9 | 2 |
| AQMS 9 | Konarupalli | 1 | 2 | 2 | 3 | 3 | 0.63 | 3.2 | 2 |

Carbon Monoxide

| Code | AQMS | Min | 25th percentile | 50th percentile | 75th percentile | 98th percentile | sd | Max | Avg |
|---|---|---|---|---|---|---|---|---|---|
| AQMS 1 | Mine Site | 0.006 | 0.100 | 0.140 | 0.200 | 0.525 | 0.14 | 0.7 | 0.161 |
| AQMS 2 | Rallagedda | 0.008 | 0.080 | 0.140 | 0.200 | 0.532 | 0.14 | 0.7 | 0.159 |
| AQMS 3 | Jerilla | 0.010 | 0.100 | 0.130 | 0.195 | 0.283 | 0.07 | 0.3 | 0.140 |
| AQMS 4 | Reyyelagedda | 0.005 | 0.090 | 0.100 | 0.200 | 0.360 | 0.09 | 0.4 | 0.138 |
| AQMS 5 | Viravaram | 0.004 | 0.100 | 0.150 | 0.200 | 0.660 | 0.18 | 0.7 | 0.198 |
| AQMS 6 | Chikatpalli | 0.006 | 0.100 | 0.100 | 0.220 | 0.800 | 0.22 | 1 | 0.189 |
| AQMS 7 | Lasar | 0.007 | 0.070 | 0.160 | 0.200 | 0.520 | 0.14 | 0.6 | 0.162 |
| AQMS 8 | Gudivada | 0.008 | 0.058 | 0.100 | 0.185 | 0.510 | 0.15 | 0.7 | 0.143 |
| AQMS 9 | Konarupalli | 0.004 | 0.070 | 0.100 | 0.200 | 0.680 | 0.18 | 0.8 | 0.164 |

**Table 3.8 b: Comparison of 98$^{th}$ Percentile Values (in $\mu g/m^3$) with CPCB limits for industrial and residential zones**

| Parameter | 98$^{th}$ Percentile values | Residential Standards | Industrial Standards |
|---|---|---|---|
| SPM | 16-29 | 200 | 500 |
| RSPM | 12-19 | 100 | 150 |
| $SO_2$ | 4-11 | 80 | 120 |
| $NO_X$ | 3-9 | 80 | 120 |

## 3.4 Noise Environment

The landuse pattern and presence of various physical attributes indicate that the ambient noise levels will be important. In order to assess the baseline Ambient Noise levels (ANL), monitoring was carried out at ten different locations in the study area. The ANL monitoring was carried out for day and night.

**ANL Monitoring Stations:** Monitoring stations were selected considering the landuse pattern, traffic intersection and diversion. Details of the ANL monitoring station are presented in **Table 3.9**. **Figure 3.5** shows sampling locations for ambient noise levels. The locations were selected to represent various land use categories with respect to ANL standards of MOEF / CPCB

**Table 3.9: Ambient Noise Quality Monitoring Stations**

| Sl. No. | Station | Location |
|---|---|---|
| 1 | N-1 | MS |
| 2 | N-2 | Mine Site |
| 3 | N-3 | Rallagedda |
| 4 | N-4 | Jerilla |
| 5 | N-5 | Reyallagedda |
| 6 | N-6 | Viravaram |
| 7 | N-7 | Chikatipalli |
| 8 | N-8 | Lasar |
| 9 | N-9 | Godivada |
| 10 | N-10 | Konarupalli |
| 11 | N-11 | Mondigedda |
| 12 | N-12 | Burugupakula |

**Error! No topic specified.**

**Figure 3.5: Noise Sampling Locations**

**Methodology:** The noise levels were observed using handheld sound level meter as per the applicable standards of BIS. Instantaneous noise levels were observed at every 6-min interval manually. Based on this hourly equivalent noise levels were computed.

**Results and discussions:** The ANL monitoring data is presented in **Table 3.10.** The ambient noise level shows that the levels recorded were all within the prescribed limits. The highest levels were observed at Jerilla [52 dB (A)], and Viravaram [51dB (A)] during the daytime. The lowest noise levels recorded were at Mine site [30 dB (A)], and Burugupakula [31 dB (A)] during night time. The high levels of noise at Jerilla and Viravaram due to normal activities while plying of vehicles.

**Table 3.10: Ambient Noise Levels in the Study Region (dB (A))**

| Sr. No | Location | Leq Day | Leq Night |
|---|---|---|---|
| | Standards | 55 | 45 |
| N-1 | MS | 44 | 30 |
| N-2 | Mine Site | 50 | 42 |
| N-3 | Rallagedda | 50 | 42 |
| N-4 | Jerilla | 48 | 37 |
| N-5 | Reyallagedda | 45 | 32 |
| N-6 | Viravaram | 51 | 43 |
| N-7 | Chikatipalli | 50 | 41 |
| N-8 | Lasar | 45 | 32 |
| N-9 | Godivada | 50 | 41 |
| N-10 | Konarupalli | 52 | 32 |
| N-11 | Mondigedda | 48 | 34 |
| N-12 | Burugupakula | 44 | 32 |

## 3.5 Land Environment

### 3.5.1 Terrain / Geology

The study area is underlain, mostly by rocks belonging to Archaean period which are overlain by laterites of sub recent period and thin alluvial covers in valley portions. Mostly the rock types found over the study area are Charnockite and Khondalite. The generalized stratigraphic succession of the formations present in the area include the following.

| Age | Super Group | Group | lithounit |
|---|---|---|---|
| Recent | | Alluvium | Sand, Silt & Clay |
| Sub-recent | | | Laterite |
| Archaean | Eastern Ghat | Younger Intrusive, | Quartzo - feldspathic |

| | | | |
|---|---|---|---|
| | | Migmatites Charnockite Khondalite | gneisses, Bio Quartz gneisses Charnocite. Khondalite Calc granulite Calc granulite quartzite. |

**Achaean formations:** The khondalite series belonging to eastern Ghat Super Group consists of garnet – sillemanite – gneisses, garnet – sillimanite – graphite schists, garnetiferous quartzite, calcgranulites and limestone. The garnetiferrous gneiss is country rock forming the bulk of the Eastern Ghats. Khondalites can be identified by its spotted grey to red appearance resulting from the weathering and alternations, of grains and clots of garnet mineral.

The Archaeans consist of porphyritic granite gneiss and the charnockite series. Pink granites, pegmatities and quartz veins are also associated.

**Structural features:** The Archaean rocks are characterized by NE-SW foliation, which aligns with the trend of Eastern Ghats ranges. At places the strikes varies from NNE-SSW to ENE-WSW directions.

**Alluvium:** Recent deposits resulted by the weathering of older rocks and also as alluvial materials, residual solid and in the form of dune / blown sands

The fluvial deposits occur as narrow bands along the margin of coastal plain. This alluvial consists of alternate layers of medium to coarse – grained sand, silty clay gravel, pebbles and pellets of Kankar and Laterite. They attain a thickness of about 30 m.

The intermotane valleys, pediment zones, certain hill slopes and foot hill portions are covered by talus material, which possess high infiltration as evidenced by the losing streams. The central portions of valleys of Bodu gedda are underlain by silty gradational material.

**Local geology:** The region falls under the Eastern ghats. The region forms a part of the peninsular shield and is represented by mostly rocks of Kondalite and Charnockite groups of Archean Age. The other rock types are banded gneiss, composite gneiss and associated Migmatites. Granite, Pegmatite and quartz veins intrude all the rock types. The formations follow a general strike trend of northeast-southwest and moderate to steep dips to southeast. Kondalites form high and linear ridges whereas Charnockite forms dome shapes hills.

The Jerrila Block I is capped by a blanket of laterite / bauxite of varying thickness. The landform is characterised by flat to gentle and moderate topography. Bauxite is reddish or brownish coloured and is moderately hard. Lenses and patches of weathered Khondalite are occasionally seen in the capping. These exhibit relict foliation, which is in consonance with the parent rock. The extensive outcrop of bauxite indicates physical continuity. Scarps exposing bauxite mark is the periphery of capping. The spectacular physiographic feature is the vertical escarpment exposed over a length of 400 m with a sheer drop of 20 m to 25 m on the north-western side of capping. The bauxite is residual in origin and is of quaternary age.

### 1.3.3 3.5.2 Land use / Land cover (using Remote Sensing Data)

The land use pattern observed in the study area (Circumscribed within 10 km radius) described in the following subsections.

The landuse of the region as per the revenue department records indicate that Total area is 5213 ha under revenue department of Forest area is 11.16%, Irrigated area is 3.00%, Unirrigated land 47.49%, Cultural waste land 17.40 % and Area not available for cultivationis 19.66%.

Land use/land cover data was determined using remote sensing data acquired from the National Remote Sensing Agency, Department of Space, Government of India. LISS I payload sensors of the Indian Remote Sensing Satellite (IRS) collect the data. The classified data enables effectively the identification of all features. The regional landuse pattern of the project is presented in **Figure 3.6.**

The landuse / landcover comprises of various types viz. open and dense reserved forests, crop and fallow land, steep slopes, water features, road networks etc.

The built-up area includes mainly habitation/village.

The land use is depicted at **Figure 3.6.** and remote sensing IRS 1D LISS I FCC image is in **Figure 3.7**. The land use in the ten km circle of the mines (proposed-new and extension) is at **Table 3.11**.

Forest constitutes 62.8 % of the land cover in the study region. The land cover percentages of various types of forest are: sparse forest (8.1 %), dense forest (24.1%), open scrub (19.6 %), and medium forest (11 %). Barren lands occupy 4.9 % of the region. Area under rock outcrops is 7.5 %. Cropland and water bodies occupy around 21.2 % and 1.6 % in the area. Settlements cover 0.4 % of the area.

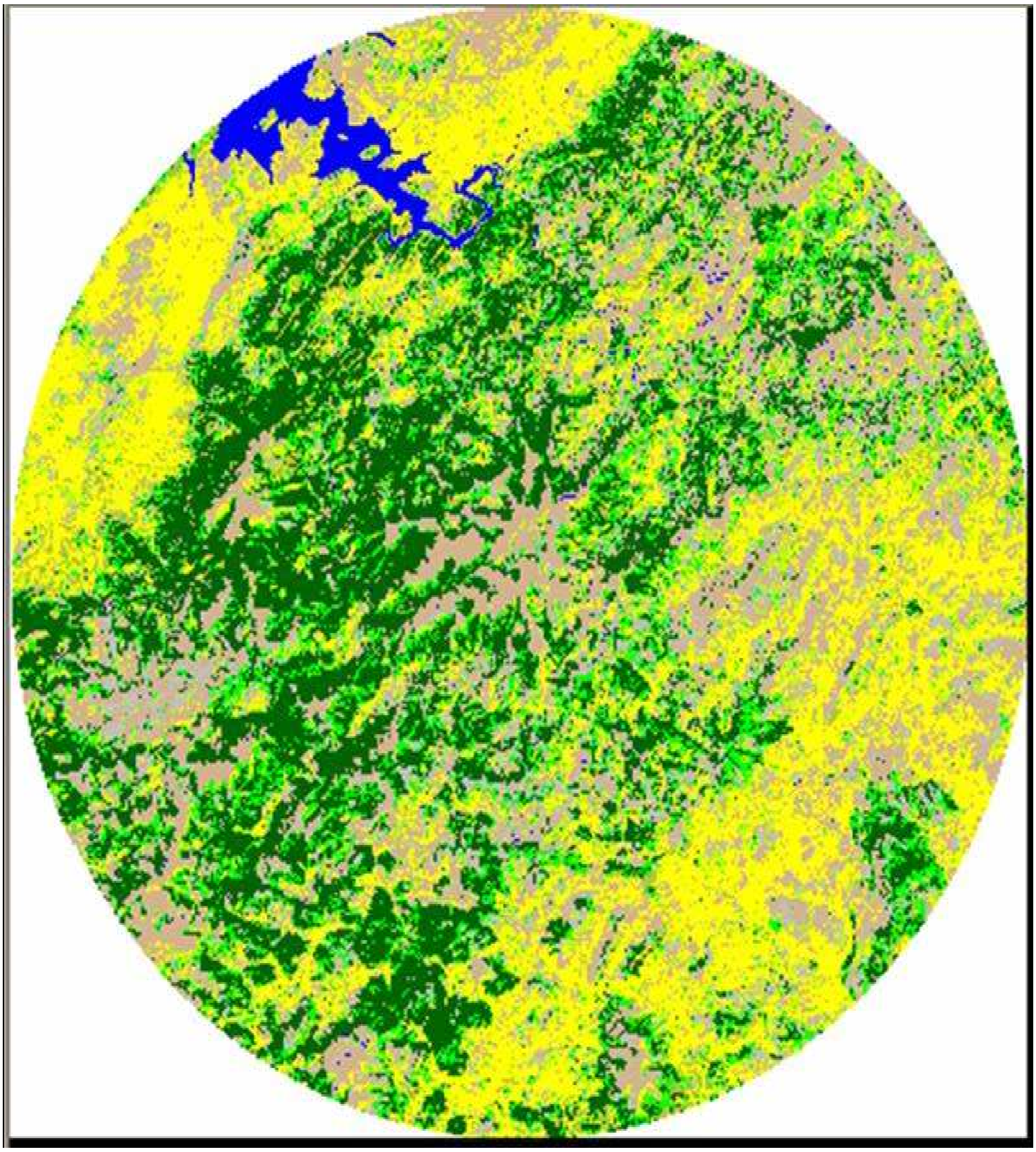


**Figure 3.6: Landuse/ Landcover within Study Area for Jerrila I Mines**

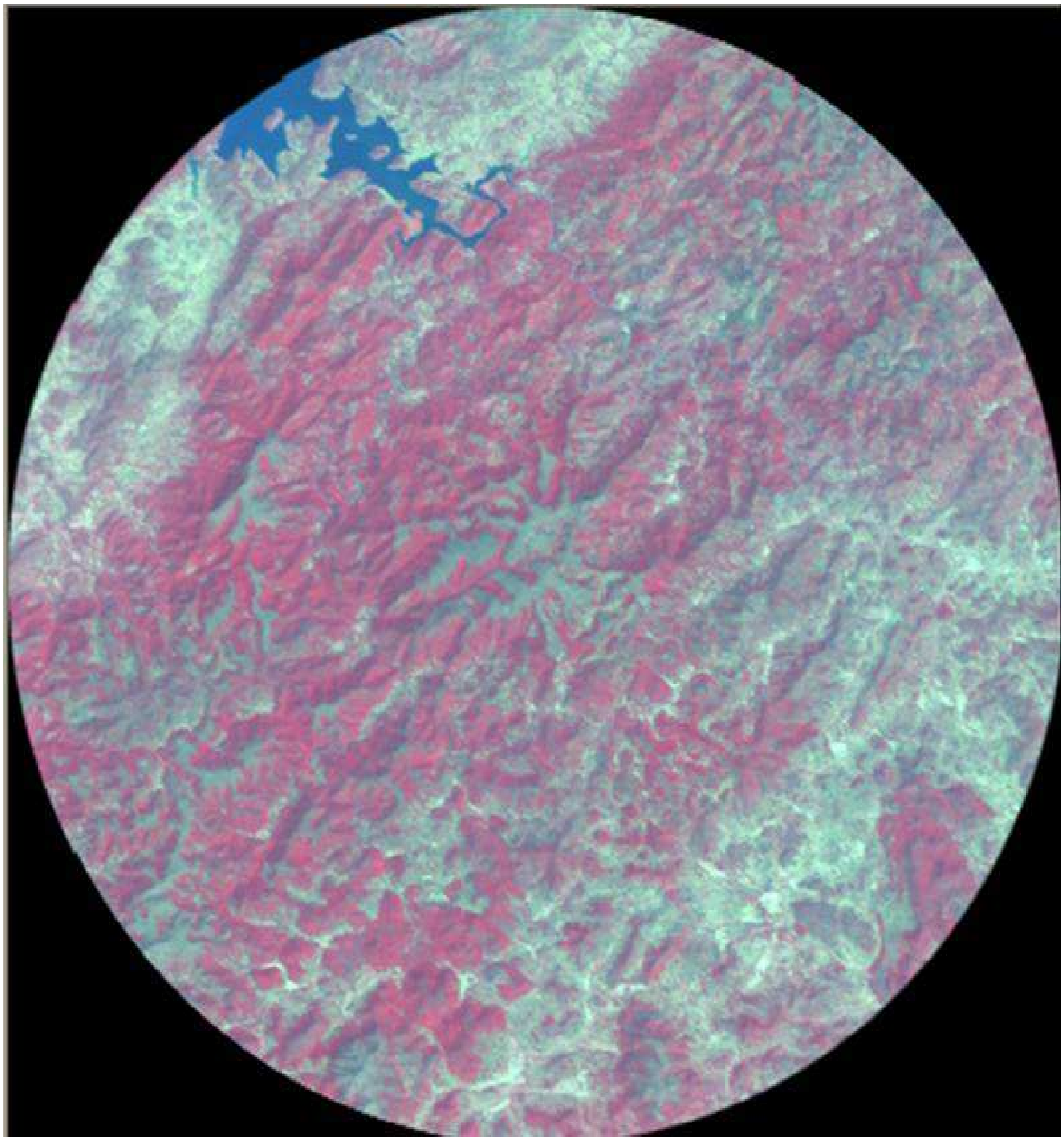


**Figure 3.7: False Color Composite (FCC) showing Mine Area Locations**

### 1.3.4 Table 3.11: Landuse in buffer zone of 10 km of Mines (%)

| 1.3.5 Sl. No. | 1.3.6 Landuse / Landcover | 1.3.7 % |
|---|---|---|
| 1 | Dense forests | 24.1 |
| 2 | Medium forest | 11 |
| 3 | Open scrub | 19.6 |
| 4 | Sparce forest | 8.1 |
| 5 | Crop land | 21.2 |
| 6 | Waste land | 1.6 |
| 7 | Barren land | 4.9 |
| 8 | Rock outcrop | 7.5 |
| 9 | Rivers and water bodies | 1.6 |
| 10 | Settlements | 0.4 |
| | | 100 |

### 3.5.3 Soil Types

The soils are of residual nature as they are formed in-situ from the under lying rocks. Under a warm humid climate the parent rocks have weathered to brown to reddish, sandy to loamy type of soils with frequent laterite rapping. The clay and humus content are less. The soils are medium to fine grained and essentially non-clay and hence susceptible to erosion particularly because of the undulating nature of the ground. The soils in the broad valley are deep and the fertility status is moderately good when compared to the soils on the hill slopes and hill tops. The soils in and around the project area can be broadly classified into nine types (**Figure 3.8**) and their descriptions are given as **Table 3.12**.

In general, the soils in these areas are mostly red silty loam and brown silt, except for some area of black brown silty loam. The pH and electrical conductivity are generally normal, organic carbon content varies from medium to high. The soils are having high content of phosphorus and potash.

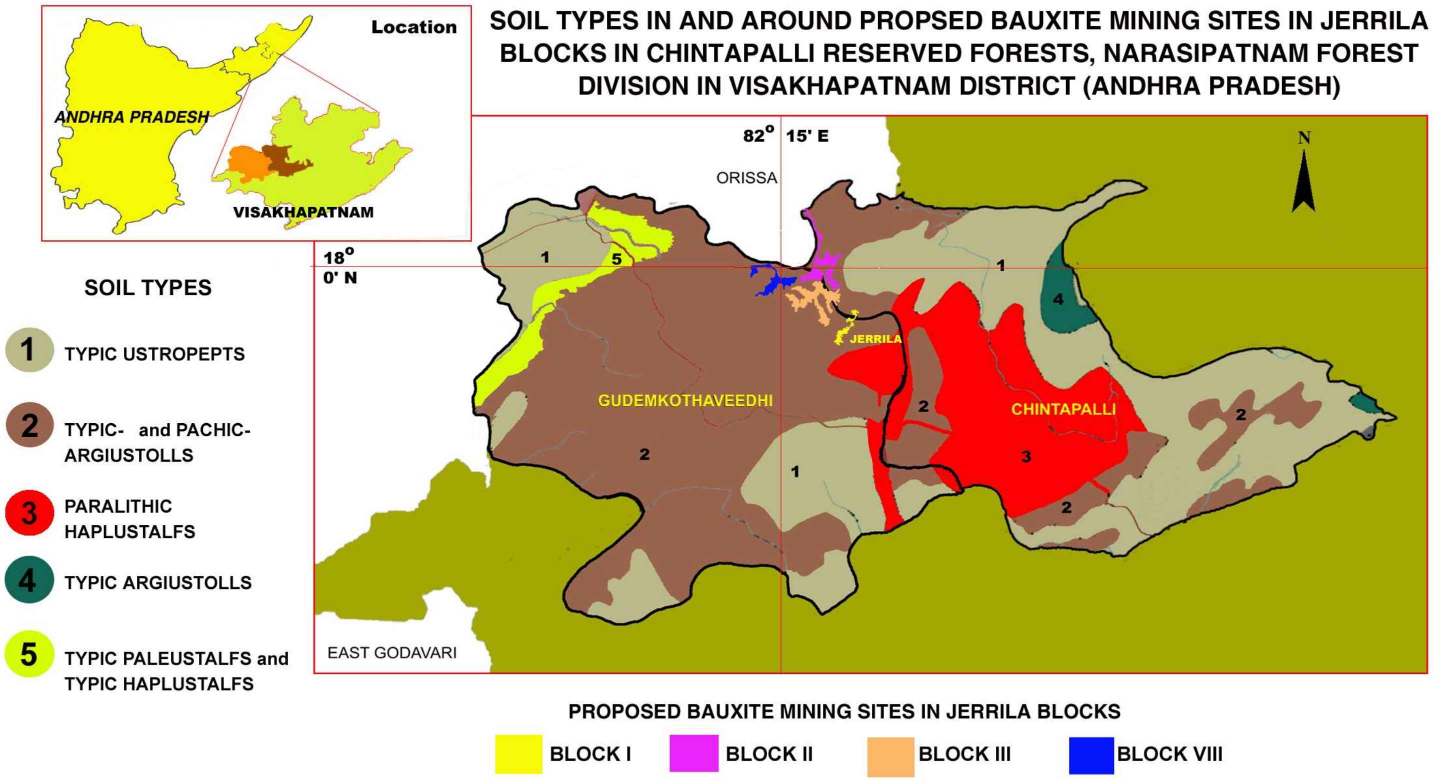

SOIL TYPES IN AND AROUND PROPSED BAUXITE MINING SITES IN JERRILA BLOCKS IN CHINTAPALLI RESERVED FORESTS, NARASIPATNAM FOREST DIVISION IN VISAKHAPATNAM DISTRICT (ANDHRA PRADESH)
Location
ANDHRA PRADESH
VISAKHAPATNAM
82° 15' E
18° 0' N
N
ORISSA
EAST GODAVARI
GUDEMKOTHAVEEDHI
JERRILA
CHINTAPALLI
SOIL TYPES
1 TYPIC USTROPEPTS
2 TYPIC- and PACHIC-ARGIUSTOLLS
3 PARALITHIC HAPLUSTALFS
4 TYPIC ARGIUSTOLLS
5 TYPIC PALEUSTALFS and TYPIC HAPLUSTALFS
PROPOSED BAUXITE MINING SITES IN JERRILA BLOCKS
BLOCK I
BLOCK II
BLOCK III
BLOCK VIII

Table 3.12: Classification and description of soil types in and around project area in cccc, Visakhapatnam District, Andhra Pradesh

| Map legend Number | Soil classification | Description |
|---|---|---|
| 1 | Typic Rhodustalfs | Very deep well drained, red clayey soils, with surface crusting and medium AWC, on rolling lands, moderately eroded – associated with moderately deep, well drained, red gravelly loamy soils with low AWC, loamy-skeletal, mixed, typic Ustropeps. |
| 2 | Typic Ustropepts | Moderately deep, somewhat excessively drained red clayey soils with medium AWC on steeply sloping hill ranges, severely eroded – associated with rock out crops. |
| 3 | Montmorillinitic, vertic, Ustropepts | Very deep, moderately well drained, black, craking clay soils with very high AWC, on nearly level valleys, slightly eroded – associated with deep, well drained, black clayey soils with high AWC, fine, mixed, typic Ustropepts |
| 4 | Typic Ustropepts and Typic Haplustalfs | Deep, moderately well drained red clayey soils with high AWC, on very gently sloping inter-hill valleys, slightly eroded – associated with deep well drained, red clayey soils |
| 5 | Paralithic Haplustalfs | Shallow, somewhat excessively drained, red gravelly clay soils with very low AWC on steeply sloping hill ranges, severely eroded – associated with rock out crops. |
| 6 | Typic Argiustolls | Moderately shallow, somewhat excessively drained, brown gravelly clay soils with very low AWC on steeply sloping hill ranges, very severely eroded – associated with rock out crops |
| 7 | Typic Haplustalfs | Deep, well drained, red-calyey soil with surface crusting high AWC, on rolling lands, moderately eroded – assocoaited with well drained red clayey soils. |
| 8 | Typic Paleastalfs | Deep, well drained, red loamy soils, with high AWC, on gently sloping inter-hill valley, moderately eroded – associated with deep, well drained, red loamy soils, fineloamy, mixed, typic Haplustalfs |
| 9 | Typic- pachic-Argiustoll | Moderately deep, somewhat excessively drained, brown, gravelly loamy soils with low AWC on steeply sloppy hill ranges, moderately eroded – associated with deep, somewhat excessively drained brown gravelly clay soils, severely eroded |
| AWC – Available Water Capacity i.e. water retained in soil between field capacity and permanent wilting point.<br><br>Reference: Land resources of Vizag District. June 2002. NBSS RPT /Publ. 578. NBSS & LUP, ICAR, Nagpur. | | |

### 1.3.8 3.5.4 Soil quality in Project Site

Soil quality for determining environmental baseline was studied thoroughly with a dual perspective. One being the general soil quality at various locations. Soil samples were collected and analysed at nine locations (**Table 3.14).** These were collected in the mining area and outside mine area. **Figure 3.9** shows the sampling locations.

The soil samples were analysed for physico-chemical characteristics, heavy metals, Total Phosphates, Kjeldhal Nitrogen and Exchangeable Cations. **Table 3.15 (a & b)** details the soil characteristics in the study region.

The laterite soil is found in the region. The soils contain, alumina, silica, oxides of iron, the soil also contain calcium, potassium, phosphorous, and their acidic compounds etc.

Though the soils have concentration of the heavy metals viz., Zn, Mn and B, the levels are well within the limits for low-level contaminated soils.

**Table 3.14: Soil Sampling Locations**

| Section 1.03 Sr. No | Section 1.04 Code | Location |
|---|---|---|
| 1 | S1 | Mine Site |
| 2 | S2 | Rallagedda |
| 3 | S3 | Jerilla |
| 4 | S4 | Mondigedda |
| 5 | S5 | Viravaram |
| 6 | S6 | Chikatipalli |
| 7 | S7 | Lasar |
| 8 | S8 | Godivada |
| 9 | S9 | Konarupalli |

**Error! No topic specified.**

**Figure 3.9: Soil Sampling Locations**

## Table 3.15 a: Soil characteristics in the Study Region

| | Parameter | Units | S-1 | S-2 | S-3 | S-4 | S-5 | S-6 | S-7 | S-8 | S-9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| [1] | **General Parameter** | | | | | | | | | | |
| | pH of 10 % Suspension | - | 6.4 | 6.6 | 7 | 6.6 | 6.5 | 6.5 | 6.4 | 6.9 | 6.5 |
| | Conductivity of 10 % suspension | µS/cm | 72 | 45 | 62 | 68 | 68 | 76 | 68 | 65 | 65 |
| [2] | **Physical Parameter** | | | | | | | | | | |
| | Moisture Content | % | 1.62 | 1.72 | 1.49 | 1.74 | 1.59 | 1.59 | 1.72 | 1.69 | 1.59 |
| | Fixed Residue | % | 86 | 75 | 70 | 75 | 72 | 72 | 78 | 75 | 72 |
| | Organic Content | % | 0.85 | 0.45 | 0.45 | 0.85 | 0.75 | 0.75 | 0.84 | 0.85 | 0.85 |
| | Water Retaining Capacity | % | 22 | 20 | 32 | 20 | 24 | 28 | 28 | 32 | 22 |
| | Bulk Density | gm/cc | 1.28 | 1.2 | 1.14 | 1.2 | 1.14 | 1.26 | 1.22 | 1.24 | 1.24 |
| | Silt/Clay | % | 32 | 38 | 38 | 30 | 28 | 38 | 28 | 48 | 36 |
| | Sand | % | 65 | 75 | 55 | 65 | 45 | 85 | 55 | 65 | 60 |
| [3] | **Chemical Parameter** | | | | | | | | | | |
| | **By Water Leachate** | | | | | | | | | | |
| | Sulphates, as $SO_4$ | mg/Kg | 180 | 1950 | 178 | 160 | 150 | 185 | 190 | 190 | 190 |
| | Chlorides, as $Cl_-$ | mg/Kg | 122 | 124 | 118 | 120 | 110 | 122 | 122 | 130 | 125 |
| [4] | **By Acid Digestion** | | | | | | | | | | |
| | Total Phosphate as $PO_4$ | % | 0.007 | 0.004 | 0.006 | 0.006 | 0.005 | 0.002 | 0.007 | 0.004 | 0.006 |
| | Kjeldhal Nitrogen as N | % | 0.05 | 0.08 | 0.08 | 0.09 | 0.08 | 0.04 | 0.07 | 0.05 | 0.09 |
| [5] | **Exchangeable Cations** | | | | | | | | | | |
| | Calcium as CA | meq/ 100 gm | 11.2 | 10.5 | 6.5 | 8.5 | 6.4 | 11.5 | 11.3 | 11.5 | 10.5 |
| | Magnesium as MG | meq/ 100 gm | 1.8 | 1.64 | 1.8 | 1.48 | 1.88 | 1.8 | 1.88 | 1.88 | 1.8 |
| | Sodium as NA | meq/ 100 gm | 0.14 | 0.14 | 0.05 | 0.2 | 0.06 | 0.08 | 0.05 | 0.08 | 0.04 |
| | Potassium as K | meq/ 100 gm | 0.42 | 0.42 | 0.26 | 0.34 | 0.18 | 0.26 | 0.14 | 0.5 | 0.28 |

## Table 3.15 b: Soil characteristics in the Study Region

| | Parameter | Units | S-1 | S-2 | S-3 | S-4 | S-5 | S-6 | S-7 | S-8 | S-9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| [6] | **Metals/ Heavy Metals** | | | | | | | | | | |
| | Copper, as Cu | mg/Kg | 0.14 | 0.16 | 0.14 | 0.16 | 0.16 | 0.14 | 0.14 | 0.16 | 0.16 |
| | Chromium, as Cr | mg/Kg | 0.5 | 0.3 | 0.3 | 0.4 | 0.5 | 0.5 | 0.4 | 0.3 | 0.4 |
| | Cadmium, as Cd | mg/Kg | 0.04 | 0.04 | 0.05 | 0.05 | 0.03 | 0.04 | 0.05 | 0.04 | 0.05 |
| | Lead, as Pb | mg/Kg | 0.2 | 0.18 | 0.2 | 0.2 | 0.2 | 0.2 | 0.22 | 0.1 | 0.2 |
| | Mercury, as Hg | mg/Kg | NIL | NIL | NIL | NIL | NIL | NIL | NIL | NIL | NIL |
| | Zinc, as Zn | mg/Kg | 1 | 1.2 | 1.2 | 1.2 | 1.2 | 1 | 1 | 1.2 | 1.2 |
| | Iron, as Fe | mg/Kg | 0.15 | 0.15 | 0.14 | 0.14 | 0.24 | 0.15 | 0.1 | 0.14 | 0.14 |
| | Manganese, as Mn | mg/Kg | 0.16 | 0.18 | 0.28 | 0.18 | 0.18 | 0.18 | 0.18 | 0.28 | 0.18 |
| | Boron, as B | mg/Kg | 0.22 | 0.25 | 0.26 | 0.34 | 0.18 | 0.16 | 0.14 | 0.12 | 0.1 |

# CHAPTER *4*

# BIOLOGICAL *ENVIRONMENT*

## 4.1 Introduction

Plant and animal communities are indicators of the environment. They respond not only to one environmental factor, but also to an interacting group of factors. The plant and animal communities integrates these influences and reacts sensitively to changes in the balance of environmental stresses such as abitotic and biotic factors and anthropogenic activities. This could cause changes in the physiognomy, structure and species composition of the flora and fauna. Since the ecological integrity is one of the fundamental factors towards attaining a sustainable ecosystem, following biological study in and around of mine lease areas of Galikonda was undertaken to assess the species diversity, distribution and present status of flora and fauna.

## 4.2 FOREST TYPES

The block is located in the North of Jerrila Village in the Chintapalli Range of Narsipatnam Division. The division is located on the Eastern slopes of Eastern Ghats. The Eastern Ghats are the range of hills running parallel in the North-South Direction. The forests are distributed from about 130 m to 1529 m. The dry scrub forests in the foot hills are gradually replaced by deciduous forests and semi-evergreen forests with the increase in altitude. The hilltops are characterized by dry Savannah forests. Though the distribution of forests is largely influenced by the altitudinal variation, anthropogenic activities have changed the landscape. The single major activity which changed the face of forests in the region is Podu cultivation. Jack and Tamarind trees are the mute spectators of the past Podu cultivation.

Based on Champion and Seth’s classification, the forests of the Narsipatnam Division can be divided in to the 5 types. Though the mine area is restricted to the hilltops, the impact of mining will have bearing on the vegetation in the adjoining areas.

| Sl. No. | Technical description | Types of forests |
|---|---|---|
| 1 | 2B/2S | Southern tropical semi evergreen forest |
| 2 | 3B/2S | Southern tropical secondary Moist mixed forests |
| 3 | 5A/2S1 | Southern tropical secondary Dry Deciduous forests |
| 4 | 6A/C1 | Southern Thorn forests |
| 5 | 5D/S2 | Dry Savannah forests |

## 4.3 ANTHROPOGENIC ACTIVITIES IN THE AREA

### 4.3.1 PODU CULTIVATION

Podu cultivation (shifting cultivation) practiced by the tribes in the region. The trees in the area are cut and the cleared patch is burnt. Crop seeds are sown before the rains. There will be fairly good harvest for few years in the beginning, later the yield comes down due to soil erosion and due to lack of soil erosion control measures. Almost all the villages adjoining the block practice Podu cultivation. According to the Working Plan of Narsipatnam Division (2003 to 2013), an area of 29890 ha is under Podu cultivation in the Division. Out of this about 10,400 ha is under Chintapalli Range alone. Interaction with local officials revealed that the Podu cultivation is increasing continuously because of the recent Tribal Act which encourages vesting ownership of the land to the local tribal. The Podu cultivation, in the long run will not only affect the ecology of the region but also the very existence of the people living in the nearby villages.

### 4.3.2 COFFEE PLANTATION

The hill slopes in and around Chintapalli are under coffee plantation. Coffee plantations were observed in the mid slopes of Jerrila area (Photo 2). The coffee plantations are raised by Government agencies like APFDC as well as by the tribes. About 3318.37 Ha of coffee plantations are raised by the Andhra Pradesh Forest Development Corporation as detailed below:

| Name of the Reserve Forest | Ebulam | Chintapalli | Lothugedda | Sileru | Wangasara | Bointhi | Total |
|---|---|---|---|---|---|---|---|
| Area in Ha | 1871.49 | 82.00 | 91.00 | 201.85 | 477.28 | 594.75 | 3318.37 |

### 4.3.3 GRAZING

The villagers rear livestock and let the cattle, sheep and goats to graze in the forests. There are about 4.42 lakhs cattles, 3.67 lakhs buffaloes, 1.83 lakhs sheep and 2.38 lakhs goats, respectively present in the Narsipatnam Division. The livestock apart from grazing, trample the emerging seedlings, cause of soil compaction and there by affect the biodiversity.

## 4.4 VEGETATION TYPES AND DISTRIBUTION

The study was aimed at enumeration of the available plant resources and obtaining a broad representation of the existing floristic variation in the mine and surrounding areas. The study was conducted in Jerrila Block I, the proposed bauxite mine area and adjoining areas in Narsipatnam Division during November 2007 – April, 2008. Enumeration of the plant wealth of the area in Jerrila blocks was done by surveying the area through walking along the gradients of hillocks and valleys and collection and identification of plant specimens to find out the floristic diversity.

Phyto-sociological aspects of the study were carried out by perambulating and sampling through quadrat sampling method. Sample plots were selected in such a way to get maximum representation of different types of vegetation and plots were laid out in different parts of the areas within the mine area as well as outside mine area (Photo-3). Accordingly quadrats of 10 m x 10 m for the study of tree layer were laid out in the above mentioned areas. Within these sample plots, plots of 3 m x 3 m were laid out to study shrubs/ herbs/ tree saplings respectively.

The girth at breast height (gbh) of all individuals in each quadrat was measured for all species of trees and woody climbers. All individuals with gbh $\geq$ 10 cm were considered and recorded as trees (Parthasarathy and Karthikeyan, 1997). This concept was tested further during the fieldwork. Considering the low stature of species in some parts of hillocks, all individuals $\geq$ 10 cm gbh were included in tree category. All individuals below 10 cm gbh are considered as saplings and shrubs. Basal area of plants was measured following Philips (1959). The plants were identified using floras by Gamble (1915-36), Saxena and Brahmam (1994-96), Nair and Henry (1983), Henry *et al*. (1987), Henry *et al.* (1989), Pullaiah and Chennaiha (1997), Pullaiah and Ali Moulali (1997), Pullaiah (1997), Subba Rao and Kumari (2002) and comparing the specimens from MH and FRC, Coimbatore herbaria.

The primary data recorded on number of individuals in a species and girth was analyzed for secondary attributes like density and frequency following standard phyto-sociological methods of Misra (1968). Relative values were calculated by following Philips (1959). Important Value Index (IVI) was calculated by adding up the three relative values of relative frequency, relative density and relative dominance (Curtis, 1959). In the case of shrubs, herbs and saplings, IVI was calculated using two relative values, i.e., relative frequency and relative density. Formulae used for various calculations are:

$$\text{Density (D)} = \frac{\text{Total number of individuals of a species}}{\text{Total area of quadrats studied}}$$

$$\text{Frequency (F)} = \frac{\text{Number of quadrats of occurrence}}{\text{Total number of quadrats studied.}} \times 100$$

$$\text{Relative Density (RD)} = \frac{\text{Number of individuals of a species}}{\text{Total number of individuals of all species}} \times 100$$

$$\text{Relative Frequency (RF)} = \frac{\text{Number of occurrence of a species}}{\text{Total number of occurrence of all species}} \times 100$$

$$\text{Relative Basal Area (RBA)} = \frac{\text{Total basal area of a species}}{\text{Total basal area of all species}} \times 100$$

Importance Value Index (IVI) = RD + RF + RBA

Species diversity indices like Shannon-Wiener Index (H`) and Simpson Index ($\lambda$) were calculated as per Magurran (1988) using following formulae:-

Shannon- Wiener Index $(H`) = -\sum pi \ln pi$

Simpson index $(\lambda) = \sum pi^2$

Where, $pi$ is the proportion of individuals of the $i^{th}$ species; $pi = Ni / N$

$Ni$ is the number of individuals in the $i^{th}$ species and $N$ is the total number of individuals of all species in the stand.

### 4.4.1 Flora of project affected area

Floristic composition, which is one of the major characteristic features of plant communities, varies depending upon site and its environmental features. The plant resources of the mine lease area consisted of 43 species belonging to 41 genera and 27 families. Rubiaceae was the most specious family with 6 species followed by Euphorbiaceae with 3 species. Sixteen families were represented by only one species (Table 4.1*, Annexure I*). The total 43 species consisted of 7 herbs, 9 shrubs, 22 trees, 3 climbing shrubs and 2 woody climbers (Table 4.2*, Annexure I*).

Out of the species enumerated, 13 species were found to be medicinally important (Table 4.3*, Annexure I*), 11 timber species (Table 4.4*, Annexure I*), 8 species were food plants (Table 4.5*, Annexure I*), 3 fodder plants (Table 4.6*, Annexure I*), 20 categorized as fuel wood species (Table 4.7*, Annexure I*), 8 species can be included under commercially important species (Table 4.8*, Annexure I*), and no rare, endangered and threatened plants could be located in this area.

### 4.4.2 Flora of surrounding area (Surrounding mine lease area of Jerrila blocks)

From the study area (outside the mine lease area), 482 plant species belonging to 363 genera and 113 families were recorded. Poaceae is the most specious family with 39 species followed by Fabaceae with 36 species, Asteraceae with 25 species and Euphorbiaceae with 24 species. Fifty families were represented by only one species (Table 4.9*, Annexure I*). The total 482 species consisted of 191 herbs, 85 shrubs, 134 trees, 43 climbing shrubs, 23 woody climbers and 6 ferns (Table 4.10*, Annexure I*)

Out of 482 species, 54 species are medicinally important (Table 4.11*, Annexure I*), 38 timber yielding species (Table 4.12*, Annexure I*), 48 food plants providing fruits, tubers, leafy vegetable etc. (Table 4.13*, Annexure I*), 28 fodder plants (Table 4.14*, Annexure I*), 66 categorized as fuel wood species (Table 4.15*, Annexure I*) and 40 commercially important species which yield various products like fibre, essential oils, leaves for plate making, spices and condiments, oil seeds, gums, tannins, etc. (Table 4.16*, Annexure I*), while 7 species are rare, endangered and threatened plants, which are found around Jerrila blocks (Table 4.17*, Annexure I*).

### 4.4.3 Phytosociology

All information collected on the vegetation from mine lease area and surrounding the mine lease area, like the number of individuals and girth at breast height (for trees and lianas only) of all species were analyzed to arrive at different phytosociological attributes, namely, density, frequency, basal area, IVI, Shannon-Weiner index and Simpson index and the same are summarized in Tables 4.18 to 4.26*, Annexure I*.

#### 4.4.3.1 Project affected area (Mine Lease Area)

Vegetation parameters of woody species, shrubs and herbs encountered in the sample plots are provided in Table 4.18*, Annexure I*. Species richness is the total number of species in a stand. From sampled plots in mine lease area, 27 woody species (26 trees and one liana) of ≥ 10 cm gbh were recorded (Table 4.19*, Annexure I*). *Celastrus paniculatus* was the liana*.* Other species of lianas observed outside the sampled area were *Ichnocarpus frutescens, Hiptage benghalensis* and *Acacia torta.* The number of tree species encountered in mine lease area is less than the range (35 to 90 species) reported for dry tropics (Murphy and Lugo 1986, Dixit 1997 and Kunhikannan, 2000). The density of tree species varied from 10 stems /ha to 260 stems/ha. Highest density was shown by *Phyllanthus emblica* (260 stems/ha) followed by *Buchanaia lanzan* (120 stems/ha). The stand density and stand basal area of tree species were 1050 stems/ha and 19.13 $m^2$ /ha (Table 4.18 and 4.19*, Annexure I*), respectively.

The number of shrubs and tree saplings together recorded from mine lease area was 23 species and was dominated by *Phoenix acaulis*, *P. loureirii* and several grasses. Most of the area was covered by these species and the area is open to sun and favours growth of more herbaceous species than shrubs. The density values (stems/100$m^2$) for different species of shrubs varied from 1.11 to 161 (Table 4.21*, Annexure I*). *Phoenix acaulis* recorded the highest value (161).

Number of herbaceous species encountered in mine lease area was 35 species. In this area, most of the species have dried up during the study period (November 2007 - April 2008). The stand density with regard to herbaceous species was 2380 stems/100$m^2$ (Table 4.18*, Annexure I*) and dominated by grasses like *Themeda triandra* (330 stems/100$m^2$) and *Leptochloa chinensis* (270 stems/100$m^2$) (Table 4.18 and 4.22*, Annexure I*). This area was dominated by species which can endure hot and xeric conditions. The herbaceous species encountered were mostly spreading or prostrate types. As the ecosystem supports an array of wild animals, the vegetation in mine lease area is very important for wild life management and cattle rearing because herbivorous animals depend mostly on grasses and other herbaceous species.

The concept of Importance Value Index (IVI) has been developed in order to express the dominance and ecological success of any species by a single value. Among trees species, P*hyllanthus emblica* showed highest IVI (53.91) followed by *Buchanania lanzan* (26.73), *Cassine glauca* (22.55) and *Terminalia chebula* (20.64). These four tree species were significant in occupying majority of space and resources being represented by 2/5$^{th}$ of total IVI in sampled area in mine lease area (Table 4.19*, Annexure I*). Among shrubs, highest IVI was recorded as 86.11 and 28.17 in the case of *Phoenix acaulis* and *Polygonum chinensis,* respectively (Table 4.21*, Annexure I*). Among herbaceous species, *Themeda triandra* (19.22) followed by *Cymbopogon flexuosus* (16.91) showed highest IVI in the mine lease area (Table 4.22*, Annexure I*). High IVI value of a species indicates its high regeneration capacity and greater ecological amplitude.

The diversity values for different life forms like trees, shrubs and herbs showed that the area is less diverse with regards to diversity of trees and shrubs. There are two important indices to denote the diversity such as Shannon Wiener Index (H') and Simpson Index (λ). The mine lease area showed Shannon Wiener Index (H') value as 2.75 for trees, 1.363 for shrubs and 3.123 for herbs and Simpson Index (λ) values as 0.101 for trees, 0.383 for shrubs and 0.061 for herbs (Table 4.18*, Annexure I*).

The study showed that regeneration of most of the woody species recorded in mine lease was very low. Only *Phoenix loureirii* has shown better regeneration with highest IVI value (59.63) in mine lease area (Table 4.20*, Annexure I*). *Albizia odoratissima, Diospyros montana, Glochidion tomentosum, Kydia calycina, Litsea glutinosa, Mallotus philippensis, Phyllanthus emblica, Sterculia villosa, Terminalia chebula* and *Ziziphus rugosa* were the woody species showed regeneration and no regeneration was recorded in case of species like *Bauhinia vahlii, Bridelia retusa, Buchanania lanzan, Cassine glauca, Dillenia pentagyna, Gardenia latifolia, Grewia tiliaefolia, Homalium nepalense, Lannea coromandelica, Pterocarpus marsupium, Schleichera oleosa, Semecarpus anacardium* and *Syzygium cumini* on the hilltops i.e. mine lease area.

#### 4.4.3.2 Surrounding mine lease area

Vegetation parameters of woody species, shrubs and herbs encountered in the sample plots is provided in Table 4.18*, Annexure I*. From sampled area, outside mine lease area 48 woody species of ≥ 10 cm gbh were recorded. Stand density values for the study area for trees (stems/ha), shrubs (stems/100m$^2$) and herbs were 1360, 186 and 3000, respectively (Table 4.18*, Annexure I*). Highest density value was recorded in the case of *Phyllanthus emblica* followed by *Glochidion tomentosum* among trees, *Phoenix acaulis* and *Chromolaena odorata* among shrubs, *Stachytarpheta jamaicensis* and *Themeda triandra* among herbs in the surrounding mine lease area. The density (stems/ha) of trees and lianas varied from 10 to 190 in the forest surrounding mine lease area (Table 4.23*, Annexure I*). For shrubs, it varied from 1 to 40 stems/100m$^2$ and herbs from 10 to 320 stems/100m$^2$ (Table 4.25*, Annexure I*). Among trees, *Acacia torta, Acronychia pedunculata, Albizia odoratissima, Artocarpus heterophyllus, Canthium dicoccum, Caryota urens* (Photo-6)*, Cassia fistula, Diospyros montana, D. sylvatica, Ficus microcarpa, F. semicordata, Garuga pinnata, Gmelina arborea, Gnetum ula, Hiptage bengalensis, Kydia calycina, Litsea glutinosa, Madhuca longifolia* var*. latifolia, Ougeinia oojeinensis, Schleichera oleosa, Woodfordia fruticosa,* and *Terminalia alata* showed minimum density value of 10 stems/ha (Table 4.23*, Annexure I*). The stand density was 1360stems/ha in the case of trees in surrounding areas is comparable to other undisturbed deciduous forest sites in the region (Dixit, 1997).

In surrounding areas of mine lease area, *Pterocarpus marsupium* has shown the highest IVI value (28.73) followed by *Phyllanthus emblica* (27.62) among trees (Table-27*, Annexure I*), *Phoenix acaulis* (26.43) followed by *Chromolaena odorata* (19.29) among shrubs (Table 4.23) and *Themeda triandra* (14.01) and *Stachytarpheta jamaicensis* (13.57) among herbs (Table 4.26*, Annexure I*)*.* High IVI values of a species indicate its high regeneration capacity and greater ecological amplitude. Dominant species contribute more to the microenvironment within a vegetation, but species with few individuals contribute to the species structure of the vegetation. The number of tree species with small population sizes, especially the species represented by only one individual, has a close correlation to the tree diversity values. These species are important components in the composition of species diversity of the local forest vegetation. The existence of a species in a particular habitat depends on the associated species and the abiotic environment. Hence, quantitative relationship between dominant and rare species is an important structural property of any community (Cao and Zhang, 1996).

The diversity values for different life forms like trees, shrubs and herbs showed that the area is diverse with regards to plant diversity. The area showed the diversity values such as Shannon Wiener Index (H') value as 3.467 for trees, 3.134 for shrubs and 3.391 for herbs and Simpson Index (λ) values as 0.047 for trees, 0.0493 for shrubs and 0.0499 for herbs (Table 4.18*, Annexure I*). High Shannon Weiner index value with low Simpson index value for a stand indicates that the stand is more diverse in character.

The density of various trees, lianas, shrubs and herbs varied greatly between the study sites (Table 4.18*, Annexure I*). This low value of number of species and density in mine lease area among different life forms may be attributed to the site quality and disturbances in the site. Grazing and illicit felling may also be one of the reasons for low species richness and low stand density in the site. The vegetation on the hilltops recorded less species diversity as per the study. The composition of species in this vegetation will drastically change immediately after monsoon showers. A different picture may emerge when these studies are conducted during and immediately after monsoon.

In comparison to the mine lease area, surrounding mine lease area showed better diversity values for all the life forms. The study showed the Shannon Wiener Index (H') as 3.467 for trees, 3.134 for shrubs and 3.391 for herbs and Simpson Index as 0.047 for trees, 0.0493 for shrubs and 0.0499 for herbs (Table 4.18*, Annexure I*). These diversity values are comparable to the diversity values reported by various workers for central Indian forest (Dixit, 1997 and Kunhikannan, 2000).

The study showed that the regeneration of most of the woody species recorded outside mine lease area was fairly good. Twenty seven woody species have shown regeneration. *Celastrus paniculatus, Ziziphus rugosa, Mallotus philippensis, Albizia chinensis, Sterculia villosa, Catunaregam spinosa* and *Homalium nepalense* have shown better regeneration with higher IVI values (Table 4.24*, Annexure I*). No regeneration was recorded in the case of species like *Bridelia retusa, Buchanania lanzan, Canthium dicoccum, Chionanthus ramiflora, Dillenia pentagyna, Diospyros sylvatica, Ficus microcarpa, Ficus semicordata, Lannea coromandelica, Madhuca* *longifolia* var. *latifolia, Neolitsea foliosa, Ougeinia oojeinensis, Phoenix loureirii, Schleichera oleosa, Terminalia alata* and *Terminalia chebula.*

### 4.4.4 Potential plant species from the study area

#### 4.4.4.1 Project affected area (Mine Lease Area)

The dry savannah forest on the hilltops particularly mine lease area was dominated by *Phoenix acaulis* (Konda-ita), which is a multipurpose plant species used by tribes and different grasses like *Themeda triandra* and *Leptochloa chinensis*. Sporadic stunted trees were also observed. During the survey to assess the impact of bauxite mining on the plant wealth in the project affected area, several medicinal plants, namely, *Casearia graveolens, Catunaregam spinosa, Chromolaena odorata, Cissampelos pareira, Gardenia latifolia, Mallotus philippensis, Naravelia zeylania, Neolitsea foliosa, Pterocarpus marsupium, Rubia cordifolia, Terminalia bellirica, Terminalia chebula* and *Woodfordia fruticosa* were recorded (Table 4.3*, Annexure I*).

The species of timber yielding category recorded were *Albizia chinensis, Albizia odoratissima, Bridelia retusa, Cassine glauca, Diospyros Montana, Grewia tiliaefolia, Kydia calycina, Ougeinia oojeinensis, Pterocarpus marsupium, Terminalia bellirica* and *Terminalia chebula* (Table 4.4*, Annexure I*).

During the survey, several plants of food value such as *Bauhinia vahlii* (Photo-5)*, Buchanania lanzan, Dendrocalamus strictus, Dioscorea oppositifolia, Grewia tiliaefolia, Phoenix acaulis, Sterculia villosa* and *Ziziphus rugosa* were enumerated (Table 4.5*, Annexure I*).

The important fodder plants like *Albizia chinensis, Dendrocalamus strictus* and *Terminalia chebula* and several grass species were also recorded. (Table 4.6*, Annexure I*).

The plants of fuel value recorded during the survey were *Albizia chinensis, Albizia odoratissima, Bridelia retusa, Buchanania lanzan, Casearia graveolens, Cassine glauca, Catunaregam spinosa, Cipadessa baccifera, Dendrocalamus strictus,* *Diospyros montana, Gardenia latifolia, Grewia tiliaefolia, Homalium nepalense, Kydia calycina, Mallotus philippensis, Ougeinia oojeinensis, Pavetta tomentosa, Terminalia chebula, Woodfordia fruticosa* and *Ziziphus rugosa* (Table 4.7*, Annexure I*).

The commercially important plants recorded during the survey were *Bauhinia vahlii, Dendrocalamus strictus, Phoenix acaulis, Pterocarpus marsupium, Sterculia villosa, Terminalia bellirica* and *Terminalia chebula* (Table 4.8*, Annexure I*).

#### 4.4.4.2 Surrounding mine lease area

Several economically important plant species on which the tribal and local people depend for their livelihood were recorded from the surrounding mine lease area. They were classified according to their uses as medicinal, timber yielding, edible, fodder, fuel wood species and used for other commercial purposes like, gum, fibre, chemicals, essential oils etc. Some of the Important and potential medicinal plants recorded were *Acacia sinuata, Aegle marmelos, Andrographis paniculata, Argyreia nervosa, Asparagus racemosus, Azadirachta indica, Baliospermum montanum, Cardiospermum halicacabum, Cassia fistula, Cassia tora, Centella asiatica, Chlorophytum tuberosum, Chloroxylon swietenia, Clerodendrum serratum, Costus speciosus, Curculigo orchioides, Cyperus rotundus, Elephantopus scaber, Entada pusaetha, Gymnema sylvestre, Helicteres isora, Hemidesmus indicus, Holarrhena pubescens, Limonia acidissima, Litsea glutinosa, Mucuna pruriens, Oroxylum indicum, Persea macrantha, Phyllanthus emblica, Plumbago zeylanica, Pterocarpus marsupium, Rauvolfia serpentina, Schleichera oleosa, Semecarpus anacardium, Spilanthes calva, Terminalia bellirica, Terminalia chebula, Woodfordia fruticosa, Wrightia arborea* and *Zanthoxylum armatum* (Table 4.11*, Annexure I*).

The timber yielding trees recorded were *Acrocarpus fraxinifolius, Albizia chinensis, Albizia odoratissima, Anogeissus latifolia, Azadirachta indica, Bauhinia semla, Bischofia javanica, Bridelia retusa, Cassia fistula, Chloroxylon swietenia, Dalbergia paniculata, Diospyros melanoxylon, Diospyros sylvatica, Gmelina arborea, Grewia tiliaefolia, Haldina cordifolia, Kydia calycina, Lagerstroemia parviflora, Miliusa tomentosa, Ougeinia oojeinensis, Pterocarpus marsupium, Schleichera oleosa,* *Semecarpus anacardium, Soymida febrifuga, Syzygium cumini, Tectona grandis, Terminalia alata, Terminalia arjuna, Toona ciliata* and *Xylia xylocarpa* (Table 4.12, *Annexure I*).

Some of the edible plants species, which provide fruits, nuts, tubers etc. recorded were *Aegle marmelos, Alangium salvifolium, Amaranthus spinosus, Amaranthus viridis, Amorphophallus paeoniifolius var. paeoniifolius, Ardisia solanacea, Artocarpus heterophyllus, Bauhinia vahlii, Buchanania lanzan, Carissa carandas, Caryota urens, Cayratia pedata, Colocasia esculenta, Dendrocalamus strictus, Dioscorea glabra, Dioscorea oppositifolia, Dioscorea pentaphylla, Dioscorea tomentosa, Diospyros melanoxylon, Ficus racemosa, Glycosmis pentaphylla, Gnetum ula, Indigofera cassioides, Limonia acidissima, Madhuca longifolia var. latifolia, Mangifera indica, Phoenix acaulis, Phoenix loureirii, Phoenix sylvestris, Phyllanthus emblica, Pueraria tuberosa* (Photo-10), *Rubus ellipticus, Schleichera oleosa, Semecarpus anacardium, Spondias pinnata, Syzygium cumini, Tamarindus indica, Ziziphus oenoplia, Ziziphus maurtiana* and *Ziziphus rugosa* (Table 4.13, *Annexure I*).

The major fodder plants recorded during the survey were *Albizia chinensis, Apluda mutica, Bothrichloa pertusa, Brachiaria ramosa, Cynodon dactylon, Digitaria ciliaris, Digitaria longiflora, Echinochloa colona, Eragrostis unioloides, Eulalia trispicata, Ficus benghalensis, Ficus racemosa, Heteropogon contortus, Imperata cylindrica, Indigofera cassioides, Ischaemum indicum, Leptochloa chinensis, Paspalum scrobiculatum, Pennisetum hohenackeri, Pennisetum polystachion, Setaria intermedia, Setaria pumila, Sporobolus indicus* and *Themeda triandra* (Table 4.14, *Annexure I*).

The important plants of fuel value recorded during the survey were *Acasia chundra, Acer laurianum, Acrocarpus fraxinifolius, Alangium salvifolium, Albizia chinensis, Albizia odoratissima, Anogeissus latifolia, Aphanamixis polystachya, Artocarpus heterophyllus, Atalantia monophylla, Azadirachta indica, Bauhinia racemosa, Bauhinia semla, Bischofia javanica, Bridelia crenulata, Bridelia retusa, Buchanania lanzan, Butea monosperma, Callicarpa tomentosa, Canthium dicoccum, Careya arborea, Cassia fistula, Cassine glauca, Catunaregam spinosa, Chionanthus ramiflora,* *Chloroxylon swietenia, Cipadessa baccifera, Cordia dichotoma, Dalbergia paniculata, Dillenia pentagyna, Diospyros melanoxylon, Diospyros montana, Diospyros ovalifolia, Diospyros sylvatica, Gardenia latifolia, Garuga pinnata, Gmelina arborea, Grewia tiliaefolia, Haldina cordifolia, Hardwickia binata, Holoptelea integrifolia, Homalium nepalense, Kydia calycina, Lagerstroemia parviflora, Lannea coromandelica, Madhuca longifolia var. latifolia, Mallotus philippensis, Mangifera indica, Miliusa tomentosa, Ougeinia oojeinensis, Persea macrantha, Pongamia pinnata, Pterocarpus marsupium, Pterospermum xylocarpum, Schleichera oleosa, Syzygium cumini, Tamarindus indica, Terminalia alata, Terminalia arjuna, Terminalia chebula, Toona ciliata, Trichilia connaroides, Wrightia arborea, Xylia xylocarpa, Xylosma longifolium* and *Ziziphus rugosa* (Table 4.15*, Annexure I*).

Plants of commercial importance used for making leaf plates, brooms, ropes, extracting tannin, oil and gum yielding and for making other handicrafts etc. recorded in this study sites were *Acacia sinuata, Aegle marmelos, Agave americana, Aristida setacea, Artocarpus heterophyllus, Bauhinia vahlii, Buchanania lanzan, Calamus rotang, Caryota urens, Dendrocalamus strictus, Diospyros melanoxylon, Hemidesmus indicus, Jatropha curcas, Limonia acidissima, Litsea glutinosa, Madhuca longifolia var. latifolia, Mangifera indica, Phoenix acaulis, Phoenix loureirii, Phoenix sylvestris, Phyllanthus emblica, Pongamia pinnata, Santalum album, Semecarpus anacardium, Sterculia urens* (Photo-11)*, Sterculia villosa, Syzygium cumini, Tamarindus indica, Terminalia bellirica, Terminalia chebula, Thysanolaena maxima* and *Ziziphus maurtiana* (Table 4.16*, Annexure I*).

*Cyathea gigantea, Entada pusaetha, Gnetum ula, Melasma avense, Phyllanthus narayanaswami, Rauvolfia serpentina* and *Toxocarpus longistigma,* (Table 4.17*, Annexure I*) were the Rare, Endangered and Threatened (RET) plants recorded from outside the mine lease area.

The main cultivated crops were *Setaria italica* (Korralu), *Sorghum bicolor* (Jonnalu), *Eleusine corocana* (Chollu, Ragulu), *Oryza sativa* (Vari), *Amaranthus tricolor* (Thota kura), *Capsicum annuam* (Mirapa), *Musa paradisiaca* (Arati), *Guizotia abyssinica*

(Alsi), *Citrus aurantium* (Kamala), Beans, Rajma, and other vegetable crops. People in the area also cultivate cash crops like coffee and pepper. Most of the forest and the *Grevillea* plantations are under coffee and pepper cultivation (Photo-2). During commercial cultivation of these species, all undergrowth and tree seedlings/saplings are removed to curtail competition in the forest.

### 4.4.5 Impact on flora and vegetation

In the present study, the impact of mining on plant wealth needs to be addressed taking into account both mine lease area and surrounding mine lease areas. The proposed mining is, in the ridges of hill ranges. It is understood that consequent to mining, vegetation in the mine areas will completely disappears. Any such mining activity will not only remove the vegetation from the mining sites, but also shows great bearing on vegetation in the adjoining areas, hill slopes and valleys. The vegetation (dry savannah) on the ridges invariably has herbaceous plants including grasses, which form the dominant community. The savannah vegetation on the hilltops recorded less species diversity. The composition of species in this vegetation will drastically change immediately after monsoon showers. A different picture may emerge when these studies are conducted during and immediately after monsoon. The vegetation on mine lease area has a predominant stemless palm, *Phoenix acaulis* and another palm *P. loureirii.* Apart from the floristic diversity, the grasslands have a great ecological role in conservation of moisture. During rainy season, these grasslands and the underneath strata of soil act as sponge in holding the moisture and help in percolation of water. The water is released from this ecosystem slowly even after the end of rainy season as springs. As a result, the streams and rivulets in the valleys below these grasslands get continuous supply of water. These streams and rivulets not only help in growth and regeneration of the forests on the slopes, which consist of evergreen elements like *Persea macrantha, Anamirta coculus* (Photo-4)*, Cyathea gigantea,* etc. but also act as the sole drinking water source for adjacent villages and further help life sustaining activities downstream finally enriching the Machkhand river.

Mining will be carried out in comparatively small area of 85 ha in Block 1, but impact has to be assessed holistically as there are different blocks in the area for mining. Within the Jerrila blocks bauxite mine areas, the ecological role of the grasslands and the forest need careful consideration. It is also to be noted that such vegetation is characteristic of all hillocks in this region. The outside mine area is very important in view of its phytogeography and occurrence of Himalayan, northeastern and Western Ghats elements in the flora. A few plant species, namely, *Acer laurianum, Achronychia pedunculata, Bischofia javanica, Clematis smilacifolia* (Photo-7)*, Cyathea gigantea, Ficus auriculata* (Photo-9)*, Gnetum ula, Litsea glutinosa, Melasma avense, Persea macrantha,* etc., that are common to Himalaya, North India, Assam, Meghalaya and Western Ghats are occurring in these hills.

The forests in the whole of Jerrila area are subjected to anthropogenic activities resulting in their degradation. Most of the fertile areas in slopes are under coffee and pepper plantations. The local tribes also practice podu cultivation. Apparently what is seen as good tree cover is either coffee plantation or pepper plantation. Vegetation remains only on the steep slopes and valleys, which are inaccessible. With such anthropogenic pressures, assessment of impact of mining on plant wealth assumes a greater dimension.

### 4.4.6 Management and conservation measures

The surrounding mine lease area in Jerrila blocks has 482 plant species and out of these, 7 species, namely, *Cyathea gigantea* (Wall. ex Hook.) Holttum, *Entada pusaetha* DC., *Gnetum ula* Brongniart, *Melasma avense* (Benth.) Hand.-Mazz., *Phyllanthus narayanaswami* Gamble, *Rauvolfia serpentina* (L.) Benth. ex Kurz and *Toxocarpus longistigma* (Roxb.) Steudel are categorized as rare, endangered and threatened taxa (Table 4.20*, Annexure I*).

Generally, any species conservation programme involves conserving the species in their natural habitat *"in-situ"* and growing the species outside the natural habitat "*ex-situ*". In the present situation, *in situ* strategy need to be followed since the above RET plants are found only in the surrounding mine lease areas. The Chintapalli area inclusive of Jerrila blocks forms the natural habitat for many important plant species including threatened species. The surrounding mine lease area also nurtures many other interesting plants. *Acer laurianum, Alstonia venenata, Ficus auriculata* (Photo-9), *Melasma avense, Phyllanthus narayanaswami* and *Stemonia tuberose,* etc. which may be protected in their natural habitat by fencing the mine lease area.

In order to minimize the impact of mining on the vegetation outside the mine area, it is important that adequate protection measures need to be followed. They include assisted regeneration in the forest area and soil and water conservation measures. As mining involves movement of vehicles and increased anthropogenic activities, mine lease areas should be fenced. Mine dust should be suppressed by regular sprinkling of water on the mine overburden dumps and haul roads. It is essential to create a green belt around the proposed mine lease area and along the haul roads well before initiation of the mining activities. The width of the green belt around the mine lease area should be at least 30 m. Five rows of shrubs followed by 5 rows of trees have to be planted (3 m x 3 m spacing) to mitigate dust pollution from the mine area as suggested in green belt development. Species of *Ficus* and other trees which have hairs on the leaves can be used for the green belt. The green belt will act as a barrier to trap the suspended dust particles and also suppress the air pollutants. It is also important to establish a green belt with tall seedlings (of more than 1 m height) of indigenous species so as to create the green belt at the earliest with good survival percentage.

## 4.5 FAUNAL DIVERSITY AND AQUATIC FAUNA

To study the possible impacts of the mining activities on the fauna, the following methodology was used for listing the available fauna.

**Methodology:**

A survey for mammalian, avian, reptile and insect fauna was conducted in the proposed mining area of the block near Rallagadda, Jerrila and Kondrupally villages in Chintapalli Reserve Forest in Narsipatnam Division, Visakhapatnam District, Andhra

Pradesh. Extent of proposed block is 85 Ha. The team has perambulated around one square kilometer of the proposed area (Photo-13).

Both direct and indirect methods of population assessment were followed. In direct method, the entire area under consideration has been perambulated all along the line transects and observations were recorded for direct sighting of the animals. The local people, who are well conversant with the area, have also accompanied the team. Indirect method of population assessment of fauna was based on the following evidences.

- Dung, droppings, scats, or pellets of the animals
- Hair or hoofs of the animals
- Calls of the animals
- Pug marks of the animals
- Existing habitats such as caves or burrows of wild life
- Interaction with the local people
- Interaction with local forest officials
- Other secondary sources like Working Plan of the Division, reports, etc.

With respect to insects, the entire area under reference is perambulated during day time. Direct visual observations were made on herbivorous insect fauna. In the case of aerial insects, collections were made using an insect collection net and identified. Working Plan for Narsipatnam Forest Division was consulted as secondary source (Anonymous, 2003).

### 4.5.1 Faunal diversity

The presence or absence of an animal or plant in a certain region depends on its ecological and geographical setting. Wild animals can exist in a region only if prevailing set of conditions are congenial for their survival and perpetuation. Diversity of the species and their abundance is largely dependent on the availability of required habitats. Tropical forests in their pristine form are rich abodes of a variety of fauna. However, their existence is threatened due to increased demands of burgeoning human population that necessitated more and more forest area to be brought under agriculture, housing, mining, multipurpose irrigation projects and industries. As a result, large tracts of forests are being cleared and wildlife habitats are shrinking drastically. In addition, exploitation of existing forests beyond their carrying capacity, illicit felling of trees, encroachments and pernicious practices such as shifting cultivation (*podu*) make forest ecosystem vulnerable and fragile. Many of the species have become extinct and much more are on the verge of extinction. The rate of species extinction world over is progressing at an alarming pace. Therefore, before diverting forestland for other activities such as mining, it is essential to assess the status of the fauna of the area, to predict possible impacts of mining on existing fauna and to suggest appropriate strategies for conservation and management of fauna, mitigating the adverse impacts. Under this backdrop, the present study was undertaken in the proposed bauxite mining area.

**Status of fauna**

**Mammals**

The survey team could not record direct evidences to confirm the occurrence of mammals in the proposed mine lease area. However based on interactions with local people and forest officials a total of 10 species of mammals are found to be existing in and around the proposed mining area (Table 4.27*, Annexure I*). Out of these, no species is listed under Schedule I of Indian Wildlife Protection Act (1972) and grouped under vulnerable category (IUCN, 2007).

**Birds**

The survey team could not collect much of the direct evidences regarding the avi fauna. However, 82 species of birds were reported in the Working Plan of Narsipatnam Division in the entire Division and a check list of the same is given in Table 4.28*, Annexure I*.

**Reptiles**

During the course of the survey, no direct evidences with respect to reptiles were observed. However, interactions with local tribal people and consultation of the

Working Plan of Narsipatnam Division revealed the occurrence of 11 species of reptiles in and around the mine lease area (Table 4.29*, Annexure I*).

**Insects**

Class Insecta is the largest in the animal kingdom. Insects exhibit enormous variability in their habits and habitats. Ecological services rendered by insect fauna as parasites, predators and pollinators in ecosystem function are of great importance. Their role in forest litter decomposition and nutrient cycling is highly significant. Some insects form a source of food for wildlife and even to human beings. Grubs of the Red palm weevil (*Rhyncophorus ferrugenius*) found infesting the growing shoots of *Pheonix aucalis*, a dominant species of the flora on hill tops is a delicacy to the local tribal people. During the survey 24 insect species have been recorded in and around the mine lease area (Table 4.30*, AnnexureI*).

### 4.5.2 Impact on fauna

The hill tops of Eastern Ghats in general and Jerrila blocks in particular are characterized by dry Savannah type of forests in which grass lands are interspersed with trees of stunted growth, whereas flora on hill slopes ranges from dry deciduous to moist deciduous type. This kind of terrain with associated flora is supposedly a suitable habitat for a variety of animals. The proposed site is observed to be under biotic pressure. Adjacent to mine lease area, on hill slopes coffee is being cultivated. Shifting cultivation is being practiced and newer patches are being brought under the same by removal of existing flora and subjecting the area to fire.

During the survey 10 species of mammals 82 species of birds, 11 species of reptiles and 24 species of insects have been recorded by direct and indirect methods. Out of these, no species is listed under Schedule I of Indian Wildlife Protection Act (1972) and grouped under vulnerable category (IUCN, 2007). Sambar, Hare (Photo-14) and Wild boar form the herbivorous primary consumers and Hyena, Fox and Jackal form the carnivorous secondary consumers of the trophic level. Another apparent feeding guild is of burrowing animals consisting of Porcupine, Mangoose and Wild boar.

The impact of mining is chiefly due to habitat destruction, sound and air pollution during mining operations, material conveyance and influx of human population into the area. Due to the proposed project activity the hill top will be completely excavated, removing the entire grassland depriving food source for the herbivores. These animals will have no alternative than moving away from the mining site in search of food and shelter. Carnivore predators dependent on these animals also will be deprived of their prey population and tend to move away from the site of disturbance. The proposed mining area is in contiguity with other hills. Therefore, there is every scope for the animals to move away from the disturbed site of mining to undisturbed areas within their home range.

#### 4.5.2.1 Management and conservation measures

In order to mitigate the adverse impacts of bauxite mining in the proposed area the following measures need to be adopted.

- Necessary steps must be taken for habitat improvement within the home range of the animals beyond the mining impact area. These steps must include adoption of suitable afforestation programme, provision of water holes, ponds, check dams and salt licks. Plant species that support wild life for shelter and food, particularly grasses, have to be included in afforestation programme
- Wild animals encountered during the mine operations must be rescued and released safely into alternate habitats with the help of State Forest Department. The same procedure should be adapted for other animals whenever they are encountered
- A dense (at least 30 m wide) belt of shrubs and trees of different species must be created around the mine lease area and along the haul roads, which acts as an effective acoustic barrier attenuating the levels of noise and vibrations
- Methods to mitigate the adverse effects of sound and air pollution have to be adopted. Adopting Ripper-dozer for excavation and pipe/conveyer belt system for

transport of mineral ore from the site of mining to handling will reduce the sound and air pollution significantly

- On haul roads, sprinkling of water has to be adopted on regular basis to minimize air pollution
- The movement of men and operation of machinery is to be restricted between 9 a.m. to 5 p.m. since the activity of the wild life is before the dawn and after the dusk
- Both the sides of haul roads must be cordoned off with chain link fence in order to prevent accidents to wild animals from vehicular traffic
- Intense campaign has to be launched to create awareness amongst the local people as well as project staff regarding the importance of wildlife, its diversity, their habit and habitats and the need for their conservation for posterity. For this purpose **Eco Development Committees (EDC)** in adjoining settlements with local people as its members have to be formed as in the case of **Community Forest Management Project** being implemented by the Andhra Pradesh Forest Department. Members of EDCs have to be educated and trained in wild life management and conservation. EDCs are to be sufficiently motivated to patrol the area on regular basis particularly during the initial period of the project to monitor the movement of the wildlife and to prevent hunting and poaching. If any animal becomes vagrant and invades human settlements, they have to be rescued, rehabilitated and released into other undisturbed natural forest habitats with the help of forest officials
- During the mining period and post mining period, the project authorities have to establish a "**Forestry and Wild Life Management Cell**" consisting of competent professionals to undertake habitat improvement programmes including afforestation, management and conservation of wild life and mine dump rehabilitation. The Cell is to be headed by Executive Director (Forestry and Wild Life) or Deputy Conservator of Forests supported by Forest officials, Environmental Officers, Technical assistants and Field assistants

### 4.5.3 Aquatic fauna

#### 4.5.3.1 Methodology

Water samples were collected from the surface of the streams with minimum disturbance during March, 2008 (Photo-15). Ten buckets full of water was passed through a plankton mesh of 63 µ resulting in 100 litres of water passing through the mesh. The plankton concentrate was washed mildly with 150 ml of water into a sample container of 250 ml capacity. The samples were preserved in FAA (Formaldehyde-Acetic Acid-Alcohol) solution of the following composition (Knudsen, 1966).

Formaldehyde commercial grade: 10 ml
Alcohol 95%: 50 ml
Acetic Acid: 2 ml
Water: 40 ml

Surface water temperature and pH were measured using Eutech pH tester. The samples were examined in the laboratory under a Nikon Stereo Zoom Binocular Microscope and the organisms identified using standard manuals.

#### 4.5.3.2 Aquatic faunal diversity

An aquatic ecosystem comprises of rivers and streams, ponds and lakes, oceans and bays, swamps and marshes and associated fauna. Aquatic habitats provide food, shelter and space essential for the survival of aquatic flora and fauna, which are adapted to life in water. Biodiversity in an aquatic ecosystem is very rich and harbours variety of plants and animals, ranging from primary producers to tertiary consumers.

Depending on water residence time and flow velocity, freshwater habitats are divided into two types, i.e., lentic and lotic ecosystems. Lentic ecosystem is a stagnant water body without significant water movement whereas lotic ecosystem is a dynamic water body with a certain flow in a definite direction. The water current in the lotic systems at the surface is more pronounced than in the bottom. Hence, the bottom substrates resemble lentic habitats. Dissolved oxygen normally will be more in these systems because of continuous mixing by water movement. Plankton available at these habitats are at the mercy of water currents whereas fish can resist the same and are adapted to swim against currents. However, the common character of these ecosystems is that they are sensitive to any alteration in the catchment area and the water quality in turn affects the fauna.

Analysis of plankton, among various communities in the aquatic ecosystem gives a fair idea of the possible diversity of all other fauna in the system because of the place it occupies in the food web, as primary producer. Routine monitoring of biological communities will be inexpensive particularly compared to the cost of assessing water quality changes over a period of time. Biological communities may be the best practical means of evaluation of the status of aquatic bodies and their faunal environment, especially in the case of non-point source impacts.

The survey area forms catchment of Machhakunda reservoir and consists of the watershed of Budugedda. The streams descending from the hills merge with the NE-SW trending valleys forming again an overall dendritic pattern. Springs on the hill slopes feed the perennial streams in the valleys below, which constitute the main water regime of the area. The main drainage is towards west, southwest, northwest, northeast and southeast directions which represents a typical radial drainage. The drainage in the west is controlled by the Budugedda rivulet. The physiography and drainage pattern were studied using the satellite imageries, Survey of India maps and ground truthing at all collection points. The biota available at the time of sampling in different streams are listed in Table 4.32*, AnnexureI*. The different planktonic forms were identified following Kodarkar *et al.* (1998) and Ramachandra *et al.* (2006). Common fish occurring usually in all streams are reported to be present in the study area also.

Details of areas from where water samples were collected along with information on water flow, temperature and pH are provided in Table 4.31*, AnnexureI*. The biota inhabiting different streams at the time of sample collection are listed in Table 4.32*, AnnexureI*. Percentage occurrence of each component of biota is provided in Table 4.33*, AnnexureI*.

#### 4.5.3.3 Impact on aquatic fauna

Mining of bauxite is proposed to be done by open cast mechanization. Boulders exposed during ripping operation are proposed to be broken by resorting to shot hole drilling up to a depth of 60 - 120 cm depending upon the size of the boulder. The waste material comprises of laterite, siliceous and ferruginous and intercalations of parent rock. It is proposed to stack the waste material in such places from where it can be rehandled for back-filling purpose. The ore is proposed to be transported to the factory by road employing trucks.

There are no water bodies in the mining areas. In the course of mining, some localized depressions may be formed. The accumulated water in these depressions is proposed to be pumped out using motors. Several seasonal and perennial nalas originate around the mine area. The problem of mine discharge and other activities would be very critical in terms of preservation of natural drainage.

Degradation of aquatic ecosystems and receiving water bodies often involving substantial reductions in water quality can be among the most severe potential impacts of mining. Pollution of water bodies results from three primary factors, i.e., sedimentation, acid drainage and metal deposition. Potential source of concern include mine water discharge from open pit mine and run off from waste disposal facilities.

In the present case, waste dump is proposed to be stacked up to a height of 10 m with each step of 5 m. During heavy rains, the waste will drain off downwards and flow into the streams down below. If large amount of waste is discharged into an aquatic system, it will have potential to cause serious environmental impacts downstream. Erosion from waste piles and run off after heavy rain fall increase the sediment load of nearby water bodies. It will also result in elevation of dissolved heavy metal concentrations having toxic effects on stream biota. Sedimentation of the water body also decreases the depth of the water column leading to flooding of streams, resulting in die-back of vegetation. The fine sediments can also have impacts further downstream.

Addition of silt to the water body increases the turbidity, decreases penetration of sunlight affecting phytoplankton populations that depend on sunlight for photosynthesis (Ripley, 1996). Decrease in phytoplankton populations will lead to disruption of the ecosystem as they play a very significant role as primary producers. Increased sediment loads also may change the number and population of aquatic species. Smothering of benthic fauna is a likely impact.

The addition of mine waste may, sometimes, result in alteration of pH of the water body affecting the biota present in the system, as most of the aquatic species are sensitive to changes in pH. The effects of change in water chemistry may lead to reduction of nutrients, disturbance of feeding grounds and habits, alteration of breeding potential, seasons and grounds, induction of diseases and influencing the migratory patterns of fish.

#### 4.5.3.4 Management and conservation measures

Mine discharges and waste disposal should be carefully planned in such a way that obstructions are not caused to drainage. During monsoon, rainfall in the area will be heavy and care needs to be taken to ensure smooth running of mining operations. Some localized pits will be created for collection of water, which will be pumped out. It is suggested that these pits should be constructed at two levels and lined with water proof material to minimize possible seepage. The pits should also be provided with filtration beds to trap sediments and other solid material. Pure water from the second pit should be let out slowly to join the streams, so that sedimentation effects in the streams will be minimal. The drain also should pass through a series of biological and engineering structures like gully plugs, check dams, rock filled dams and gabion structures, etc., to maintain the water to the near normal level before allowing it to flow in to the streams. The overburden should be filled back in such a way that the water drains out into the streams in the same rate as is flowing now. Provision should be made to allow flow down of rain water gradually in all natural streams so that gullies leading to soil erosion are not formed. Garland trenches should be provided all along the active mine area to prevent soil erosion and siltation of streams. To prevent soil erosion due to rain water flow, soil binding grasses and herbs should be planted as suggested in Catchment Area Treatment Plan.

The ore is proposed to be transported by conveyor belt between blocks to a stack yard and by road to the refinery by trucks. To avoid dust pollution and possible fall of the dust in to the streams resulting in change in water chemistry, it is proposed that water should be sprinkled at frequent intervals on the haul roads to facilitate dust suppression.

### 4.6 Soil Microflora

Microorganisms are ubiquitous, can be found in air, water, soil; within plants, animals and human being. A wide array of microorganisms is available in natures, which are free living, parasitic, saprophytic and symbiotic in forms. The different groups of microorganisms include actinomycetes, bacteria and fungi. In forest ecosystem, there is a symbiotic group of fungi called 'mycorrhiza'. They are extremely important as they help in transport of phosphorous and other essential nutrients to the plant system from the soil. The term *mycorrhiza* is literally meaning Fungus Root. There are two major types of mycorrhizae *viz.,* ecto- and endomycorrhizae. The ectomycorrhizal fungi are commonly associated with tree species belong to gymnosperms and certain angiosperms. The endomycorrhzial fungi especially the Vesicular Arbuscular Mycorrhizal (VAM) fungi are widely distributed in varied ecosystems and associated with all the plants.

It is important to know the diversity and abundance of the microbial species in any given area before subjecting to activities like mining. With this background, an attempt was made to study the status of microbial population (Soil Fungi, Symbiotic (VAM) Fungi, Bacteria and Actinomycetes) in the soils and roots collected from the proposed project affected area (mine lease area) and surrounding mine lease areas.

## Methodology

### 4.6.1 Collection of samples

Soil and root samples were collected from different sample plots in and around proposed mine lease areas of Block-I during March, 2008. Roots and soil samples were collected from two different sample plots each, from proposed mine lease and outside mine lease areas, which constituted the replications (Plate-4). All the samples were brought to the laboratory for processing and estimation of soil microbial population by adopting standard procedures and techniques.

### 4.6.2 Enumeration of soil microbial population

The soil microbial load *viz.*, bacteria, fungi, actinomycetes and mycorrhizal fungi (Arbuscular Mycorrhizal Fungi - AMF) was determined in the soil samples collected from different sample plots in and around proposed bauxite mine lease areas. Serial dilution and plating techniques as described by Parkinson *et al*. (1971) was adopted for enumerating the population of bacteria, fungi and actinomycetes. The AMF spore population was estimated by using wet sieving and decanting technique (Gerdemann and Nicolson, 1963) and sucrose density gradient technique. Root colonization by AMF was done using root clearing and staining techniques (Phillips and Hayman, 1970; Koske and Gemma, 1989) and data on percent root colonization of AM fungi was estimated by using gridline intersect method (McGonigle *et al.,* 1990).

### 4.6.3 Details On Soil Types, Land Use Pattern And Microflora

The soils in and around the proposed bauxite mining sites in Jerrila Blocks in Narsipatnam Forest Division are mostly of residual nature. The soils are monogenetic, red ferruginous loams and sandy loams in the hills and valleys, which support luxuriant growth of vegetation. At elevations above 1000 m, the soils are bauxite ferrous, laterites supporting only grasses.

### 4.6.4 Status of Soil Microbial Population

Soil Microbial Population are extremely important and help in transfer of phosphorus and other essential nutrients to the plant system from the soil leading to improved seedling growth and increased root life. They also help in protecting the roots against other pathogenic organisms in overcoming and environmental stresses such as heavy metal toxicity, soil salinity, etc.

Therefore, it is important to know the diversity and abundance of such microbial species in any given area before subjecting the areas to activities like mining. So, an attempt was made to investigate the status of microbial populations (soil fungi, symbiotic (AMF) fungi, soil bacteria and soil actinomycetes) in soils and plant roots in and around the proposed mine lease areas of Block-I.

**Colonization and soil spore population of AMF**

Data on percent root colonization and soil spore population of AM fungi recorded in 2 different sample plots are presented in Table 4.34*, Annexure I* and Plate-5. The arbuscular structures were observed only in the root samples collected from the sample plots of outside mine lease area. The vesicular structures were globose to sub-globose in shape. The root segments also show extramatriceal mycelia with vesicular structures of AMF (Plate-4).

It was interesting to note that maximum percent root colonization (88%) and soil spore population (272/100g soil) of AM fungi was recorded in the samples collected from the sample plots outside mine lease area. The sample plots of proposed mine lease area had less percent colonization (12%) and soil spore population (76/100g soil) of AMF during the period under investigation. It was observed during the investigations that the percent colonization and spore population of AMF was greater in vegetated areas compared to top of the hill (grassland areas).

**Frequency distribution of AMF**

Data on the frequency distribution of AMF recorded in the rhizosphere soils of different sample plots of Block-I are presented in Table 4.35*, Annexure I* and Plate-6. A total of 10 different species of AMf belonging to two genera such as *Glomus* and *Gigaspora* were isolated and identified. Between them, the genus *Glomus* was found predominant. It was also recorded that the AMF genera *Glomus* had 9 species, while *Gigaspora* had only one species. Among the different species of *Glomus*, *i.e., albidum* and *geosporum* were the most frequent species (100%) recorded. Among different sample plots screened, the sample plots of outside mine lease area had registered 9 different AMF types (*Glomus*-8 species and *Gigaspora*-1 species) and the sample plots of proposed mine lease area had only 3 AM fungal types (*Glomus*-3 species).

**Fungi**

Data on fungal population in soil samples collected from different sample plots are presented in Table 4.36*, Annexure I* and Plate-7. It was observed that the soils collected from the sample plots outside mine lease area had registered higher population of fungi (138 x $10^3$ cfu.$g^{-l}$). The sample plot of proposed mine lease area had less population (colony forming units) of fungi (56 x $10^3$ cfu.$g^{-l}$).

The species composition of different fungi isolated and identified is presented in Table 4.37*, Annexure I*. Total of eight different fungi were recorded from soil samples screened during the period under investigation. It was noticed that the fungus *Aspergillus niger* was the dominant one (106 x $10^3$ cfu.$g^{-l}$), followed by *Rhizopus* (28 x $10^3$ cfu.$g^{-l}$) and *Aspergillus* (17 x $10^3$ cfu.$g^{-l}$). Among different fungi recorded from various samples, *Curvularia* is found to be the least (4 x $10^3$ cfu.$g^{-l}$).

**Bacteria**

Data on bacterial population estimated from the soil samples are presented in Table 4.38*, Annexure I*. The bacterial population (colony forming units) range varied between 2.00 x $10^7$ cfu.$g^{-l}$ and 42.0 x $10^7$ cfu.$g^{-l}$. Among the different sample plots screened, the sample plot 2 (proposed mine area) had more bacterial colonies (53.5 x $10^7$ cfu.$g^{-l}$)

whereas the sample plot 1 (outside mine lease area) had less bacterial colonies (33.0 x $10^7$ cfu.$g^{-l}$). Three types of bacteria viz., *Bacillus*, *Pseudomonas* and an unidentified genus were recorded in different samples screened during the period under observation. Among them, *Bacillus* was found dominant in sample plot 2 (proposed mine lease area) and *Pseudomonas* in sample plot 1 (outside mine lease area).

**Actinomycetes**

Data on actinomycetes population estimated from the soil samples are presented in Table 4.38*, Annexure I*. The actinomycetes population (colony forming units) ranged between 1.5 x $10^2$ cfu.$g^{-l}$ and 2.0 x $10^2$ cfu.$g^{-l}$. The population of actinomycetes was found low in both the sample plots during the period under investigation.

### 4.6.5 Impact on Microflora

Different fungal and bacterial organisms were recorded in samples collected. Among them, the symbiotic microbes, especially the Arbuscular Mycorrhizal Fungi (AMF) were distributed in different sample plots in the study areas. The spore population and types of AM fungi distributed in proposed mine lease area were low as compared to outside mine lease area. Due to mining activity, these microorganisms in the proposed mine lease area will be removed along with overburden. However, the microbial species that have been recorded in the proposed mine lease area also occur outside mine lease areas and periphery of the mine areas. Hence, there will not be any significant loss in microflora.

### 4.6.6 Management and Conservation Measures

The top soil collected from the proposed mine lease areas and adjoining forest areas were found to contain several effective AMF and other beneficial microorganisms that are helpful for plant growth. Hence, the top soil must be dumped separately at a predetermined area for its subsequent utilization. As a part of overburden rehabilitation, the top soil containing beneficial microflora of the site must be spread over external dumps as well as over the back filled areas. Necessary precautions have to be taken to preserve the fertility and shelf life of the microflora in the top soil by adopting suitable height to the top soil dumps and preventing losses due to erosion during temporary storage phase. The overburden and top soil which contains most of the soil organic matter, nutrients, microbes and seeds are stockpiled for future use or directly re-spread on areas ready for rehabilitation. These beneficial microorganisms may again be introduced at the time of mine reclamation and rehabilitation activities by using the separated top soil along with biofertilizers. In addition, adopting the following management techniques using the beneficial microorganisms will be effective during the mine spoil rehabilitation programme.

**Application of beneficial microbes**

Application of beneficial microbes is to enhance the fertility of the soil conditions in degraded areas. The microbes are being exploited in two important ways – utilization of Mycorrhizal Biofertilizers and Nitrogen-fixing organisms. The biofertilizer potential of *Rhizobium, Aztobacter, Beijerinckia*, *Azospirillum* and *Frankia* has been exploited so that these could serve as an alternative to chemical fertilizers. The nitrogen fixing bacteria like *Rhizobium* or actinomycete genus *Frankia* can be used to induce nodule formation in a variety of plant species, so as to improve soil fertility of mined overburden areas.

Use of mycorrhizal biofertilizers is to enhance the uptake of nutrients and water for better survival and establishment of seedlings/saplings in degraded lands like mined overburdens. The mycorrhizal fungi profoundly influence the growth of vegetation, reclamation and rehabilitation of mine spoils. Many earlier reports show that the mycorrhizal fungi bring an improvement in the growth of plants through an increased Phosphorus uptake and better survival and establishment in mine wastes (Allen, 1984 and Sylvia, 1988). Therefore, it is suggested to undertake the application of suitable AMF and ECM fungi and other beneficial microbes (A*zospirillum, Azotobacter, Phosphobacterium, Rhizobium, Frankia*) for quality tree seedling production during afforestation of the mined out areas.

**Quality seedling production**

Tree seedlings can be inoculated using potential mycorrhizal biofertilizers and other microbial bio-inoculants for production of quality seedlings. The mycorrhizal biofertilizers such as AMF and ECM fungi can be applied as a layer in the nursery bed (1 kg AMF) or poly bag (5 gm AMF inoculum/ bag). Similarly, basidiospores of ECM fungus (*Pisolithus albus*) can be inoculated as layer in the nursery bed (500gm of basidiospore inoculum) per poly bag (1 tea spoon/bag) before sowing the seed. The same method can be followed using vermiculite based mycelial inoculum of ECM fungus (*Pisolithus albus*) for nursery bed and poly bags before sowing seeds. The following combinations can be adopted for production of quality seedlings in nursery.

- AM fungus + *Rhizobium* (for leguminous plants) + Vermicompost/ Weed compost.
- AM fungus + *Phosphobacterium* + *Azospirillum* (for non-leguminous plants) + Vermicompost/ Weed compost.
- ECM fungus + *Rhizobium* (for leguminous plants) + Vermicompost/ Weed compost.
- ECM fungus + *Phosphobacterium* + Azospirillum (for non-leguminous plants) + Vermicompost/ Weed compost.
- AM fungus + *Frankia* (for Casuarinas) + Vermicompost/ Weed compost.
- ECM fungus + *Frankia* (for Casuarinas) + Vermicompost/ Weed compost.

Caproni *et al.* (2003) observed that addition of top soil with planting of mycorrhizal seedlings was efficient to colonize areas with AM fungi after open cast bauxite mining. Hence, the mined overburden areas can be reclaimed with suitable fast growing indigenous plant species inoculated with potential mycorrhizal biofertilizers (AMF and ECM fungi) and other microbial bio-inoculants (*Rhizobium, Azospirillum, Azotobacter, Phosphobacterium, Frankia,* etc.).

# Chapter 5

# SOCIOECONOMIC ENVIRONMENT

## 5.1 Introduction

The environmental impact assessment study comprises of the cumulative impacts of multifarious activities on the socio-economic environment resulting in the changes in socio-economic conditions of the region. The fundamental objective of Social Impact Assessment (SIA) is to assess the range of potential impacts on the communities & families due to the proposed mining operation and provide planners, decision makers and managers with a competent assessment of the anticipated social impacts of proposed actions and to assist the project proponent in meeting the challenges for sustainable development. The SIA is the process of estimating in advance, the social consequences that are likely to follow from specific policy action or project developments.

The area delineated for the EIA study covers an area circumscribed by 10 km radius from the proposed Jerrila Bauxite Mines covering mining deposit Jerrila Blocks I **(Figure 5.1)**. The study area comprises of three mandals covered partially i.e. G. Madugula, G.K.Veedhi, Chintapalle Mandals of Vishakapatnam District of Andhra Pradesh and a part of Malkanjgiri sub-district, which comes under the Orissa State. The proposed mine deposit block I falls under G. K. Veedhi Mandal of Visakhapatnam district of Andhra Pradesh (AP).

The area is the home for four tribes namely Valmiki, Kondu, Konduera and Bhagata who eke out their livelihood from a range of occupations that include hunting, gathering minor forest produce, horticulture, slash-and-burn (Podu) agriculture, and dry- wet cultivation, etc. Multi-tribal villages are common all over the area and depending upon the tribal composition of a village, all the groups are arranged in a social ranking based on high and low positions that conform to the social order in other villages. The residence pattern of higher tribes occupying the land with higher elevation leaving low lying land to the lower groups to construct their houses conforms with the social order. The Bagatha occupy the highest position while the Valmiki is assigned the lowest position. The expressions of social hierarchy can be observed at different socio-political and religious contexts that include spatial distance of dwellings, endogamous marriages, commensal relations, socio-ritual distance, traditional occupational practices and traditional political positions of every village. The control over land that is a basic resource makes the Bagatha a dominant group and other tribes depend on them. Carpentry, black smithy and pottery are not considered unclean and thus also carried out by the higher classes of tribes. Cattle business, removing carcasses, treating the hides are considered to be the lowest occupation and therefore, the Valmiki that practice these menial occupations are the lowest in the social scale.

The village level socio-economic profile of the study area has been prepared considering the circumscribed area of 10 km radius and the family wise socio-economic profile considering only the buffer zone of 5 km radius from the mining deposit block I. The details pertaining to the entire study area has been collected. However, more emphasis has been laid on the 5 km radius buffer zone because the actual impacts experienced at the given project site is based on the pre-existing situation, the process of community engagement, capacity and livelihood opportunity of the house residing close to the proximity of the impact area.

## 5.2 Village level socio-economic profile of the study area

The study area of 10 km radius cover part of 3 mandals of AP and 1 sub district area of Orissa State. The details on landuse, demography, occupational pattern, infrastructure, and amenity base for education, medical facilities, water supply, communication and accessibility are given in Annexure I. The buffer zone i.e., the 5 km radius covers 21 villages under G.K. Veedhi Mandal; 9 villages under of Chintapalle Mandal and 1 village under Malkanjgiri sub-district of A.P.

**Error! No topic specified.**

**Figure 5.1: Habitations in the study area**

### 1.0 Table 5.1: Showing the village distribution under various mandals in the proposed mining area of Jerrila Block I with 5 km radius

| 1.1 S. No. | 1.2 Distance | 1.3 Chintapalle | 1.4 G. K. Veedhi | 1.5 Malkangiri |
|---|---|---|---|---|
| **1.6 1** | **1.7 0-1** | 1.8 | 1.9 | 1.10 |
| 1.112 | 1.121-2 | 1.13 | Rallagedda | 1.14 |
| 1.15 | 1.16 | 1.17 | Kondrupalle | 1.18 |
| 1.19 | 1.20 | 1.21 | Gudiwada | 1.22 |
| 1.233 | 1.242-5 | Egajanaba | Gollapalle | Kerapalli |
| 1.25 | 1.26 | Cheruvuru | Chintalawada | 1.27 |
| 1.28 | 1.29 | Buradamamidi | Nadimiveedhi | 1.30 |
| 1.31 | 1.32 | Digavalasapalle | Pebbampalle | 1.33 |
| 1.34 | 1.35 | Turamamidi | Reyyalagedda | 1.36 |
| 1.37 | 1.38 | Burugubailu | Ammavaridharakonda | 1.39 |
| 1.40 | 1.41 | Veeravaram | Jajipakalu | 1.42 |
| 1.43 | 1.44 | Egavalasapalle | Kakulagedda | 1.45 |
| 1.46 | 1.47 | Kudumulu | Panasapalle | 1.48 |
| 1.49 | 1.50 | 1.51 | Jerrila | 1.52 |
| 1.53 | 1.54 | 1.55 | Mondigedda | 1.56 |
| 1.57 | 1.58 | 1.59 | Burugupakalu | 1.60 |
| 1.61 | 1.62 | 1.63 | Kothawada | 1.64 |
| 1.65 | 1.66 | 1.67 | Vanabalingam | 1.68 |
| 1.69 | 1.70 | 1.71 | Nittamamidi palem | 1.72 |
| 1.73 | 1.74 | 1.75 | Chintalapadu | 1.76 |
| 1.77 | 1.78 | 1.79 | Veeravaram | 1.80 |
| 1.81 | 1.82 | 1.83 | Chekkalamaddi | 1.84 |

## 5.2.1 Land use

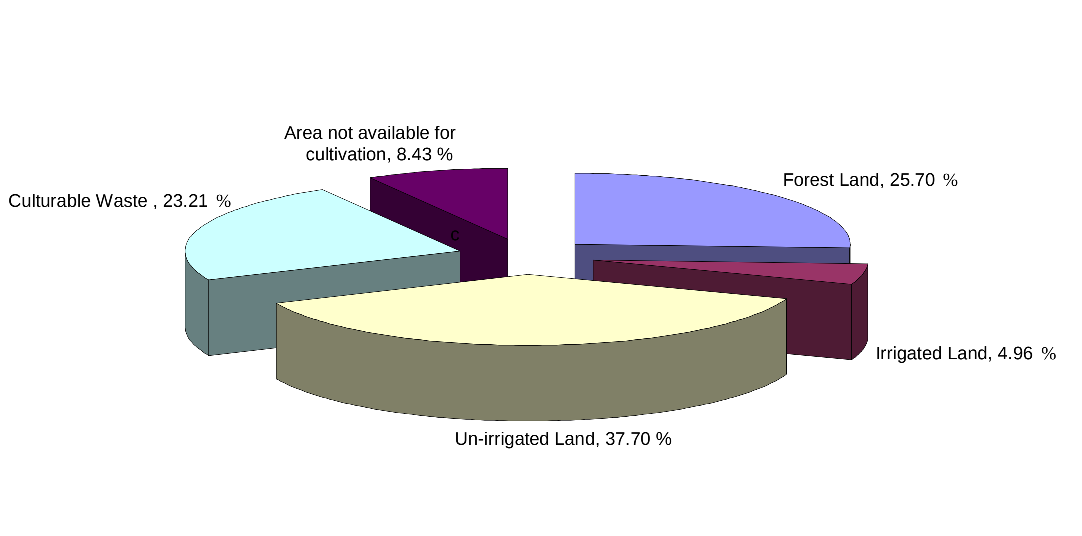
1.3.9 **Within 10 km radius:** The total geographical area of the 66 villages that fall within the 10 km radius as per revenue records consists of 6277 ha. Out of which, the forest land consists of 976 ha, irrigated land - 165 ha, un-irrigated land – 2757 ha; cultivable wasteland -1218 ha and 1131 ha area not available for cultivation (**Table 5.2)** The mandal wise and Village wise landuse pattern as per the revenue records is given in **Annexure I-a**.

**1.3.10 Table 5.2: Mandal wise Landuse pattern in the 10 km radius of the study area**

| Sl. No . | Mandal | Villages (No's) | Revenue land (ha) | Forest Land (ha) | Irrigated Land (ha) | Un-irrigated Land (ha) | Cultivable Waste (ha) | Area not available for cultivation (Ha) |
|---|---|---|---|---|---|---|---|---|
| 1 | G. Madugula(AP) | 2 | 221 | 45 | 27 | 57 | 23 | 68 |
| 2 | Chintapalle (AP) | 24 | 2245 | 0 | 0 | 1455 | 462 | 328 |
| 3 | G. K. Veedi (AP) | 32 | 2113 | 444 | 138 | 971 | 389 | 172 |
| 4 | Malkanjgiri (Orissa) | 8 | 1698 | 487 | 0 | 274 | 344 | 593 |
| | **Total** | 66 | 6277 | 976 | 165 | 2757 | 1218 | 1161 |

1.3.11 **5 km buffer area zone:** The total area within the 5 km radius from the mining deposit consists of 1807 ha, out of which 25.70% is under forest, 4.96 % is under irrigated land, 37.70% is under un-irrigated land, 23.21 % is cultural waste land and 8.43% is area not available for cultivation (**Figure 5.2** & **Table 5.3**).

**Figure 5.2: Showing the land use pattern within the radius of 5 km buffer area of the proposed mining site**




1.3.12

**1.3.13 Table 5.3: Showing the landuse pattern within the 5 km Buffer area of the study area**

| S. No. | Village Name | Revenue land (ha) | Forest Land (ha) | Irrigated Land (ha) | Un-irrigated Land (ha) | Culturable Waste (ha) | Area not available for cultivation (Ha) |
|---|---|---|---|---|---|---|---|
| | **Chintapalle mandal (AP)** | | | | | | |
| 1 | Egajanaba | 10 | 0.00 | 0.00 | 9.16 | 0.00 | 0.84 |
| 2 | Cheruvuru | 64 | 0.00 | 0.00 | 15.97 | 46.81 | 1.22 |
| 3 | Bradamamidi | 16 | 0.00 | 0.00 | 13.00 | 2.80 | 0.20 |
| 4 | Digavalasapalle | 7 | 0.00 | 0.00 | 6.92 | 0.00 | 0.08 |
| 5 | Turamamidi | 65 | 0.00 | 0.00 | 24.85 | 33.04 | 7.11 |
| 6 | Burugubailu | 119 | 0.00 | 0.00 | 60.39 | 53.38 | 5.23 |
| 7 | Veeravaram | 67 | 0.00 | 0.00 | 26.49 | 22.87 | 17.64 |
| 8 | Egavalasapalle | 43 | 0.00 | 0.00 | 15.93 | 4.98 | 22.09 |
| 9 | Kudumulu | 87 | 0.00 | 0.00 | 63.60 | 23.39 | 0.01 |
| | **G. K. Veedi Mandal (AP)** | | | | | | |
| 1 | Rallagedda | 34 | 0.00 | 0.00 | 22.06 | 11.01 | 0.93 |
| 2 | Gollapalle | 38 | 0.00 | 0.00 | 32.51 | 4.64 | 0.85 |
| 3 | Chintalawada | 11 | 0.00 | 2.54 | 7.82 | 0.56 | 0.08 |
| 4 | Kondrupalle | 6 | 0.00 | 5.98 | 0.00 | 0.00 | 0.02 |
| 5 | Nadimiveedhi | 22 | 0.00 | 4.68 | 0.00 | 0.00 | 17.32 |
| 6 | Pebbampalle | 33 | 0.00 | 1.48 | 19.04 | 12.02 | 0.46 |
| 7 | Reyyalagedda | 1 | 0.00 | 0.00 | 0.76 | 0.00 | 0.24 |
| 8 | Ammavaridharakonda | 10 | 0.00 | 0.00 | 3.76 | 4.21 | 2.03 |
| 9 | Jajipakalu | 4 | 0.00 | 1.57 | 1.40 | 0.60 | 0.43 |
| 10 | Kakulagedda | 477 | 444.04 | 0.00 | 20.00 | 10.12 | 2.82 |
| 11 | Panasapalle | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 12 | Jerrila | 168 | 0.00 | 33.75 | 42.32 | 67.11 | 24.82 |
| 13 | Gudiwada | 20 | 0.00 | 4.65 | 8.01 | 6.56 | 0.78 |
| 14 | Mondigedda | 88 | 0.00 | 0.00 | 75.43 | 4.80 | 7.77 |
| 15 | Burugupakalu | 34 | 0.00 | 7.11 | 22.85 | 1.40 | 2.64 |
| 16 | Kothawada | 109 | 0.00 | 0.68 | 63.72 | 44.22 | 0.38 |
| 17 | Vanabalingam | 26 | 0.00 | 0.00 | 21.55 | 3.56 | 0.89 |
| 18 | Nittamamidi palem | 19 | 0.00 | 0.00 | 17.29 | 0.00 | 1.71 |
| 19 | Chintalapadu | 6 | 0.00 | 0.00 | 4.99 | 0.68 | 0.33 |
| 20 | Veeravaram | 29 | 0.00 | 0.00 | 22.84 | 0.00 | 6.16 |
| 21 | Chekkalamaddi | 168 | 0.00 | 27.18 | 53.82 | 59.82 | 27.18 |
| | **Malkanjgiri Sub District (Orissa)** | | | | | | |
| 1 | Kerapalli | 26 | 20.00 | 0.00 | 4.78 | 0.88 | 0.00 |
| | Total | 1807 | 464.04 (25.68%) | 89.62 (4.96%) | 681.26 (37.70%) | 419.46 (23.21%) | 152.26 (8.43%) |

**1.3.14** Data in parenthesis represents the percentage

**1.3.15 Source : Census 2001**

**1.3.16**

## 5.2.2 Demographic Profile of the Study Area

The total study area of **10 km** radius comprises of sixty-six villages that falls under four mandals. Chintapalle mandal consists of 24 villages having 1447 households with 7319 persons; G.K. Veedhi Mandal consists of 32 villages having 1674 households with 7576 persons; G. Madugula Mandal consists of 2 Villages having 132 household with 471 persons in A.P. The Malkanjgiri mandal of Orissa has 8 villages having 340 households with 1470 persons. There is no urban population in the region. The total population of the study region according to 2001 census is 16836. The scheduled caste and scheduled tribe population in the study region is 76 and 6138 in Chintapalle Mandal, 78 and 7419 in G. K. Veedhi Mandal, 0 and 453 in G. Madugula Mandal and 83 and 1353 in Malkanjgiri sub district respectively (**Annexure – I-b**).

Among all 66 villages, the villages such as Jerrila, Konarupalli Viravaram, Burugupakulu, Reyallagedda, Rallagedda, Chintalpadu, Korukonda and Nittamamidipalem are the one that occur in close proximity within the 10 km radius.

**Within the 5 km buffer zone**, there are 9 villages that comes under Chintapalle mandal having 234 households with 1162 people especially with more of female population of 607 against 555 males. Under GK Veedhi Mandal, 21 villages comes under the buffer zone having 875 households with 4229 persons; the one village Kerappale falls under Malkanjgiri sub district area of Orissa having 6 households with 21 persons(**Table 5.4**).

**Table 5.4: Showing the demographic details of the villages that fall within 5 Km buffer zone of the study area**

| Sl No | NAME OF THE MANDAL | Total No. of HHs | Population | | | S.C | S.T |
|---|---|---|---|---|---|---|---|
| | | | Total | Male | Female | Total | Total |
| | **Chintapalle Mandal (AP)** | | | | | | |
| 1 | Egajanaba | 28 | 135 | 58 | 77 | 0 | 133 |
| 2 | Cheruvuru | 37 | 155 | 75 | 80 | 2 | 153 |
| 3 | Buradamamidi | 11 | 56 | 27 | 29 | 0 | 56 |
| 4 | Digavalasapalle | 16 | 86 | 42 | 44 | 0 | 86 |
| 5 | Turamamidi | 12 | 76 | 45 | 31 | 0 | 76 |
| 6 | Burugubailu | 43 | 208 | 94 | 114 | 0 | 206 |
| 7 | Veeravaram | 23 | 136 | 71 | 65 | 0 | 136 |
| 8 | Egavalasapalle | 15 | 70 | 29 | 41 | 0 | 70 |
| 9 | Kudumulu | 49 | 240 | 114 | 126 | 0 | 240 |
| | **Sub total** | **234** | **1162** | **555** | **607** | **2** | **1156** |
| | **Gudem Kotha Veedhi Mandal (AP)** | | | | | | |
| 1 | Rallagedda | 48 | 193 | 111 | 82 | 0 | 193 |
| 2 | Gollapalle | 43 | 235 | 131 | 104 | 0 | 235 |
| 3 | Chintalawada | 39 | 202 | 107 | 95 | 0 | 202 |
| 4 | Kondrupalle | 47 | 220 | 108 | 112 | 0 | 220 |
| 5 | Nadimiveedhi | 20 | 122 | 69 | 53 | 0 | 122 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 | Pebbampalle | 27 | 133 | 62 | 71 | 0 | 133 |
| 7 | Reyyalagedda | 6 | 27 | 14 | 13 | 0 | 27 |
| 8 | Ammavaridharakonda | 28 | 130 | 65 | 65 | 0 | 130 |
| 9 | Jajipakalu | 16 | 71 | 38 | 33 | 0 | 71 |
| 10 | Kakulagedda | 3 | 14 | 6 | 8 | 0 | 14 |
| 11 | Chekkalamaddi | 37 | 165 | 69 | 96 | 46 | 119 |
| 12 | Panasapalle | 16 | 75 | 37 | 38 | 0 | 75 |
| 13 | Jerrila | 158 | 820 | 494 | 326 | 31 | 771 |
| 14 | Gudiwada | 23 | 110 | 56 | 54 | 0 | 110 |
| 15 | Mondigedda | 117 | 509 | 262 | 247 | 0 | 506 |
| 16 | Burugupakalu | 52 | 297 | 126 | 171 | 0 | 295 |
| 17 | Kothawada | 38 | 201 | 100 | 101 | 0 | 201 |
| 18 | Vanabalingam | 39 | 192 | 94 | 98 | 0 | 192 |
| 19 | Nittamamidi Palem | 50 | 220 | 115 | 105 | 0 | 220 |
| 20 | Chintalapadu | 18 | 72 | 35 | 37 | 0 | 72 |
| 21 | Veeravaram | 50 | 221 | 105 | 116 | 0 | 220 |
| | **Sub-total** | **875** | **4229** | **2204** | **2025** | **77** | **4128** |
| | **Malkanjgiri (Orissa)** | | | | | | |
| 1 | Kerapalli | 6 | 21 | 7 | 14 | 0 | 21 |
| | **Sub - Total** | **6** | **21** | **7** | **14** | **0** | **21** |
| | **Total** | **1115** | **5412** | **2766** | **2646** | **79** | **5305** |

**1.3.17**

### 5.2.3 Literacy

The literacy level in the 10 km radius of the study area is comparatively low (22.94 %). Out of the literates, male literacy is higher (30 %) than the female literacy (15.49 %). Two villages of Chintapalle Mandal and 5 villages of G. K. Veedhi Mandal have no literacy at all **(Annexure I-b)**.

**5 Km Buffer Zone:**

The overall literacy is very poor. The illiteracy level is 83.85 % in buffer zone. Female literacy is poor with only 8 % (**Table 5.5**).

**Table 5.5: Showing the level of literacy in all the villages within 5 kms buffer zone of the study area**

| Sl. No | VILLAGE (Mandal) | Literates | | | Illiterates | | | Illiteracy (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | Male | Female | Total | Male | Female | Total | Male | Female |
| | **Chintapalle (AP)** | | | | | | | | | |
| 1 | Egajanaba | 8 | 8 | 0 | 127 | 50 | 77 | 94.07 | 86.21 | 100.00 |
| 2 | Cheruvuru | 18 | 11 | 7 | 137 | 64 | 73 | 88.39 | 85.33 | 91.25 |
| 3 | Buradamamidi | 4 | 4 | 0 | 52 | 23 | 29 | 92.86 | 85.19 | 100.00 |
| 4 | Digavalasapalle | 0 | 0 | 0 | 86 | 42 | 44 | 100.00 | 100.00 | 100.00 |
| 5 | Turamamidi | 2 | 2 | 0 | 74 | 43 | 31 | 97.37 | 95.56 | 100.00 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | Burugubailu | 22 | 19 | 3 | 186 | 75 | 111 | 89.42 | 79.79 | 97.37 |
| 7 | Veeravaram | 11 | 11 | 0 | 125 | 60 | 65 | 91.91 | 84.51 | 100.00 |
| 8 | Egavalasapalle | 1 | 1 | 0 | 69 | 28 | 41 | 98.57 | 96.55 | 100.00 |
| 9 | Kudumulu | 22 | 18 | 4 | 218 | 96 | 122 | 90.83 | 84.21 | 96.83 |
| | Sub total | 88 | 74 | 14 | 1074 | 481 | 593 | 92.43 | 86.67 | 97.69 |
| | **G. K. Veedhi (AP)** | | | | | | | | | |
| 1 | Rallagedda | 18 | 8 | 10 | 175 | 103 | 72 | 90.67 | 92.79 | 87.80 |
| 2 | Gollapalle | 27 | 24 | 3 | 208 | 107 | 101 | 88.51 | 81.68 | 97.12 |
| 3 | Chintalawada | 1 | 1 | 0 | 201 | 106 | 95 | 99.50 | 99.07 | 100.00 |
| 4 | Kondrupalle | 3 | 1 | 2 | 217 | 107 | 110 | 98.64 | 99.07 | 98.21 |
| 5 | Nadimiveedhi | 11 | 8 | 3 | 111 | 61 | 50 | 90.98 | 88.41 | 94.34 |
| 6 | Pebbampalle | 0 | 0 | 0 | 133 | 62 | 71 | 100.00 | 100.00 | 100.00 |
| 7 | Reyyalagedda | 0 | 0 | 0 | 27 | 14 | 13 | 100.00 | 100.00 | 100.00 |
| 8 | Ammavaridharakonda | 9 | 7 | 2 | 121 | 58 | 63 | 93.08 | 89.23 | 96.92 |
| 9 | Jajipakalu | 0 | 0 | 0 | 71 | 38 | 33 | 100.00 | 100.00 | 100.00 |
| 10 | Kakulagedda | 1 | 1 | 0 | 13 | 5 | 8 | 92.86 | 83.33 | 100.00 |
| 11 | Chekkalamaddi | 50 | 27 | 23 | 115 | 42 | 73 | 69.70 | 60.87 | 76.04 |
| 12 | Panasapalle | 14 | 9 | 5 | 61 | 28 | 33 | 81.33 | 75.68 | 86.84 |
| 13 | Jerrila | 311 | 283 | 28 | 509 | 211 | 298 | 62.07 | 42.71 | 91.41 |
| 14 | Gudiwada | 18 | 9 | 9 | 92 | 47 | 45 | 83.64 | 83.93 | 83.33 |
| 15 | Mondigedda | 140 | 100 | 40 | 369 | 162 | 207 | 72.50 | 61.83 | 83.81 |
| 16 | Burugupakalu | 29 | 21 | 8 | 268 | 105 | 163 | 90.24 | 83.33 | 95.32 |
| 17 | Kothawada | 3 | 2 | 1 | 198 | 98 | 100 | 98.51 | 98.00 | 99.01 |
| 18 | Vanabalingam | 9 | 6 | 3 | 183 | 88 | 95 | 95.31 | 93.62 | 96.94 |
| 19 | Nittamamidi Palem | 65 | 43 | 22 | 155 | 72 | 83 | 70.45 | 62.61 | 79.05 |
| 20 | Chintalapadu | 7 | 4 | 3 | 65 | 31 | 34 | 90.28 | 88.57 | 91.89 |
| 21 | Veeravaram | 60 | 44 | 16 | 161 | 61 | 100 | 72.85 | 58.10 | 86.21 |
| | Sub-total | 776 | 598 | 178 | 3453 | 1606 | 1847 | 81.65 | 72.87 | 91.21 |
| | **Malkanjgiri (Orissa)** | | | | | | | | | |
| 1 | Kerapalli | 10 | 2 | 8 | 11 | 5 | 6 | 52.38 | 71.43 | 42.86 |
| | Sub – Total | 10 | 2 | 8 | 11 | 5 | 6 | 52.38 | 71.43 | 42.86 |
| | Total | 874 | 674 | 200 | 4538 | 2092 | 2446 | 83.85 | 75.63 | 92.44 |

### 5.2.4 Occupational Pattern and Worker Population:

Based on the occupational pattern, the population of the study area is classified into workers and non-workers. Workers include the people that are having some occupation, while school-going children, young ones and old people are grouped under the non-worker category.

Worker category is further sub-divided into main worker and marginal workers. People who work for the whole year are grouped under main workers while the other who works seasonally are grouped under marginal workers. Both main and marginal workers are further categorized into cultivators, agricultural labours and others.

Cultivators earn their livelihood through agricultural practices. The agricultural labours are the landless people who work on others land or dependent on cultivators. Others include self-employed people such as carpenters, barbers maisons.

The total population in the 10 km radius region is 16836 comprises of 9102 workers (includes main worker & marginal worker) and 7734 non-workers. Out of the workers population the main workers (cultivators, agricultural labours, household workers and others) are 7148 while the marginal workers (includes cultivators, agricultural labours, household workers and others) are 1954. Among the main & marginal workers 5309 persons and 712 persons belong to the cultivator category, followed by 1543 and 1152 persons from the agriculture laborers category. The agricultural laborers (1152) form the stronger proportion of Marginal workers. While the cultivators form main worker population. The female population forms a higher number under marginal agricultural laborers as compared to the male counterpart (782:370). Similarly, the non-worker population is comparatively higher in the female (3981) than the male (3753) **(Annexure I-c)**.

**5 km buffer zone:** The total population in the buffer zone of 5 km radius consists of 5412 individuals. Out of which the worker population comprise of 2965 (54.78 %) that includes cultivator population of 2182 of 2965 workers (73.59 %) as compared to the agricultural labour of 714 (24.08 %). Out of the total worker population (2965) the main worker population comprises of 2274 and marginal worker comprises of 691. The total non-worker population is 2447 (50.71% female & 49.29 % male (**Table 5.6**).

**Table 5.6: Showing the occupational Pattern in 5 km buffer zone of the study area**

| Sl. No | Name Of The Mandal | Total No. of HHs | Total workers | | | Total Main workers | Total Marginal Workers | Total Non-workers |
|---|---|---|---|---|---|---|---|---|
| | | | Total | Male | Female | | | |
| | **Chintapalle Mandal (AP)** | | | | | | | |
| 1 | Egajanaba | 28 | 100 | 43 | 57 | 100 | 0 | 35 |
| 2 | Cheruvuru | 37 | 107 | 54 | 53 | 107 | 0 | 48 |
| 3 | Buradamamidi | 11 | 28 | 14 | 14 | 0 | 28 | 28 |
| 4 | Digavalasapalle | 16 | 47 | 21 | 26 | 44 | 3 | 39 |
| 5 | Turamamidi | 12 | 46 | 28 | 18 | 44 | 2 | 30 |
| 6 | Burugubailu | 43 | 121 | 57 | 64 | 107 | 14 | 87 |
| 7 | Veeravaram | 23 | 83 | 40 | 43 | 66 | 17 | 53 |
| 8 | Egavalasapalle | 15 | 45 | 21 | 24 | 33 | 12 | 25 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 9 | Kudumulu | 49 | 161 | 78 | 83 | 132 | 29 | 79 |
| | **Sub-Total** | **234** | **738** | **356** | **382** | **633** | **105** | **424** |
| | **G. k. Veedhi mandal (AP)** | | | | | | | |
| 1 | Rallagedda | 48 | 121 | 66 | 55 | 112 | 9 | 72 |
| 2 | Gollapalle | 43 | 104 | 51 | 53 | 51 | 53 | 131 |
| 3 | Chintalawada | 39 | 109 | 56 | 53 | 43 | 66 | 93 |
| 4 | Kondrupalle | 47 | 127 | 63 | 64 | 46 | 81 | 93 |
| 5 | Nadimiveedhi | 20 | 53 | 29 | 24 | 29 | 24 | 69 |
| 6 | Pebbampalle | 27 | 27 | 21 | 6 | 27 | 0 | 106 |
| 7 | Reyyalagedda | 6 | 6 | 6 | 0 | 6 | 0 | 21 |
| 8 | Ammavaridharakonda | 28 | 28 | 27 | 1 | 28 | 0 | 102 |
| 9 | Jajipakalu | 16 | 16 | 13 | 3 | 16 | 0 | 55 |
| 10 | Kakulagedda | 3 | 3 | 3 | 0 | 3 | 0 | 11 |
| 11 | Chekkalamaddi | 37 | 51 | 43 | 8 | 51 | 0 | 114 |
| 12 | Panasapalle | 16 | 42 | 22 | 20 | 42 | 0 | 33 |
| 13 | Jerrila | 158 | 388 | 198 | 190 | 356 | 32 | 432 |
| 14 | Gudiwada | 23 | 84 | 44 | 40 | 43 | 41 | 26 |
| 15 | Mondigedda | 117 | 211 | 141 | 70 | 184 | 27 | 298 |
| 16 | Burugupakalu | 52 | 211 | 94 | 117 | 94 | 117 | 86 |
| 17 | Kothawada | 38 | 173 | 94 | 79 | 94 | 79 | 28 |
| 18 | Vanabalingam | 39 | 133 | 73 | 60 | 101 | 32 | 59 |
| 19 | Nittamamidi Palem | 50 | 126 | 62 | 64 | 113 | 13 | 94 |
| 20 | Chintalapadu | 18 | 50 | 24 | 26 | 46 | 4 | 22 |
| 21 | Veeravaram | 50 | 152 | 69 | 83 | 150 | 2 | 69 |
| | **Sub-total** | **875** | **2215** | **1199** | **1016** | **1635** | **580** | **2014** |
| | **Malkanjgiri (Orissa)** | | | | | | | |
| | Kerapalli | 6 | 12 | 5 | 7 | 6 | 6 | 9 |
| | **Sub-total** | 6 | 12 | 5 | 7 | 6 | 6 | 9 |
| | **Total** | **1115** | **2965** | **1560** | **1405** | **2274** | **691** | **2447** |

## 5.3 Amenities and Infrastructure Resource Base

### 5.3.1 Educational Institutions

Out of 66 villages in the 10 km radius, 51 villages are having primary educational facility (1 Village of G. Madugula Mandal, 22 of Chintapalle Mandal, 26 of G. K. Veedhi Mandal and 2 in Malkanjgiri Mandal) in the study area. Three villages – Balapam, Jerrila, and Lothugedda are having middle school in addition there are 22 other private schools. The schools are mainly Girijan Vidya Vikas Kendra and Tribal Ashram Schools. **(Annexure – I-d)**.

**5 km Buffer zone:** The educational facilities in 5 km buffer zone is restricted to only 20 primary school (2 in Chintalpalle mandal and 18 in G.K. Veedhi mandal) and 1 middle school in Jerrila village. In all the mandals, only 17 villages have educational infrastructure. There is no high school in the region. It is inferred that the children need to go atleast 5 kms to attend the school. There are 6 other private schools existing in the area (**Table 5.7**).

**Table 5.7: Showing the educational facilities available in 5 km buffer zone of the study area**

| Sr. No | Name of Mandal & Village | Primary School | Middle School | Senior Secondary School | College | Training School | Adult Literacy | Other Schooling |
|---|---|---|---|---|---|---|---|---|
| | **Chintapalle mandal** | | | | | | | |
| 1 | Egajanaba | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Cheruvuru | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Buradamamidi | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | Digavalasapalle | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Turamamidi | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Burugubailu | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Veeravaram | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Egavalasapalle | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Kudumulu | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **G. K. Veedi Mandal** | | | | | | | |
| 1 | Rallagedda | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Gollapalle | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Chintalawada | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | Kondrupalle | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Nadimiveedhi | 2 | 0 | 0 | 0 | 0 | 0 | 1 |
| 6 | Pebbampalle | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Reyyalagedda | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Ammavaridharakonda | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Jajipakalu | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Kakulagedda | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | Panasapalle | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | Jerrila | 2 | 1 | 0 | 0 | 0 | 0 | 1 |
| 13 | Gudiwada | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | Mondigedda | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| 15 | Burugupakalu | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | Kothawada | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | Vanabalingam | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | Nittamamidi palem | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | Chintalapadu | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | Veeravaram | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 21 | Chekkalamaddi | 2 | 0 | 0 | 0 | 0 | 0 | 1 |
| | **Malkangiri Sub-district** | | | | | | | |
| 1 | Kerapalli | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Total** | **20** | **1** | **0** | **0** | **0** | **0** | **6** |

### 5.3.2 Medical facilities

Basic medical facilities are available in only 10 villages within 10 km radius in all of 66 villages (2001 census) which is inadequate. The people depend on local traditional medical practice "Guruvudu". The people believe to resolve their health problems through practice of rituals systems. The study area has a total of 10 villages with basic medical facility that includes 7 Primary Health Centre (PHC) and 7 Primary Health Sub-centres (**Annexure I-e).**

**5 km buffer Zone:** Of the 31 villages in the buffer zone only 3 villages have access to medical facilities. There are only 3 Primary Health Centers one each at Jerrila, Gollapale and Burugubailu and one sub centre at Jerrila (**Table 5.8**).

**Table 5.8: Showing the medical facilities in 5 km buffer zone of the study area**

| Sl. NO | Mandal & Village | MEDI FAC | MCW CNTR | M_ HOME | H_ CNTR | PH_ CNTR | PHS CNT | FWC-CNTR | N_ HOME | OTH_ CNTR |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Chintapalle I** | | | | | | | | | |
| 1 | Egajanaba | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Cheruvuru | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Buradamamidi | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | Digav'palle | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Turamamidi | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Burugubailu | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 7 | Veeravaram | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Egav'palle | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Kudumulu | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **G. K. Veedi** | | | | | | | | | |
| 1 | Rallagedda | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Gollapalle | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 3 | Chintalawada | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | Kondrupalle | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Nadimiveedhi | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Pebbampalle | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Reyyalagedda | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Ammavari | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Jajipakalu | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Kakulagedda | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | Panasapalle | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | Jerrila | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 13 | Gudiwada | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | Mondigedda | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | Burugupakalu | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | Kothawada | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | Vanabalingam | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | Nittamamidi | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | Chintalapadu | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | Veeravaram | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | Chekkalamaddi | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Malkanjgiri** | | | | | | | | | |
| 1 | Kerapalli | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | 3 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 |

*MEDI FAC – Basic Medical Facility, M_HOME- Maternity home, H_CNTR- Health Centre, PH_CNTR- Primary Health Centre, PHS CNT- Primary Health Sub-centre, N_HOME- Nursing Home, OTH_CNTR- Other Centers (1 – Available ; 0 – not available

### 5.3.3 Water Facilities

Drinking water facilities are mainly in the form of natural springs in 58 villages. There are only 15 handpumps and 4 dug wells in the region. (**Annexure I-**f)

**5 km Buffer area:** All the villages have access to water. 30 villages have access to springs, 2 villages have handpumps and 1 village to the river. The access to water for irrigation purpose is very low. There are no taps or dug wells within 5 km distance (**Table 5.9**).

**Table 5.9: Showing the Water facilities in 5 km buffer zone of the study area**

| S. No. | VILL_NAME | DRNK _WAT_F | TAP | WELL | TANK | TUBE WELL | HAND PUMP | RIVER | CANAL | LAKE | SPRING | OTHER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Chintapalle mandal** | | | | | | | | | | | |
| 1 | Egajanaba | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 2 | Cheruvuru | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | Buradamamidi | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 4 | Digavalasapalle | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 5 | Turamamidi | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 6 | Burugubailu | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 7 | Veeravaram | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 8 | Egavalasapalle | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 9 | Kudumulu | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | **G. K. Veedi Mandal** | | | | | | | | | | | |
| 1 | Rallagedda | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 2 | Gollapalle | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | Chintalawada | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 4 | Kondrupalle | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 5 | Nadimiveedhi | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 6 | Pebbampalle | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 7 | Reyyalagedda | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 8 | Ammavari | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 9 | Jajipakalu | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 10 | Kakulagedda | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 11 | Panasapalle | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 12 | Jerrila | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 13 | Gudiwada | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 14 | Mondigedda | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 15 | Burugupakalu | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 16 | Kothawada | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 17 | Vanabalingam | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 18 | Nittamamidi palem | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 19 | Chintalapadu | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 20 | Veeravaram | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 21 | Chekkalamaddi | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| | **Malkanjgiri Mandal** | | | | | | | | | | | |
| 1 | Kerapalli | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| | | 31 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 30 | 0 |

*DRNK_WAT_F :- Drinking Water Facility,
1 – Available ; 0 – not available

### 5.3.4 Communication Facilities

The communication facilities are very poor in the entire region. There are only 6 post offices in this region at Killamkota, Korukonda, Annavaram, Lothugedda, Jerrila, and Gudiwada (**Annexure II-**g).

**5 km buffer area:** Only two villages Jerrila and Gudiwada have post office, one in each.

### 5.3.5 Transport Facility

The facility is available in the form of bus service, accessible to only 4 villages mainly Jerila, Veeravaram, Lothugedda and Annavaram, while other villages do not have any connectivity with public transport (**Annexure II-g**) within the 10 km radius.

**5 Km buffer area:** Only two villages Jerrila and Viravram have access to public transport. The region lacks infrastructure and basic amenities for public movement. The accessibility to the villages is mainly through forest roads. People walk long distances. (**Table 5.10)**

### 5.3.6 Banking Facilities

There are no banks in the region within the 10 km zone of the mining area (**Annexure I-g**)**.**

### 5.3.7 Recreational Facilities

No recreational facilities exist in the region.

**Table 5.10: Showing the communication, transportation and Commercial Facilities in 5 km Buffer zone of the study area**

| S. No. | VILL_NAME | POST_ OFF | TELE_ OFF | POST_ TELE | PHONE | BS_ FAC | BANK_ FAC | COMM_ BANK |
|---|---|---|---|---|---|---|---|---|
| | **Chintapalle mandal** | | | | | | | |
| 1 | Egajanaba | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Cheruvuru | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Buradamamidi | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | Digavalasapalle | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Turamamidi | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Burugubailu | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Veeravaram | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Egavalasapalle | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Kudumulu | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **G. K. Veedi Mandal** | | | | | | | |
| 1 | Rallagedda | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Gollapalle | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Chintalawada | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | Kondrupalle | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Nadimiveedhi | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Pebbampalle | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Reyyalagedda | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Ammavaridharakonda | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Jajipakalu | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Kakulagedda | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | Panasapalle | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | Jerrila | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 13 | Gudiwada | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | Mondigedda | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | Burugupakalu | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | Kothawada | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | Vanabalingam | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | Nittamamidi palem | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | Chintalapadu | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | Veeravaram | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 21 | Chekkalamaddi | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Malkanjgiri Sub-district** | | | | | | | |
| 1 | Kerapalli | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 2 | 0 | 0 | 0 | 2 | 0 | 0 |

*BS_FAC:- Bus Facility,

## 5.4 Economic Activities

### 5.4.1 Agriculture and Horticulture

The main occupation in the region is agriculture with 97 % of the workers being engaged in it. The production is low and cultivation by tractors is not possible due to undulating topography. The main fruits grown are Jack Fruit and Mangoes. Coffee plantations are promoted by the coffee board and seeds are purchased by them. The main crops grown are vegetables such as brinjal, cauliflower, cabbage, red gram, ginger, pineapple, turmeric, lady finger and tomatoes, and cereals like maize, rice, millets, samai, red, green, black and horse and cow grams besides chilies.

### 5.4.2 Industry

Cottage industries like coffee seed processing, broom, adda leaf plates and cups making, Honey making are common in these villages along with rice and rajma cultivation. Large and medium industries are not found in the study area.

### 5.4.3 Animal Husbandry

Every household keeps few cows, buffaloes, sheep and goats. Besides providing a source of supplementing the income, the livestock serves as a source of balance diet for the people in the rural area and manure for the field.

### 5.4.4 Forestry

Forest constitutes a major portion of the land. Various kinds of medicinal herbs are found here. Major forest produce include timber, fire wood and minor forest produce like bamboo and beedi leaves are observed everywhere.

### 5.4.5 Cultural and Aesthetic Environment

The recreation activities include cultural dances, songs and food. The main recreation of the people is watching films. There are radios and televisions in some houses.

## 5.5 Ongoing Development Schemes in the region

The Integrated Tribal Development Agency (ITDA) is the other government department implementing various government programs for the welfare of the community. The following programmes are being implemented by ITDA which is the single window in the region.

- Special Schemes for Primitive tribal groups

- Educational Programs (Asram schools, GVVK, ALS, Bridge schools, Residential schools and Gurukulams etc.,)
- Health Programs - Arogyasri, Medical programs through PHCs, PHSCs, anganwadi and mid-day meals for nutrition improvement
- Agriculture – NPM, Agriculture demonstration, Organic farming
- Pavala Vaddi Scheme – grant and external linkages
- Horticulture plantation program, nursery and plantations
- Minor and major irrigation structures
- Transportations
- Pradhan Mantri Gram sadak Yojana for village roads
- NREGS – 100 days employment
- Vocational training (VTIs, ITIs, Polytechnics)
- Indiramma Housing programs
- Boys and girls hostels
- Grain banks (for food security)
- Prime Minister Rojgar Yojana (PMRY) under industries department, Rajiv Yuvasakti, UPADHI, skill upgradation programmes under Tribal Corporation
- Animal Husbandry through ITDA
- Sericulture and coffee plantation

Apart from these various agencies implementing the activities, non-government organizations are also involved in Health, drinking water, education and livelihood initiatives for socio-economic development of the tribal communities.

## 5.6 Participatory Rural Appraisal (PRA) and Community interaction

The community interaction was carried out in Annavaram, Nimmapadu, Lothugedda, Jerrila, and Balapam villages by the team constituting representatives from ICFRE. The basic aim of the community interaction was to understand the existing livelihood conditions and exploring the opportunities for livelihood development for social management plan. Secondly, understand their knowledge and willingness about the proposed Jerrila bauxite mining.

The community interactions revealed the following observations;

- During survey, it has been found that there is one primary school in each of village in the vicinity of the Bauxite Mines viz. Jerrila, Rallagedda, reyallagedda, Kondrapalli, Middle school education facilities are available at Jerrila. Other schools are at Jerrila, Rallagedda, Mondigedda and Veeravaram, However, higher education facilities are available only at Chintapalle which is 9 km from the study area. They have ITDA school and manage few alternative schools
- There is no medical facility in the villages. The people visit Primary Health Centre and Primary Health Sub-centres at Jerrila, for minor aliments. Pileria and malaria are common community in the region. Also, incidence of fever, skin diseases and acute respiratory infection are also reported to be common among the public. For major aliments, people visit Chintapalle Hospitals. Drinking water is a major problem and diseases like diarrhea, malaria are very common. The women face severe gynacological problems due to lack of proper maternity care and are mainly dependent on traditional medicine

- The roadways transportation is very poor and there are hardly any bus facility except for Jerrila and Veeravaram. The phone facility is improving since the last couple of years. There are post offices at Jerrila, Gudiwada, Kilimkota, Chintapalle.

- The source of water supply is through springs and hand-pumps are limited. Few wells are available in the region. The water quality is not satisfactory to meet the requirement; water is highly turbid and has high solid content. Power supply is available but the connections are very few next point.

- They have developed own village level development plan, identified their problems and prioritized them. They work collectively to solve their problems. The major issues of their concernare infrastructure, accessibility, health and water quality

- There are small tea stalls in Jerrila and nearby areas. The markets are organized as ‘shandies’ once in a week at wednesday. Market place are the meeting place for people and other social meetings. People also visit Chintapalle, Viravaram for major purchase.

- There are around 120 families in these 5 villages which mainly consist of cultivators, agricultural laborers, NTFP collectors and shifting cultivators.

- The average land holding is 1-4 acres. Their agricultural crops include paddy, coffee, rajma, millets, pulses etc.

- As per the discussion, the average income of the family varies from Rs. 3000 to Rs. 8000 per annum. There is rarely any alternative employment during lean season. Few people do small petty jobs as labour in construction activities in the near by towns.

- Women play active role in maintaining the house with their own income from agriculture and NTFP collection activities. They also play active role in community development and are more enthusiastic for education and income generation activities.

- There are active SHGs who have established opportunities like bank linkages for running Kirana stores, leaf plate making, rajma processing, fruit vending katechu and fruits of medicinal importance like amla and karrakaiya.

- The recreation activities include cultural dances, songs, food and water. The people will have recreation through observing films. Few of the households have radios and television sets.

- The community is not aware about the proposed mining activity.

## 5.7 Household Survey

Villages for the household survey were selected within immediate vicinity of Jerrila Bauxite Mine Block I because these villages are likely to be indirectly and partially affected due to the proposed project as they are dependent on the natural resources for their daily substance. During the household survey, various target groups were interviewed to asses their status on economic activity, livelihood, food security, water availability, income, and their dependence on forest produce. Though in some villages, it has not been possible to interview female population due to their inhibitions and thus the findings in general are representative. Household survey has been carried out for Rellayagedda, Rallagedda, Kondrapalli, Chintalwada, Turmamidi, Jerrila. The survey targeted at collecting micro level data about individual household within the villages in the vicinity and other villages of the study area. A total of 264 households from 6 villages mentioned above were surveyed for the information on the family profile, the education level, community, economic pattern, agriculture and farm dependent activities, land under cultivation and type of crops, other economic activities, activities related to collection of non-timber forest produce (NTFP). The total population surveyed include 1073, out of which female population consists of 49.2 % and children below the age of 12 years comprise 22.46 % of the population. The surveyed villages of the mining area are dominated by the Scheduled tribes (94.97 %), the literacy in these villages is very low (8.11 %). Only 6.8 % of the population stay in thatched *kuccha* houses and remaining 93.18 % live in tiled roof with mud wall *pucca* houses (**Figure 5.3**). In terms of family income 60.98 % have annual income less than Rs. 10000/-; 27.27 % have income between Rs.10000-20000 and 11.75 % have income above Rs. 20,000(**Figure 5.4**). The landholding size is relatively low. 53.78 % of population has land size less than ½ acre; and 30.68 % have more than ½ acre land. Only minimal number of the households have more than 1 acre of land holding size. 15.5 % of the total households are landless (**Figure 5.5**). Water availability for both drinking purpose and irrigation is through springs. Almost 83.74 % of the families use spring / natural stream water for irrigation and has no well. Water Tank and Bore wells water is used by 11.33 % and 4.93 % of the population (**Figure 5.6**). In all the villages, more than 95 % of the population depends on agriculture. Major crop is paddy, millets, rajma, red grams, and tubers and also dependent on NTFP. The land holdings are mostly marginal and irrigated through spring waters. The individual household data is enclosed in **Annexure II**.

**Figure 5.3: Type of house occupied by households**

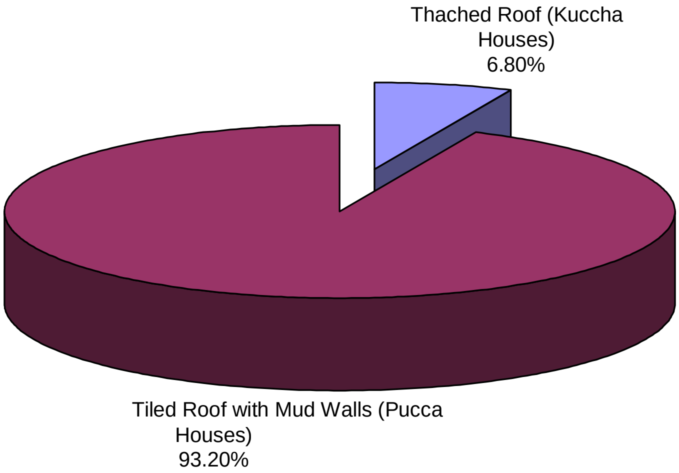


**Figure 5.4: Annual Income in households**

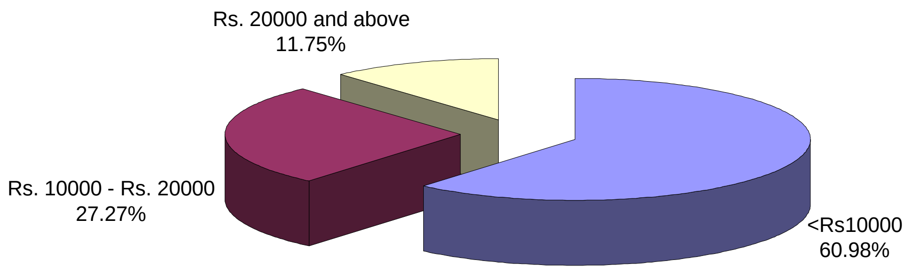



**Figure 5.5: Land holding in the households**

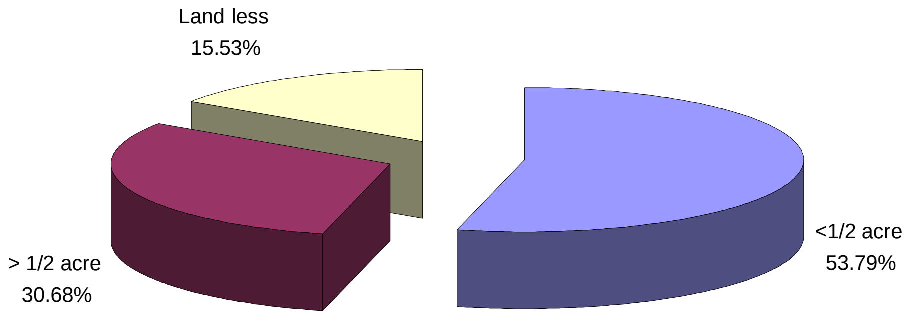
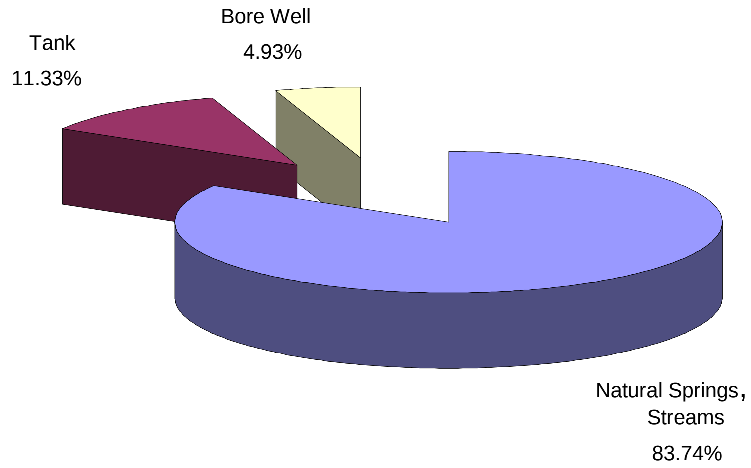


**Figure 5.6: Irrigation pattern in the villages**




### 5.7.1 Traditional Occupation

Almost 80 % of surveyed families have some traditional occupation other than agriculture. Out of all of the 264 families surveyed, 59.68 % collect fuel wood, 25.78 % carry weaving, 0.37 % depend on carpentry, 80 % carry out coffee plantation and 1.89 % are masons. Other traditional occupations like honey extraction, herbal medicine advisor, broom making, pan leaf collection, astrology and hair cutting were also observed. The daily income from sale of brooms would be around Rs. 20-40, depending on the collections and income from coffee would be around Rs. 40.

The people of the region have developed many skills related to preparation of coffee processing as cottage activity honey collection and in some cases certain trades like carpentry & wood works, masonry or construction works. The vocational levels on formal basis is very low, however traditional skills like weaving, mat making, gum karea collection, processing of oils etc. is observed in the inhabitants.

### 5.7.2 Non Timber Forest Produce Collection

NTFP collection is an important part of the tribals in the study area. A considerable portion of their resources and income are directly from forest. The NTFP extracted from the forest by the tribes include coffee seeds, firewood, honey, fruits, herbal plants, *adda* leaves and tuber collection.

As per the household survey, 264 households in 7 villages, it was observed that 100 % of the households are collecting *amla* and *adda* leaf from the forest. Out of which, 59.84 % collect firewood, 84.8% collect honey, 46 % herbal plants viz. *shekakai* and *karakkai*, 80 % coffee and 25 % collect tamarind.

On an average every family collects two headloads of wood every day and each load earn them Rs. 20-40 per day. The other activities include collection of honey, herbals, viz. *shekekai, karakaih, amla*, fruits like jackfruits, custard apple, mango etc. and betal leaves, roots, and grass for broom making etc. the people also sell about eight to twelve jackfruits during the season which earn an income of about Rs. 3-4 per jackfruit. Few people are involved in basket making and handicrafts, sieves, etc.

## 5.8 Observations

- Literacy level amongst the respondents is very poor as only 16.15 % of the respondents are illiterates.
- The main caste is the bhagta, valmiki, goud, and konda dora.
- The respondents are concerned for medical facilities
- Spring water is the main source of drinking water and potability also appears not to be satisfactory.
- The education levels in Reyallagedda, Rallagedda, Chintalwada is very low and even negligible. Majority of the people are concerned for education of their children.

- Sanitation facilities in the villages seems to be very poor/non-existent.
- The diseases malaria and pilaria are very common. People are concerned about the health facilities.
- The road & communication facilities are very poor in the region.
- No regular sources of employment but expect employment possibilities from the mining activity.
- Development of proper market facility is much needed in the area to the people for sale of their products.

# CHAPTER 6

# IMPACT IDENTIFICATION, PREDICTION AND ASSESSMENT

## 6.1 Introduction

The environmental impact assessment study includes identification, prediction and evaluation of potential impacts of the proposed mining activities on the environment in the 85 ha mine lease area at Jerrila Block I within the study area.

In the existing scenario, for the proposed mines of APMDC, the air environment, land environment, acoustic environment, biological environment are identified as the significant environmental components likely to be impacted. Our impact assessment also includes observations on impacts on water environment and socio-economic factors. For the evaluation purpose and to understand the existing environmental scenario in the study area, the baseline setting for the above mentioned environmental components are documented in the previous chapter. In the present chapter the description of the potential impacts during the operation of mining activities, on the said environmental components are identified, predicted and qualitatively evaluated.

The Impact Identification Matrix (IIM) has been prepared to identify impacts due to the proposed mining activities on various environmental attributes. The matrix shows various environmental and social issues in the row while different activities involved in the project are listed in column. The resultant impacts of the various activities against the different environmental issues are assessed. The impact identification matrix is presented in **Table. 6.1.** Various impacts and the mitigation measures to minimise the same are discussed in the following sections.

## Section 1.05 Table 6.1: Impact Identification Matrix

| Environmental Issues | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Project activities** | **Land use** | **Terrain** | **Water** | **Drainage** | **Soil** | **Ambient Air Quality** | **Ambient noise levels** | **Vibration** | **Ecology** | **Natural habitats** | **Cultural property** | **Sensitive receptors** | **Traffic and transport** | **Health** | **Socio-economic** | **Aesthetics** | **Infrastructure** |
| 1 | Mobilisation | T/M/-ve | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2 | Clearing | T/S/-ve | - | - | T/M/-ve | T/M/-ve | T/S/-ve | T/S/-ve | T/M/-ve | T/M/-ve | - | - | T/M/-ve | T/S/-ve | T/I/-ve | P/S/+ve | T/M/-ve | - |
| 3 | Equipment mobilization | T/M/-ve | - | - | - | T/M/-ve | T/M/-ve | T/M/-ve | - | - | - | - | - | T/M/-ve | - | - | T/M/-ve | - |
| 4 | Setting up of labour camps | T/M/-ve | - | - | - | T/M/-ve | T/M/-ve | T/M/-ve | - | T/M/-ve | - | - | - | T/M/-ve | T/S/-ve | - | T/M/-ve | T/M/-ve |
| 5 | Material transport | T/I/-ve | - | T/M/-ve | T/M/-ve | P/M/-ve | T/S/-ve | T/S/-ve | - | - | - | - | - | T/M/-ve | - | | T/M/-ve | - |
| 7 | Dumping of overburden | P/S/-ve | T/S/-ve | P/S/-ve | P/S/-ve | T/S/+ve | T/S/-ve | T/M/-ve | P/S/-ve | T/S/-ve | - | - | - | T/M/-ve | P/S/-ve | - | P/S/+ve | - |
| 8 | Earth work operation | P/S/-ve | T/M/-ve | T/M/-ve | P/S/+ve | T/M/-ve | T/S/-ve | T/S/-ve | - | - | P/S/-ve | - | T/S/-ve | T/M/-ve | - | - | T/M/-ve | - |
| 9 | Traffic signals | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | P/S/+ve | - |
| 11 | Conveyance | - | - | - | - | - | T/S/-ve | P/S/-ve | - | - | - | T/M/-ve | - | P/M/-ve | P/M/-ve | P/S/+ve | - | - |
| 12 | Local area development / project enhancement | P/S/+ve | - | P/S/+ve | P/S/+ve | - | - | - | - | - | P/S/+ve | P/S/+ve | - | P/S/+ve | - | - | P/S/+ve | - |

Note: **P-**Permanent Duration, **S** – Short Term, **T**-Temporary, **I** -Insignificant, **M**- Minor Significance, **+ve**-Positive Impact, **-ve** – Negative Impact.

## 6.2 Water Environment

### 6.2.1 Water Quality

As discussed in water environment I the study area, there is a good drainage network and tributaries/rivulets flow in the area. The baseline water quality levels tested for physico-chemical and bacteriological parameters indicate that the surface water in some locations is not suitable for potable purposes. These water bodies are used for domestic and irrigation purpose. Few sources of water are used for domestic consumption such as washing except for drinking. The ground water is used for drinking purposes, and is mainly through bore wells and hand pumps which is very rare. Most of the habitations use the spring water. The major problem associated with surface water in the region is that of high turbidity levels, high color, and fecal contamination, observed at most of water sampling locations. The turbidity levels of ground water samples show high levels. The groundwater does not have fecal contamination. The TDS levels are higher in most of the villages in both surface and ground waters. All other chemical parameters and heavy metals analysed are within the prescribed limits.

The quality and quantity of surface water and groundwater resources within and around the mining areas can adversely get affected by the surface run-off downhill carrying the fine silt from overburden material at dump site as also loose soil areas. Physical, chemical and biological changes can occur in water bodies due to interactions of these fine particles with water column and sediments.

### 6.2.2 Environmental Impacts in General

**Surface water:**

Physical quality of surface water bodies may get affected by soil erosion and sedimentation, a specific environmental impact due to overburden material /spoil (fines) dumps/red soil, whereas chemical quality may get affected in a long run. The pollution of water may result from oxidation of such materials thereby increasing the acidity of the water or from dissolution of soluble salts in the spoil, and overburden, thus increasing the levels of dissolved solids in the water. Run-off from graded or ungraded spoil surface may be chemically altered if the surface spoil materials are high in soluble materials or trace elements. This can be a problem where undesirable overburden materials are disposed off close to and above the mined areas.

**Ground Water:**

In the case of groundwater, factors viz. surface hydrology, soil texture and terrestrial vegetation, determine the nature and extent of impact on the groundwater regime. Qualitatively and quantitatively, it may get affected by alteration in flow rate, or even may be benefited by groundwater recharge. Depending on the quality of leachates generated from the overburden material whether acidic in nature or rich in mineral content, the chemical quality may get affected, warranting adoption of appropriate control measures. However, in the present situation, the overburden being disposed off in the same area, the leachate even after its occurrence would be of the same characteristics as being occurring since ages.

In general when mining explorations are conducted below the water table, groundwater is intercepted by the open cut, pumped out or lost by evaporation, and the water table tends to lowered in the mining and adjacent areas. This results in loss of head or dewatering of wells within a radius of few kilometers of the mine. Similarly, after mining and reclamation processes have been completed, groundwater quantity can still be affected although not necessary adversely, if the mine is located in a groundwater recharge area, since the recharge characteristics may get affected by the backfill material which may differ from the original characteristics of top soil and overburden of leased area.

In the present conditions the ground water is not being intercepted as the open cast mining is far above the ground water zone, even the laterite zone is far below the ore body due to its mineralogy.

Also, the same material being deposited for back filing, the groundwater recharge potential would not be negatively affected. In addition, due to the loosening of top material, after mining / during mining the recharge of ground water would increase.

### 6.2.3 Water Consumption and Effluent Sources and Quantities

During the operation of the mines, water is required for dust suppression and domestic consumption. The proposed facility for the supply of water would be through tankers from the nearby perennial sources and stop dams. Excessive usages could bring down the water levels of the stop dams. Moreover this could also effect the capacity of natural drainage. Daily the water supply requirements would be of the order of 135000 to142000 litres, which also includes the domestic consumption which is about 2000 litres /day for the mine worker population during the working hours. There is no public water supply line available to the site, and hence the quality of the water for mining activities and domestic are the same. Water coming in the tankers would be stored in the water storage tanks for the domestic purpose as well as.

The projected water consumption for each domestic and dust suppression requirements is shown in the **Table 6.2**.

**Table 6.2: The Water Requirement (cu.m/day)**

| Sl. No. | Purpose | Average required |
|---|---|---|
| 1 | Road making | 134 |
| 2 | Dust suppression | 5 |
| 3 | Drinking | 2 |
| 4 | Others (please specify) | |
| Total | | 142 |

Due to water use for the operations at the mining site, the natural streams in the watershed are likely to be affected. The effect depends on the quantum of water collected and the capacity of catchment area. The water available from the perennial streams. Due to operations of the mines water collected for use in the mining operations, is insignificant compared to capacity of catchment area. Hence additional water collection by stop dams, similarly will not impact significantly, the seasonal flow characteristics of the streams in the surrounding region.

### 6.2.4 Impacts on water environment in the region

The mines in Jerrila are of open cast type and there is no discharge of wastewater from the mining activities. The mining activities do not involve washings of ore. The mining operations involve dry crushing, sizing, sieving, storage or concurrent activity of transport and dumping of overburdens, rejects etc. Here no wet process would be involved. However during monsoon, the fine material from dump site gets carried away along the land gradient through surface run–off and may find entry into the streams carrying water downhill. As large areas are graded, erosion and transport of sediment to external drainage systems become a potential problem.

The magnitude of the problem is governed by the length and stability of slopes or graded areas, the frequency and intensity of rainfall, the erodability of spoil surface materials and the types and density of vegetative cover on reclaimed area. Diversion of surface water around the active pit and interception of surface water and groundwater by the pit are further potential sources of sedimentation. The same, if arrested in gully checks, check dams; possibility of this undesired material reaching to the surface waterbodies would be insignificant. The check dams would be effective.

As there are several water bodies /minor drains flowing through the region, mainly the rivulets, there could be impacts as described above. Similarly, the impacts could also be on the streams below which traverse on the sides of lease area.

Groundwater pollution can arise only when the top soil and overburden material contains chemical constituents. These chemical constituents can get leached away by the precipitation and can percolate into the groundwater, thus polluting the nearby groundwater sources and rendering them unfit for drinking purposes.

In the study area the overburden or dumps may contain heavy metals. The leachability of the metals totally depends on the metal species, viz. physical and/or chemical form, soil texture and environmental conditions prevailing that would facilitate either percolation into groundwater or uptake of metals by crop and vegetation. However, leachable fraction in the overburden is quite insignificant, and water table is too low. Hence, the chance of groundwater getting affected is remote.

The domestic water use will be very minimal as the mining lease area will not have any residential activities.

Overall, there will not be any adverse impact on water quality due to mining activities in the region. The major impact on water would be increase in turbidity.

During operation of mine, the quantity of domestic liquid waste generated would be the same as there won’t be any additional workforce or floating population, as the villagers would only work in the mines.

## 6.3 Air Environment

### 6.3.1 Sources and quantities of Particulate emissions:

The impact on air quality from mining project is due to activities during operation phase. In the proposed mining activities at Jerilla Block I, particulate matter will be the major air pollutant. The particulate matter generated would comprise of fugitive dust emissions in a mining environment. The fugitive dust emissions thus generated have their sources from various activities. **Table 6.3** accounts fugitive emissions from various sources.

**Table 6.3: Fugitive Dust Emissions from mining operations**

| No | Sources | Quantity |
|---|---|---|
| 1 | Scraping of top soil | |
| 2 | Ripping and Bulldozing (Pushing Operations) | 240.80 t /year |
| 3 | Drilling and Blasting | 1278.17 t/year |
| 4 | Bulk Material handling | 1977t/year |
| 5 | Erosion of Stock Piles | 271 t/year |

## Fugitive Emission Estimation

Fugitive particulates are emitted by a wide variety of sources in both the industrial and the non-industrial sectors.

Open dust sources entail the entrainment of solid particles into the atmosphere by the forces of wind or machinery acting on exposed materials. These sources include mining sources associated with the open transport, storage, and transfer of excavated/mined material, and wastes, and non-activity sources such as unpaved and paved roads and vehicular movement.

Unlike ducted sources of particulate emissions, which typically can be characterized as continuously emitting, fugitive emission rates have a high degree of temporal variability. In addition, fugitive emissions are characteristically diffuse in nature and are discharged from a wide variety of source configurations.

The mechanization would include using ripper-dozers, hydraulic excavators, heavy duty tippers/dumpers, tractors mounted bulldozers, road grader, water tanker etc.

Mining activities are temporary but important open dust sources. These activities involve a number of separate dust-generating operations that must be quantified to determine the total emissions from the site and thus their impact on ambient air quality. In turn, the specific type of activities that are conducted on-site will depend on the nature of the mining project taking place.

Operations commonly found in these types of mining projects consist of land clearing, drilling and blasting, excavation, cut-and-fill operation (i.e. earth moving), material storage and handling and truck traffic associated with mining activities involve mud/dirt carryout onto road surfaces.

Thus the following types of emission have been considered for mining operations in Jerrila Block I deposit:

[a] Top Soil Removal

[b] Ripping and Bulldozing

[c] Drilling and Blasting

[d] Bulk Material handling

[e] Storage Piles

The emission inventory for above emission sources is carried out referring to:

- Compilation of Air Pollutant Emission Factors, USEPA, 1998 (AP-42)
- Emission Estimation Technique Manual - National Emission Inventory Program - Australia

**[a] Top Soil Removal**

The top soil removal is in general done by using scrapers would be through pan scrapers. The emission factor is derived using the following equation

$$EF = 7.6 * 10^{-6} * S^{1.3} * W^{2.4} \text{ kg/VKT}$$

Where

S = Silt percentage

W = weight of vehicle

VKT = Vehicle Kilometers Travelled

Considering Silt (S) as 44 % and Weight of Scraper (W) as 40 tonnes the EF in Kg/vkt traveled is

EF = 6.4 kg/ VKT

Number of Kilometers traveled by Scraper during a day would be X kms

Thus Emissions in Kg/Day Eday= X * 6.4 kg/vkt

Or = Eday x Days * 1000 (tonnes per year)

**[b] Ripping and Bulldozing**

A ripper – dozer would be used to initially rip the rock. The loosened rock is then piled by the dozer for loading and transporting. The ripper would be used for removal of overburden, stripping thin layer of waste material and bauxite production where bench is within 5 to 6 meters.

Considering the production of 0.5 million tonne per annum the ripper dozer of capacity 400 tonnes per hour is considered. The emissions from the ripping and bulldozing activity is estimated as:

EF = $2.6 * S^{1.2} * M^{-1.4}$ kg/ hr.

Where

S = Silt content in percentage

M = Moisture content

Thus the emission factor is computed considering

S as 44 % and M as 1.98 %

Thus the EF is derived as 100 kg/hr

The total working hours considered per annum is 2400 hrs

Thus the emissions work out to be 240.80 **tonnes / year**

### [c] Drilling and Blasting

The drilling and blasting shall though be minimal would contribute to the fugitive dust. The boulders that are exposed during the ripping operations shall be broken by resorting to shot hole drilling upto a depth of 60 cm to 120 cm. in general 50 to 70 shot holes per 2000 tpd or around 120 to 150 shot holes are required per day for a 4000 t per day mining operation.

The blasting and drilling operations thus would generate the particulate matter and PM10. the Emission Factors (EF) as default parameters for drilling are

$EF_{\text{drilling for TSP}}$ = 0.59 kg.hole

$EF_{\text{drilling for PM10}}$ = 0.31 kg/hole

For Blasting the emission factor for TSP would be

$EF_{blasting\ for\ TSP} = 344 \times A^{0.8} \times M^{-1.9} \times D^{-1.8}$

$EF_{blasting\ for\ PM10} = EF_{TSP} \times 0.52$

**Emissions from drilling**

1333.4 holes would be drilled thus considering the above emission factor the total TSP emissions would be

= 0.59 * 1333.4

= 786.704 kg/year

= 0.786 t/year

The PM10 would account to

= 0.31 * 1333.4

= 413.354 kg/year

= 0.4133 t/year

**Emissions from Blasting**

The emissions are estimated considering the above equation

$EF_{blasting\ for\ TSP} = 344 \times A^{0.8} \times M^{-1.9} \times D^{-1.8}$ Kg/Blast

Where

A = area blasted in sq m

M = Moisture content in %

D = depth of blast hole in meters

Considering a 28.5 ha of mining in first phase, the effective area of blasting would be 28.5 sqm per year or 190 sqm per day assuming a 300 day per year operation

Thus the total emissions due to blasting operations with

moisture (M) = 1.98 % and Depth (D) = 1.2 m

EF per day would be = 4262.241 kg/day

= 4262 t/day

**= 1278.67 t / year for 300 days of operations**

**[d] Bulk Material handling using Excavators/ shovels/ front end loaders**

The following equation is recommended for estimating emissions from transfer operations.

$$e = k(0.0016)\ \frac{(U/2.2)^{1.3}}{(M/2)^{1.4}} \quad \text{(Kg/t)}$$

Where:

| | | |
|---|---|---|
| e | = | emission factor, in units stated |
| k | = | particle-size multiplier, (0.74 - SPM & 0.35 - RSPM), dimensionless |
| U | = | mean wind speed, m/s |
| M | = | material moisture content, % |

For estimating the emissions due to topsoil/earth handling in the mines, following input data have been used:

U = 3.3 m/sec and M = 1.98%

The particle size multiplier k varies with aerodynamic particle diameter as follows:

| <30 µm | <15 µm | <10 µm | <5 µm | <2.5 µm |
|---|---|---|---|---|
| 0.74 | 0.48 | 0.35 | 0.20 | 0.11 |

The emissions estimated using

EF = 0.001977 Kg/t of excavation

= $10^6$ * 0.001977 kgs

**= 1977 t/year**

**[e] Storage – pile wind erosion**

Inherent in operations that use aggregate, topsoil, excavated earth is the outdoor storage piles. Storage piles are usually left uncovered, partly because of the need for frequent material transfer into or out of storage.

Dust emissions occur at several points in the storage cycle: during material loading onto the pile, during disturbances by strong wind currents, and during load-out from the pile. The movement of trucks and load equipment in the storage pile area is also a substantial source of dust

Dust emissions may be generated by wind erosion of open aggregate storage piles and exposed areas within an industrial facility. These sources typically are characterized by non-homogeneous surfaces impregnated with non-erodible elements (particles larger than approximately 1 cm in diameter).

For emissions for wind erosion of active storage piles, the following total suspended particulate (TSP, particles $\leq$ ~ 30 $\mu$m in aerodynamic diameter) emission factor equation is used:

$$E = 1.9 \left( \frac{s}{1.5} \right) \left( \frac{365 - p}{235} \right) \left( \frac{f}{15} \right) \quad \text{(kg/day/hectare)}$$

Where : E= total suspended particulate emission factor, in units indicated

s =silt content of aggregate, %

p =number of days with $\geq$ 0.25 mm (0.01 inch) of precipitation per year

f =percentage of time that the unobstructed wind speed exceeds 5.4 m/s at the mean pile height,

Following data have been used in the modeling exercise:

s = 44%, p = 90 days, f = 30%

The emissions work out to be **271 tonnes /year** considering a representative of 5.7 ha per year of excavation.

### 6.3.2 Prediction of Air Quality

Prediction of impacts is an important component in environmental impact assessment process. Several techniques and methodologies are in vogue for predicting the impacts due to proposed industrial development on physico-ecological and socio-economic components of environment. Such predictions are superimposed over the baseline (pre-project) status of environmental quality to derive the ultimate (post-project) scenario of environmental conditions. The quantitative prediction of impacts lead to delineate suitable environmental management plan needed for implementation during the commissioning of proposed activities and in its operational phase in order to mitigate the adverse impacts on environmental quality.

Mathematical models are the best tools to quantitatively describe the cause effect relationship between source of pollution and different components of environment. In case, mathematical models are not available or it is not possible to identify/validate model for a particular situation, predictions are arrived through available scientific knowledge and judgment.

The impacts on air quality from mining project are due to activities during operation phase. In the proposed mining activities, particulate matter will be the major air pollutants during operation of mining activities. In the present study, the mathematical model that has been used for predictions on air quality includes steady state Gaussian Plume Dispersion model designed for area sources.

The impacts of particulate matter were predicted using **BREEZE, ISCST3** air quality model with area source.

**Modeling Scenario**

The following modeling scenarios have been considered in this study:

Estimation of Ground Level Concentrations (GLCs) of SPM due to proposed operation of mines for total annual production of 0.5 MT for which following input data is used.

**Micro-Meteorology**

The hourly wind speed, solar insolation and total cloudiness during day time and wind speed and total cloudiness during night time were used to determine the hourly atmospheric stability class (Pasquill) viz., A to F. The hourly stabilities were determined based on day time solar radiation and night time cloud cover.

**Pasquill Stability Classes**

| Stability Class | Definition | Stability Class | Definition |
|---|---|---|---|
| A | Very Unstable | D | Neutral |
| B | Unstable | E | Slightly Stable |
| C | Slightly Unstable | F | Stable |

**Micro-Meteorological Conditions that define the Pasquill Stability Classes**

| **Surface windspeed** | | **Daytime incoming solar radiation** | | | **Nighttime cloud cover** | |
|---|---|---|---|---|---|---|
| m/s | mi/h | Strong | Moderate | Slight | > 50% | < 50% |
| < 2 | < 5 | A | A – B | B | E | F |
| 2 – 3 | 5 – 7 | A – B | B | C | E | F |
| 3 – 5 | 7 – 11 | B | B – C | C | D | E |
| 5 – 6 | 11 – 13 | C | C – D | D | D | D |
| > 6 | > 13 | C | D | D | D | D |
| **Note: Class D applies to heavily overcast skies, at any windspeed day or night** | | | | | | |

The micro-meteorological data used for air quality modelling for winter season are given in **Table** below.

```
Yr m d h   wdirec.  W.speed Temp.SC MhR  MhU
 07 124 1  45.0000   1.3300 281.0 2   50.0  50.0
 07 124 2 135.0000   1.3100 281.0 2   50.0  50.0
 07 124 3  45.0000   1.1900 281.0 2   50.0  50.0
 07 124 4 315.0000   1.1100 282.0 2   50.0  50.0
 07 124 5  45.0000   0.8900 283.0 2   50.0  50.0
 07 124 6 135.0000   3.8900 283.0 3  100.0 100.0
 07 124 7 135.0000   3.3300 283.0 3  100.0 100.0
 07 124 8 135.0000   2.7800 283.0 2  537.9 537.9
 07 124 9 315.0000   1.5600 283.0 2  626.6 626.6
 07 12410  45.0000   1.7800 284.0 2  915.3 915.3
 07 12411 225.0000   1.1700 285.0 2 1004.01004.0
 07 12412 135.0000   3.6100 286.0 3 1092.61092.6
 07 12413  45.0000   1.6100 286.0 2 1281.31281.3
 07 12414 225.0000   1.1700 286.0 2 1470.01470.0
 07 12415  45.0000   0.6900 285.0 2 1570.01570.0
 07 12416  45.0000   3.3300 285.0 3 1587.01587.0
 07 12417 225.0000   0.5600 283.0 2 1670.31670.3
 07 12418 225.0000   0.8900 283.0 2 1287.41287.4
 07 12419 315.0000   1.0800 282.0 2  804.6 804.6
 07 12420 315.0000   0.9200 282.0 2  421.7 421.7
 07 12421 225.0000   3.6100 281.0 3  200.0 200.0
 07 12422 135.0000   1.1400 281.0 2  100.0 100.0
 07 12423 135.0000   1.1900 280.0 2  100.0 100.0
 07 12424 135.0000   1.0000 280.0 2   50.0  50.0
```

(SC- Stability Class, MhR – Mixing Height Rural, MhU – Mixing Height Urban)

**Air Quality Modeling and Predictions using FDM :** The impact on air quality due to emissions from single source or group of sources is evaluated by use of mathematical models. When air pollutants are emitted into the atmosphere, they are immediately diffused into surrounding atmosphere, transported and diluted due to winds. The air quality models are designed to simulate these processes mathematically and to relate emissions of primary pollutants to the resulting downwind air quality. The inputs include emissions, micro-meteorology and surrounding topographic details to predict the impacts of conservative pollutants.

The **Fugitive Dust Modelling** done using **ISCST3** is a computerized air quality model specifically designed for computing concentration and deposition impacts from fugitive dust sources. The sources may be point, line or area sources. The model is generally based on the well-known Gaussian Plume formulation for computing concentrations. Concentration are computed at all user-selectable receptor locations.

Around 41 discrete receptors (surrounding villages and forest area) have been considered and around 4 boundary receptors for Block I and total 24 Boundary receptors for all four Blocks together are processed while running the model.

Area sources has been considered with input of average dimensions of mining proposed during one day i.e. 223, 190, 174, 198 sq. m. for all Blocks III, I, II, and VIII and respective emission factor in g/m$^2$/s derived based on annual emission load.

The locations of area source for all four mines is given below:

| No | Mine | X mtrs | y Mtrs |
|---|---|---|---|
| 1 | block III | 0 | 0 |
| 2 | Block VIII | -2347.92 | 1217.44 |
| 3 | Block II | 0 | 2087.04 |
| 4 | Block I | 1739.2 | -1913.12 |

The **FDM** thus provides estimates of pollutant concentrations at various receptor locations.

It is computed that maximum SPM contribution from proposed mining operations for Block I is maximum at boundary receptor D i.e. 21 µg/m$^3$. The values at discrete levels at Burugupakalu, Mandipalli, Jerilla and Madigul , are 109, 86, 84 and 60 µg/m$^3$ respectively.

Scenario I: SPM Concentrations for Block I Mining Individually (µg/m$^3$)

| No | Discrete Receptors | X mtrs | Y Mtrs | SPM |
|---|---|---|---|---|
| 1 | Burugupakalu | 4174 | 174 | 109 |
| 2 | Mandipalli | 8087 | 4261 | 86 |
| 3 | Jerilla | 2783 | -2696 | 84 |
| 4 | Madigul | -4957 | 3391 | 60 |
| 5 | Charapalle | -3131 | -6435 | 38 |
| 6 | Bangarsudha | -4348 | 4696 | 37 |
| 7 | Banangipalle | -4696 | -8174 | 29 |
| 8 | Karupalle | -2957 | -7392 | 16 |

Block I

| No | Boundary Receptor | X mtrs | y mtres | SPM |
|---|---|---|---|---|
| 1 | D | 2225 | -1618 | 21 |

Scenario II SPM Concentrations for All four mines together (µg/m$^3$)

The SPM levels while all four mines operating simultaneously would have the concentrations as below.

| No | Discrete Receptors | X mtrs | Y Mtrs | SPM |
|---|---|---|---|---|
| 1 | Jerilla | 2783 | -2696 | 283 |
| 2 | Konarupalli | 522 | -1739 | 147 |
| 3 | Burugubayalu | 3565 | 3652 | 143 |
| 4 | Viravaram | 3391 | 3131 | 131 |
| 5 | Burugupakalu | 4174 | 174 | 107 |
| 6 | Neerudupalli | 4783 | 7479 | 93 |
| 7 | Chikatpalli | -2609 | 4435 | 93 |
| 8 | Mondigedda | 3913 | -2174 | 91 |

| | | | | |
|---|---|---|---|---|
| 9 | Bangarsudha | -4348 | 4696 | 89 |
| 10 | Mandipalli | 8087 | 4261 | 77 |
| 11 | Rallagedda | 435 | -2609 | 67 |
| 12 | Kothawada | 4957 | 783 | 60 |
| 13 | Satyavaram | 4435 | -6087 | 53 |
| 14 | Gudivada | 3478 | -783 | 50 |
| 15 | Killipalli | 5392 | 6174 | 48 |
| 16 | Gillibanda | 2000 | 4870 | 45 |
| 17 | Madigul | -4957 | 3391 | 45 |
| 18 | Terapalli | -3652 | -1913 | 44 |
| 19 | Charapalle | -3131 | -6435 | 34 |
| 20 | Lasar | 1565 | 4261 | 27 |
| 21 | Banangipalle | -4696 | -8174 | 25 |
| 22 | Ventadapalli | 2957 | -5044 | 24 |
| 23 | Karupalle | -2957 | -7392 | 15 |
| 24 | Eskapalli | -3565 | 6522 | 14 |
| 25 | Tatparahr | -3391 | 4609 | 12 |
| 26 | Ammavari | -5565 | -1304 | 11 |

Block III

| No | Boundary Receptor | X mtrs | y mtres | SPM |
|---|---|---|---|---|
| 1 | B | 957 | -870 | 705 |
| 2 | A | 1391 | 609 | 339 |
| 3 | G | -1478 | 609 | 313 |
| 4 | D | 87 | -1217 | 186 |
| 5 | F | -1913 | 348 | 138 |
| 6 | C | 783 | -1217 | 54 |

Block I

| No | Boundary Receptor | X mtrs | y mtres | SPM |
|---|---|---|---|---|
| 1 | A | 1425 | -2575 | 117 |
| 2 | B | 1391 | -1913 | 58 |
| 3 | D | 2225 | -1618 | 44 |
| 4 | C | 1739 | -1214 | 11 |

Block II

| No | Boundary Receptor | X mtrs | y mtres | SPM |
|---|---|---|---|---|
| 1 | A | -880 | 1328 | 393 |
| 2 | E | 1844 | 4300 | 99 |
| 3 | C | -293 | 1581 | 12 |
| 4 | D | 1617 | 1011 | 7 |

Block VIII

| No | Boundary Receptor | X mtrs | y mtres | SPM |
|---|---|---|---|---|
| 1 | A | -2599 | 2113 | 93 |
| 2 | B | -1174 | 1793 | 15 |

This computation has been carried out without considering environmental management plan such as sprinkling of water to reduce dust emission. The isopleths showing SPM concentrations are presented in **Figures 6.1. and 6.2**

The incremental contribution of the particulates emissions due to Mining Activities, viz. scraping, drilling and blasting, Bulk Material handling, erosion from Storage Piles, Pushing

Operations and plying of vehicles during operation of the proposed mines, to the ambient air quality is estimated, using various Models the results of which are described above.

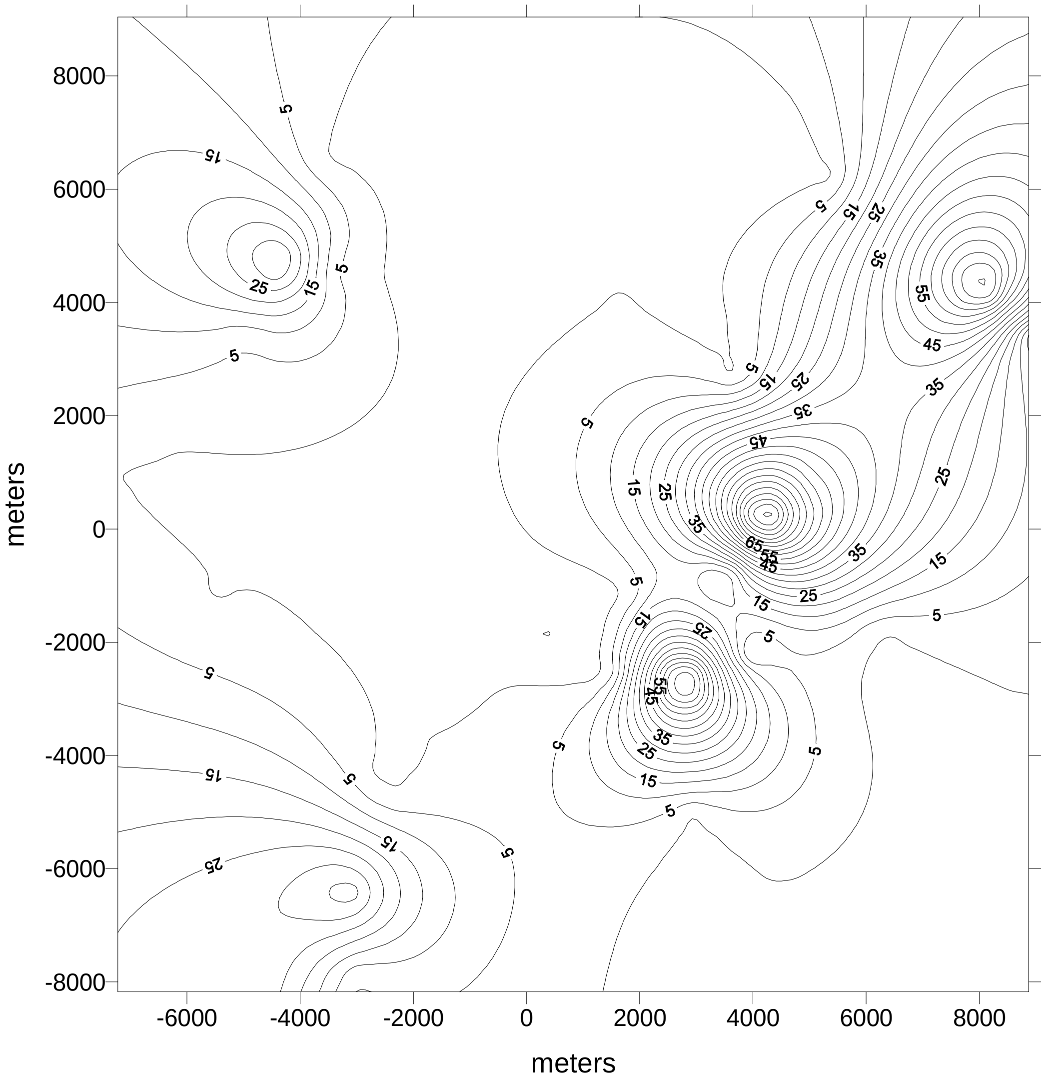



**Fig. 6.1**
**Ground Level Concentrations for Suspended Particulate Matter (SPM) in µg/m$^3$**
**(Jerilla Bauxite Mines Block I )**

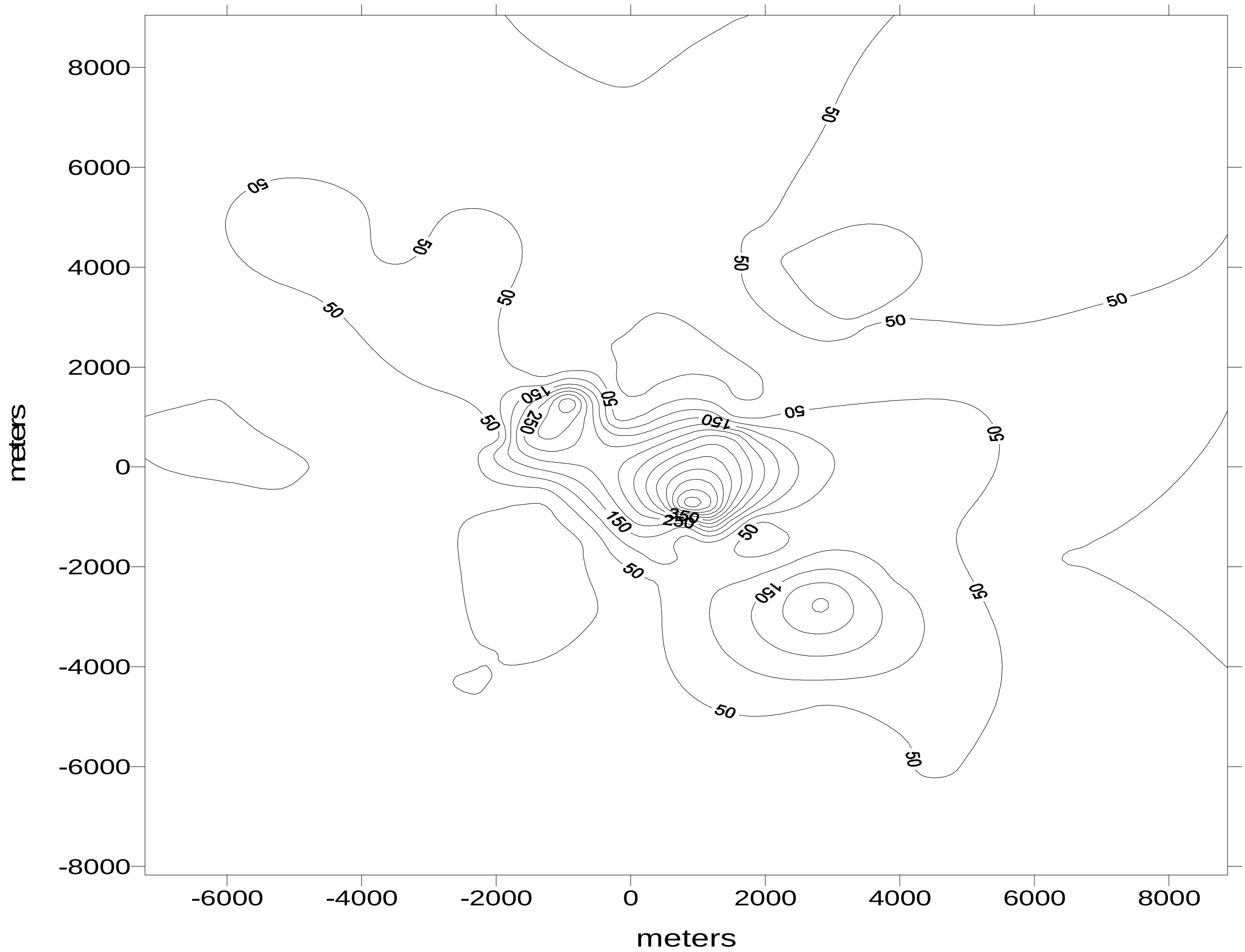



**Fig. 6.2**
**Ground Level Concentrations for Suspended Particulate Matter (SPM) in µg/m$^3$**
**(Jerilla Bauxite Mines Blocks III, VIII, II & I )**

### 6.3.3 Impacts on the Air Environment

The incremental contribution of the particulates and gaseous emissions due to Mining Activities, viz. scraping, drilling and blasting, Bulk Material handling, erosion from Storage Piles, Pushing Operations and plying of vehicles during operation of the proposed mines, to the ambient air quality is estimated, using various Models the results of which are described above.

SPM and RSPM would cause increase in localized dust conditions and impact on human health and vegetation in the study area.

## 6.4. Noise Environment

### 6.4.1 Sources and Noise Levels

The ambient noise levels would increase due to various mining operations in the mine lease area. However as no human population is in the immediate vicinity of the mine lease area the impact would be minimal.

The plying of vehicles would increase the noise levels. However, as there is no transportation of excavated/mined deposits the impact is only limited to augmentation of equipment and daily supply of water, and movement of labour and administrative vehicles. Considering the entire transportation of deposit through conveyer the noise levels are restricted unlike any other mining operations.

The noise levels due to blasting operations would increase the decibel levels in the environment. This could lead to occupational health problems and the moving fauna in the region.

**Prediction of Impact on Occupational Health**

Equivalent sound level averaged over 8 hours, is used to describe exposure of noise in work places. The damage risk criteria for hearing, as enforced by OSHA (Occupation Safety and Health Administration) and other organizations to reduce hearing loss, stipulates that noise level upto 90 dBA is acceptable for eight hours exposure. Exposure to impulses or impact noise should not exceed 140 dBA (Peak acoustic pressure). Exposure to 10,000 impulses of 120 dBA are permissible per day.

The Director General of Mines safety in circular No. DG (Tech)/18 of 1975, has prescribed the noise level in mining occupations (TLV) for workers, in a 8 hour shift period with unprotected ear as 90 dBA.

Although there are a few noise sources above the limit, however, they do not produce noise levels above 90 dBA for more than 3 –6 hours per shift reducing Leq (8 hr) to well within the limits.

In each sector of mines, workers employed (50-150 nos.) in the mining activities are exposed to noise levels above 90 dBA for 3 – 6 hours per shift. Their exposures lie close to the prescribed limit.

Noise impulses do not pose any serious problems since at 200 m distance from the blasting site; noise level is in the range of 98 – 105 dBA. There will not be any adverse impact of vibration on the personnel.

The noise computations are carried out for the worst-case scenarios. i.e. without taking into consideration the local features like landuse, barriers etc. In reality, the noise levels are expected to be on the lower side, as the area along will act as a sound barrier. The presence of forests and other vegetation will act as the barrier.

### 6.4.2 Impact on the noise environment

1.85 The prime sources of noise levels during the operations of mines are the operating mining machinery and the mining vehicular noise due to material movement at the site. Though the effect of noise would be insignificant during the daytime the residential areas located in the near vicinity of the mining site may experience increased ambient noise levels during night time due to any plying of vehicles, in case the transportation activity is resumed during night.

1.86 Similarly, the noise levels would be above the applicable limits within a distance of 20 m from the edge of the road, in case of vehicular movement.

## 1.87 6.5 Land environment

### 6.5.1 Prediction of results

Prediction of impacts of mining activities on land environment will depend on type of activities and control measures adopted by mine contractor to prevent the generation of pollution. The dust generated during blasting operation, ore handling and transport rate normally constitutes heavier particles that would easily settle within the mining area itself. Operation of grading the ore into different sizes, before loading to trucks would generate ore dust that would be deposited in nearby area. However, plantation in mining area will attenuate particulates emanating from mining activity. The mining activities would result in aesthetic improvement accompanied by change in topography, soil degradation, soil erosion, unscientific disposal of overburdens and loss of vegetation.

**Land Degradation**

The mining activities in study region would result in alterations in landform characteristics and landuse due to following activities.

– Excavation of mining lease area
– Unscientific disposal of overburden
– Stacking of top soil on separate area
– Creation of necessary infrastructural facilities like service center office building storage yard, workshop depot etc.

Necessary control measures like simultaneous backfilling, plantation/ afforestation, soil and water conservation are suggested in EMP to minimize land degradation.

**Impacts due to Overburden**

Impacts due to mining activities will be negligible if the disposal of overburden is as per the approved mining plan and area identified which will ensure that erosional effect of soil do not affect the nearby agricultural field and surface waterbodies. Reclamation of degraded soil with afforestation improve aesthetic quality of environment. Details of the reclamation measures are given under environmental management plan.

**Solid Waste**

The solid waste generated would be of the order of 2.08 million tonnes during entire five years plan period. It is proposed to dump the overburden arising out of the mining operations in the mine area in heaps.

In the rainy season, the pollutants may be carried by water through various channels along the available gradient and thus polluting the water of streams at the bottom. Possibility of spoiling of ground water and stream water due to leaching of pollutants also cannot be ruled out.

**Change in landuse pattern**

The impacts on the landuse pattern are anticipated during the operation of the project. During operation the land required for the project would be cleared which will result in removal of trees. This is more specific in the buffer zone of the conveyor area. This being entirely of agriculture and habitations, the impact on habitations is present.

### 6.5.2 Impacts on landuse

Impacts on the landuse pattern is anticipated during the operation of the mine. During pre mining stage the land required for the project would be cleared at certain locations, as the leases are containing very distinctly located habitations and vegetation is considerably low. There would be removal of certain trees, and disturbances. During operation stage the induced impacts on landuse pattern are anticipated to occur.

### 6.5.3 Possible impact on soil

**The mining plan of Jerrila Block I bauxite deposits envisages open cast mechanized method of mining in excavating bauxite deposits. It is also proposed in the mining plan that top soil and overburden are removed**

**separately and stacked for future back filling programme. As it is observed during sampling of soils for nutrient studies, the soils** in the proposed mining sites on the top of the hills (mine lease area) are intermixed with gravels and pebbles throughout the solum. Most importantly, these soils are covered under gravels and loosely packed small boulders in turn it leads to give the appearance that the land is completely eroded and devoid of soils. Hence, there exist a chance of loss of or removing away of fertile soils along with gravels and boulders, while excavating the bauxite deposits. Apart from the fertility value, it seems that the soils intermixed with gravels and **pebbles existing under** boulders binding with root systems of existing vegetation may act as sponge in harvesting of rainwater and slow release of the harvested rainwater to the down streams. Due to mining, there may be interruption in the role of soils in rainwater harvesting and slow release of harvested water to the down streams.

It is also observed that the top soil as well as the inter-locked soil along with gravels, pebbles and small boulders in this project area is very fine in nature. Hence, another possible impact is that while excavating and stacking of this fine soil for back filling, the fine soil may become dust in the air. These dust particles may be blown away along the wind direction and deposited on the canopy of surrounding vegetation in the forests, on the agricultural crops leading to interfering with photosynthesis and other physiological activities. Finally, this may result in reduction in over all ecological functions of forest ecosystems and economic productivity of agro-ecosystems.

## 6.6 Ecological environment

### 6.6.1 Flora

The vegetation (dry savannah) on the ridges invariably consists of herbaceous plants including grasses, which form the dominant community. The savannah vegetation on the hilltops (mine lease area) is dominated by the stemless palm, *Phoenix acaulis* and another palm *P. loureirii.* Forests on the slopes consist of evergreen plants like *Persea macrantha, Anamirta coculus, Cyathea gigantea,* etc. The mine lease area showed Shannon Wiener Diversity Index (H') value as 2.75 for trees, 1.363 for shrubs and 3.123 for herbs whereas the outside mine lease area showed diversity values (H') as 3.467 for trees, 3.134 for shrubs and 3.391 for herbs, respectively. Therefore, it has been inferred from the results that vegetation present in the mine lease area is less diverse with regards to diversity of trees and shrubs as compared to the vegetation in outside mine lease area.

The deposition of SPM in ambient can impact the vegetation in the vicinity of 500 mtrs. The clearing of trees for mining activities will require felling of trees during the project. The predominant species to be felled include 7 herbs, 9 shrubs, 22 trees and 3 climbing shrubs and 2 woody climbers. All these trees are indigenous species and do not fall under endangered variety. Thus significant adverse impact is anticipated on the ecological environment in the study area.

### 6.6.2 Fauna

The negative impacts of mining activities are chiefly due to habitat destruction, sound and air pollution due to mining operations, material conveyance and influx of human population into the area. During the survey 10 species of mammals, 82 species of birds, 11 species of reptiles and 24 species of insects have been recorded by direct and indirect methods.

## 6.7 Socio-economic environment

### 6.7.1 Impacts on Socio-Economic Environment

The proposed mining activities in region, would bring forth certain socio-economic impacts. Some of the impacts would be directly beneficial to the socio-economic environment due to employment potential, improvement in infrastructural facilities whereas some of them would be of adverse nature.

Similarly the impact can be classified as primary or secondary, short term or long term, reversible or irreversible and local or regional. The beneficial impacts due to the activities in the region would be:

- Job opportunities for the local people as well as immigrants from nearby areas, would increase during operation of mines as well as expansion of mines
- There would be increase in the commercial, business and shops due to influx of population in the region to cater the needs of existing population as well as the immigrants
- There may be a development of infrastructure facilities and amenities due to proposed mines in the region. It would also result in the appreciation of land values around these areas.

**Adverse Impacts**

The adverse impacts on socio-economic environment due to mining activities in the region will be:

- Disturbance of coffee plantations as perceived by local people
- Soil erosion, land slides, flooding, loss of fertility etc.
- Conflict of utilization of local resources like water
- Effect of surface run-off on water quality and also on the agricultural fields resulting in poor crop yields.
- Land vibration and shocks from blasting where mining operations are carried out

### 6.7.2 Impact on Health

Mining areas, since past have been a major source of concern to cause health impacts. The main negative impacts in such cases exposure to localized dust, development of water born diseases, water pollution due to mining, issues related resettlement and health.

**Exposure to localized dust**

The near by population as perceived by them would be exposed to localized dust due to mining activity. General impacts of such exposure would be dust allergies and respiratory problems.

**Water Borne Diseases**

Water-borne diseases are infectious diseases spread primarily through contaminated water. Though these diseases are spread either directly or through flies or filth, water is the chief medium for spread of these diseases and hence they are termed as water-borne diseases.

Most intestinal (enteric) diseases are infectious and are transmitted through faecal waste. Pathogens – which include virus, bacteria, protozoa, and parasitic worms – are disease-producing agents found in the faeces of infected persons. These diseases are more prevalent in areas with poor sanitary conditions. These pathogens travel through water sources and interfuses directly through persons handling food and water. Since these diseases are highly infectious, extreme care and hygiene should be maintained by people looking after an infected patient. Hepatitis, cholera, dysentery, and typhoid are the more common water-borne diseases

A large number of chemicals that may be released due to mining activity may dissolve in the water, thereby contaminating it and leading to various diseases.

Exposure to polluted water can cause diarrhea, skin irritation, respiratory problems, and other diseases, depending on the pollutant that is in the water body. Stagnant water and other untreated water provide a habitat for the mosquito and a host of other parasites and insects that cause a large number of diseases. Among these, malaria is undoubtedly the most widely distributed and causes most damage to human health.

The existing public health network does not have the specific facilities for the treatment of some of the above diseases and needs up-gradation. The availability and quality of biological products and services, such as vaccines and screening tests are also not assured.

**Water Pollution**

With the initiation of mining activity the iron content in the local water bodies will increase due to geological formations at project site. Iron content ranges from 13 to 15% in the local rocks which if mixed with water may become dangerous health hazard.

The levels of iron should be monitored periodically at the mining site to determine any possibility of iron buildup. It is proposed to utilize water for consumption, treatment for iron removal should be undertaken if such build up is observed. High iron content above prescribed threshold limits leads to gall bladder and thyroid problems. However there is no possibility of leaching of other minerals in nearby water bodies at mining site  as evident from details of geological formation and water quality analysis carried out at mining site.

Chapter 7

# ENVIRONMENTAL MANAGEMENT PLAN

## 7.1 Environmental Solutions

This EMP takes into account all the environmental issues and the corresponding mitigation measures proposed in following sections. The EMP presented below includes:

- Specific mitigation measures to be taken vis-à-vis site specific issues
- Responsible agencies for implementation & supervision
- Time frame for implementing mitigatory actions
- Reference to contract documents and specifications
- Project level environmental monitoring
- Institutional arrangements, strengthening of their capability and roles

The solutions delineated herein are mainly to mitigate the significant, potential and probable impacts described in the previous chapter. The significant ones are:

- Impacts on the water environment due to erosion of soil entering into the water environment, waste disposal, leachate fraction of overburden material
- Impacts on air environment due to generation of fugitive dust and particulate matter, due to mining activities and transportation, increase in commercial activities in the region and subsequent impacts on health and vegetation
- Impact on noise environment due to mining operations, vehicular movements and subsequent impacts of vibrations on workers and neighboring population
- Impacts on land environment due to mining operations, soil erosion, loss of agriculture land, etc.
- Impact on biological environment such as felling of trees
- Impact on socio-economic environment

## 7.2 Mitigation measures for Water Environment

During operations of the mines, excavation carried out may lead to soil erosion. This might occur especially during monsoon season. Hence the siltation of soil into water bodies shall be prevented to maximum extent possible by adapting soil erosion control measures. Mining work close to streams or water bodies shall be avoided during heavy rains. Other useful mitigation measures to avoid siltation will include:

- Excavated overburden should be properly disposed off at locations that doesn't obstruct the natural rainwater flow/runoff
- In areas susceptible to soil erosion, mining should be carried out before rainy season and temporary or permanent erosion protection work should be provided
- Slurry or similar debris generated in case of any deep excavation activities shall be disposed off such that it does not flow into surface water bodies or form mud puddles in the area
- Avoid excavating in areas of recharge / ground water aquifer zones
- Protection of water bodies through geotechnique methods by planting appropriate grass along water bodies to avoid flow of sediments and water saturated mine spoil
- To arrest soil erosion implement appropriate dam structures using artificial bio technique approach
- Augment water supply for mining usage and provide water through borewells, dugwell, stop dams etc.
- CAT Plan is prepared for the project site would also help in mitigating the impacts on water environment.

## 7.3 Mitigation of Impacts on Air Environment

During project initiation, the adverse impacts on ambient air quality are anticipated to occur mainly due to site clearance activities, material movement and during various other activities.

The mitigation measures recommended during mining operations are:

- All earthwork material should be protected in such a manner so as to minimize generation of dust

- The kuccha road, should be sprinkled with water at least once in a day to avoid rising of fugitive dust
- Water spraying while loading stock piles
- Variable height stackering of stock piles
- Green belt as wind breakers or plantations around stock pile area
- Re-vegetation on stock pile area
- As soon as mining activity is over the surplus earth should be utilized to fill up low-lying areas. In no case, loose earth should be allowed to pile up along the route.
- Exhaust and emission norms of mining equipment shall adhere to emission norms as laid by MoEF/ CPCB
- It should be ensured that light vehicles being used during movement should be PUC certified. To have control over ambient air pollution, during operation of the mine, as a mitigatory option vehicles complying with emission standards be allowed to ply on the road.
- All material being transported should be covered to avoid any spillage on the route or act as source of fugitive dust. Also, wherever feasible, roadside plantation may be undertaken.
- DG sets shall adhere to applicable air quality standards

## 7.4 Mitigation of Impacts on Noise Environment

The mitigation measures recommended during mining operations are:

- All mining equipment shall be fitted with exhaust silencers. Damaged silencers be properly replaced
- DG sets, if used, shall adhere to applicable noise standards by CPCB/MoEF
- A schedule of mining activities such as restricted time/ intermittent activities can be followed during critical hours

- Workers exposed to loud noise (as per Factory Act Requirements) shall wear earplugs/ earmuffs

During transportation of material, there would be an increase in the ambient noise levels along the internals roads due to increased traffic. The mitigation measures recommended are as follows:

- Noise will become a major problem if smooth flow in traffic is stopped due to congestion or bottleneck situation in the road particularly near the junction points. The identification of such locations be made and appropriate traffic diversions, adequate rectifications be made

- Near sensitive receptors such as schools, religious places, dispensary etc "no honking zones" shall be announced by placing adequate number of signboards along the road.

- Mitigation measures adopted for noise environment will also help for animals and movement.

## 7.5 Mitigation of Impacts on Land Environment

- The activities of dumping of overburden be carried out in a systematic manner taking into consideration the contamination of site due to soil leachate formulation due to interaction with water, downward movement of dumps due to gradient and increasing risk factor.
- The soil erosion and land degradation normally occurs during the mining. The work shall consist of measures as per design, or as directed by the land use planner /engineer to control soil erosion, sedimentation and water pollution, through biotechnique measures use sediment basin, mulches, grasses, slope drains etc. The erosional aspect in soil is characterized by the shrink/swell character of soil mass
- Reclamation of mined areas by using various afforestation techniques
- Oil and fuel spills from mining equipment shall be minimized by good O & M practices. Soils contaminated by such spills shall be disposed as per norms
- The topsoil from all areas of cutting and all areas to be permanently covered shall be stripped to a specified depth of 150 mm and stored in stockpiles. The topsoil from the stock piles shall be used to cover disturbed areas and cut

slopes and also for re-development of borrow areas, landscaping and roads side plantation

- During mining operations, cut section stability should be checked for erosion and rutting. Any sign of instability should warrant adequate response immediately and well before the succeeding monsoon season
- During operation phase of the project, the development of any commercial establishments be restricted and provisions for organized and limited (essential) establishments be made
- During the laying of conveyor the land would be excavated for foundation of supporting features. The buffer zone would also be leveled in case wherever such requirement is found particularly the obstructions in the chainage of conveyor. The soil is susceptible to erosion and degradation due to excavation of soil. The same may be planted with grass to keep intact the soil zone
- The landscape and restoration plan is prepared to address the issues of soil erosion and landscape degradation

## 7.6 Mitigation of Impacts on Ecological Environment

During pre-mining phase the removal of scrubs and ground vegetation in the mine site will require to be removed from the land. Vegetation falling within the lease planned for mining activities are to be removed before commencement of mining activity shall be identified and approved by the concerned agency (Forest Department). Prior permission from the concerned authority shall be obtained as laid in the Forest Act.

During operation of mines, compensatory plantation should be carried out in line with regulations and guidelines. Plant species suitable for the area shall be planted. Typical species shall include *Andrographis paniculata* (Nelavemu, Kalmegh), *Artocarpus heterophyllus* (Panasa, Jackfruit), *Asperagus racemosus* (Pillitegalu, Sathavari), *Buchanania lanzan* (Chironji, Morli), *Caryota urens* (Jeeluga), *Dendrocalamus strictus* (Veduru, Bans), *Diospyros melanoxylon* (Tendu, Tunika, Beedi aaku), *Jatropha curcus* (Nepalamu, Ratanjot), *Litsea glutinosa* (Naramamidi), *Madhuca longifolia* var. *latifolia* (Ippa, Mahua), *Mangifera indica* (Mamidi, Mango), *Phyllanthus emblica* (Usiri, Amla), *Pongamia pinnata* (Kanuga, Karanj), *Rauvolfia serpentine* (Patalagaruda, Sarpagandhi), *Semecarpus anacardium* (Nallajeedi, marking nut), *Terminalia bellirica* (Tandra, Tadi, Baheda), *Terminalia chebula*

(Karaka, Harra), *Wrightia arborea* (Pala) and site specific species like *Albizia odorotissima, Anogeissus latifolia, Buchanania lanzen, Cassia fistula, Cipadessa baccifera, Diospyros melanoxylon, Mallotus philippensis, Phoenix acaulis, Semicarpus anacardium, Terminalia* spp. *Zanthoxylum armatum,* are well suited for afforestation in similar areas with moist conditions. S*pecific parasitic trees* should not be planted as it harms this ecosystem. Adequate care of the landscaping and compensatory plantation should be taken up so as to achieve a pre-determined survival rate.

The migratory path of fauna may also be effected due the conveyor/Transport System.

**Mitigation of Impacts on Aquatic Ecology**

Mine discharges and waste disposal should be carefully planned in such a way that obstructions are not caused to natural drainage and streams.

During mining operations, some localized pits will be created for collection of rain water during monsoon, which will be pumped out. Around the dumps, peripheral drains should be constructed to trap rain water washings and flow regulated. All the existing drains arising from the plateau should be connected to natural streams only after passing through biological and engineering structures to minimize siltations of the streams. The overburden should be filled back in such a way that the water drains out into the streams in the same rate as it is flowing now. Provision should be made to allow flow down of rain water gradually in all natural streams so that gullies are not formed leading to erosion of soil. Garland trenches and sedimentation pits should be provided all along the active mine area to prevent soil erosion resulting in siltation of streams.

Also, to prevent soil erosion due to rain water flow, soil binding grasses and herbs should be planted. Details of engineering structures to be constructed and plantations to be done are provided in Catchment Area Treatment Plan.

## 7.7 Mitigation of Impacts on Socioeconomic environment

The mitigatory measures would include measures for development of the local community. A Social management plan is separately prepared to address community development.

- Economic Rehabilitation by building their capacities for NTFP (non-timber forest produce) sale activities, strengthening their capacity through entrepreneurship development, skill development for wage and self employment and other support in terms of escorting for marketing and financial linkages
- Infrastructure viz. power supply, water supply, sanitation, dry latrines, cattle sheds, approach roads
- Community infrastructure viz. educational buildings, schools, colleges, health facilities viz. hospital, clinics, dispensaries, local clinics, transport and bus facility, market centres, recreation and sports, pucca houses.
- Livelihood initiative programme by provision of irrigation structures viz. water holding structures and check dams, drinking water provisions, waste land development, food security, grant to SHGs for value addition in agriculture and horticulture, community halls, solar lanterns, livestock development, improved chullas etc.
- The blasting operations have to be planned to minimize such impacts and the critical operations that are likely to be more impacted have to be informed, apriori, of blast operation time, likely vibration and noise levels. A disaster Management Plan which includes emergency preparedness and disaster plan is prepared.

## 7.8 Environmental Management Plan

The EMP has been delineated for mining operation the project and is presented in **Table 7.1.**

## 7.9 Environmental Monitoring Plan

The environmental monitoring plan for the proposed project has been developed. The plan includes recommended monitoring sites, parameters to be monitored, time and frequency of monitoring, and collection, analysis and reporting of monitoring data. The objectives of the monitoring plan are:

- To record the impact of the proposed project on environmental quality during mining operations
- To evaluate the effectiveness of the mitigation measures during the mining operations
- To satisfy the legal and community obligations

- To respond to the unanticipated environmental issues at an early stage and to verify the accuracy of environmental impact prediction.

The monitoring plan is at **Table 7.2.**

## Table 7.1: Environmental Management Plan for Jerrila Block I Mines

| [A] Pre Project (Mining) Stage | | | | |
|---|---|---|---|---|
| **Environmental Issue** | **Mitigation Measures** | **Time Frame** | **Responsibilities** | |
| | | | **Implementation** | **Supervision** |
| Ecological Impacts | Trees felling within the mining lease area, and conveyor system area which are to be removed before commencement of mining operations, shall be identified and approved. Prior permission from forest department authorities shall be obtained, if any | Before start of mining operations | APMDC | **Forest Department** |
| Natural Habitats | All activities, vehicle movements and other miscellaneous activities must be restricted within project area<br><br>Temporary disposal of debris, felled trees or locating labour camps and stockyards beyond the mining areas must be avoided near forest zones. | Entire Mining phase. | Mining Contractor | APMDC |
| Local traffic Management | Temporary traffic arrangement during mining activity has to be planned. This plan shall be periodically reviewed with respect to site conditions.<br><br>During site clearance activity, the removal of debris shall be preferably removed during non-peak hours and with deployment of more vehicles for the purpose. | During site clearance | Mining Contractor | APMDC |
| Traffic Control and Safety | The mine contractor shall take all necessary measures for the safety of traffic during site clearing activities. He shall provide, erect and maintain such barricades, including signs, markings, flags, light and flagmen as may be required by the Supervising agency for the | During pre-mining activity | Contractor | APMDC |

| | | | | |
|---|---|---|---|---|
| | information and Protection of traffic. | | | |
| Impact on landuse outside project site | Restrict all mining activities within the mining core area without disturbing outside landuse | During entire mining phases | Mining Contractor | APMDC |
| Impact due to Conveyor construction and laying | The contractors who lay the conveyor should make provision while laying the conveyor<br>Avoid using vibratory equipment while digging and excavating of foundation<br>Sprinkling of water to curtail localized fugitive dust<br>Use of precautionary measures while excavating at slopes along the traverse length of the conveyor system | Construction phase | Contractor | APMDC |

**[B] Mining Stage:**

| Environmental Issue | Mitigation Measures | Time Frame | Responsibilities | |
|---|---|---|---|---|
| | | | Implementation | Supervision |
| **Water Environment** | | | | |
| Obstruction of Natural Flow | Excavated overburden should be properly disposed off at locations that doesn't obstruct the natural rainwater flow/runoff | Mining Phase | Mine Contractor /APMDC | APMDC |
| Soil Erosion | In areas susceptible to soil erosion, mining should be carried out before rainy season and temporary or permanent erosion protection work as may be possible should be provided | Mining Phase | Mine Contractor /APMDC | APMDC |
| Muck disposal / disposal of over burden | Slurry or similar debris generated in case of any deep excavation activities shall be disposed off such that it does not flow into surface water bodies or form mud puddles in the area. | Mining Phase | Mine Contractor /APMDC | APMDC |
| Cracks in aquifers | Avoid excavating in areas of recharge / ground water aquifer zones | Mining Phase | Mine Contractor /APMDC | APMDC |
| Fringe /rim erosion | Protection of water bodies trough geotechnique methods by planting appropriate grasses along water bodies to avoid flow of sediments and water saturated mine spoil | Mining Phase | Mine Contractor /APMDC | APMDC |

| | | | | |
|---|---|---|---|---|
| Sediment transfer | To arrest soil erosion implement appropriate check dam structures using artificial bio technique approach. | Mining Phase | Mine Contractor /APMDC | APMDC |
| Siltation of water bodies | Siltation of soil into water bodies shall be prevented as far as possible by adopting soil erosion control measures | Mining Phase | Contractor | APMDC |
| | | | | |
| **Air Environment** | | | | |
| Material spill | All vehicles delivering material from site shall be covered to avoid spillage | Mining phase | Mine Contractor /APMDC | APMDC |
| Fugitive dust | Water spraying while loading stock piles<br>Variable height stackering of stock piles<br>Wind breakers such as plantations around stock pile area<br>Re-vegetation on stock pile area | Mining phase | Mine Contractor /APMDC | APMDC |
| Earthwork | All earthwork material should be protected in such a manner so as to minimize generation of dust | | | |
| Plying vehicles on *Kuccha* roads | The kuccha road, should be sprinkled with water at least once in a day to avoid rising of fugitive dust | Mining phase | Mine Contractor /APMDC | APMDC |
| Mining equipment emissions | All material mixing machines, equipments, plants should be ensured to be licensed and authorized for operation by concerned authorities and shall intimate the engineer-in-charge prior to procuring materials from them | Mining phase | Mine Contractor /APMDC | APMDC |
| Excess mine spoil dumps | As soon as mining activity is getting over the surplus earth should be utilized to fill up low-lying areas. In no case, loose earth should be allowed to pile up along the route. | Mining phase | Mine Contractor /APMDC | APMDC |
| Mining equipment emissions | Exhaust and emission norms of mining equipment shall adhere to emission norms as laid by MoEF/ CPCB | Mining phase | Mine Contractor /APMDC | APMDC |

| | | | | |
|---|---|---|---|---|
| Vehicle emission control | It should be ensured that light weight vehicles being used during movement should be PUC certified. To have control over ambient air pollution, during operation of the mine, as a mitigatory option vehicles complying with emission standards be allowed to ply on the road. | Mining phase | Mine Contractor /APMDC | APMDC |
| **Noise Environment** | | | | |
| Noise from at blasting sites | 1.88 All mining equipment shall be fitted with exhaust silencers. Damaged silencers be properly replaced | Mining phase | Mine Contractor /APMDC | APMDC |
| Noise impact due to operation of DG sets | 1.89 DG sets, if used, shall adhere to applicable noise standards by CPCB/MoEF | Mining phase | Mine Contractor /APMDC | APMDC |
| Instantaneous noise | 1.90 A schedule of mining activities such as restricted time/ intermittent activities can be followed during critical hours | Mining phase | Mine Contractor /APMDC | APMDC |
| Worker exposure to loud noise | 1.91 Workers exposed to loud noise (as per Factory Act Requirements) shall wear earplugs/ earmuffs | Mining phase | Mine Contractor /APMDC | APMDC |
| Vehicular traffic noise | 1.92 Noise will become a major problem if smooth flow in traffic is stopped due to congestion or bottleneck situation in the road. The identification of such locations be made and appropriate traffic diversions, adequate rectifications be made | Mining phase | Mine Contractor /APMDC | APMDC |
| Vehicular traffic norms | 1.93 Near sensitive receptors such as schools, dispensaries, religious places "no honking zones" shall be announced by placing adequate number of signboards along the road. | Mining phase | Mine Contractor /APMDC | APMDC |
| Noise levels near residential areas and sensitive receptors | Providing path attenuation measures such as plantation of trees etc shall mitigate mining activity induced noise levels. | Mining phase | Mine Contractor /APMDC | APMDC |

| **Land Environment** | | | | |
|---|---|---|---|---|
| 1.94 Dumping of Mine Spoil / overburden | 1.95 The activities of dumping of overburden be carried out in a systematic manner taking into consideration the contamination of site due to soil leachate formulation due to interaction with water, downward movement of dumps due to gradient and increasing risk factor for accidents, etc. | Mining phase | Mine Contractor /APMDC | APMDC |
| 1.96 Mine area reclamation | 1.97 Reclamation of mined areas by using various afforestation techniques | Mining phase | Mine Contractor /APMDC | APMDC |
| 1.98 Oil and material spillages | 1.99 Oil and fuel spills from mining equipment shall be minimized by good O & M practices. Soils contaminated by such spills shall be disposed as per MoEF requirements. | Mining phase | Mine Contractor /APMDC | APMDC |
| 1.100 Top soil preservation and recasting | 1.101 The topsoil from all areas of cutting and all areas to be permanently covered shall be stripped to a specified depth of 150 mm and stored in stockpiles. The topsoil from the stock piles shall be used to cover disturbed areas and cut slopes and also for re-development of borrow areas, landscaping and roads side plantation. | Mining phase | Mine Contractor /APMDC | APMDC |
| 1.102 Soil erosion and movements of soil | 1.103 During operation phase, cut section stability should be checked for erosion and rutting. Any sign of instability should warrant adequate response immediately and well before succeeding monsoon season. | Mining phase | Mine Contractor /APMDC | APMDC |
| 1.104 Other developments | 1.105 During operation phase of the project, the development of any commercial establishments be restricted and provisions for organized and limited (essential) establishments be made. | Mining phase | Mine Contractor /APMDC | APMDC |

| | | | | |
|---|---|---|---|---|
| 1.106 **Ecological Environment** | | | | |
| Compensatory plantation | Compensatory plantation (Over debris disposal location) shall be done in line with concerned authority regulations and guidelines. Transplant the trees which are required to be moved due to construction of new roads or widening of existing roads | Mining phase | Mine Contractor /APMDC | APMDC |
| Obstruction due to laying of conveyor | Due to presence of conveyor system as a linear feature the impact on the migratory paths / movement of fauna may get interfered | Mining Phase | APMDC | APMDC |
| **Socioeconomic Environment** | | | | |
| 1.107 Water supply for irrigation and effect on Drainage system | 1.108 Development of check dams, local catchment area treatment measures to strengthen the water system | Mining phase | Mine Contractor /APMDC | APMDC |
| 1.109 Agricultural crops | 1.110 Compensation in terms of loss of agricultural crop, if any<br>1.111 Provision through various livelihood initiatives | Mining phase | Mine Contractor /APMDC | APMDC |
| 1.112 Social and agricultural Health | 1.113 Medical provisions to people affected to dust pollution due to transportation of ores may cause health ailments, poor yield of crops etc.<br>1.114 Proper plantation and sprinkling of water over the area | Mining phase | Mine Contractor /APMDC | APMDC |
| 1.115 Ground Vibrations | 1.116 Land vibration and shocks from blasting where mining operations are carried out near habitation, would disturb the structures and buildings. | Mining phase | Mine Contractor /APMDC | APMDC |
| 1.117 Blasting operations | 1.118 The blasting operations have to be planned to minimize such impacts and the critical operations that are likely to be more impacted have to be informed, apriori, of blast operation time, likely vibration and noise levels. | Mining phase | Mine Contractor /APMDC | APMDC |

| | | | | |
|---|---|---|---|---|
| 1.119 Pollutional impacts | 1.120 Air, water and vehicular pollution due to prevailing activities can give rise to serious diseases. Implementation of respective mitigatory measures as given in the sections | Mining phase | Mine Contractor /APMDC | APMDC |
| Providing labour facilities at site | The mining contractor shall abide by the contract conditions and directions with respect to providing sanitation facilities for use during work hours | Mining phase | Mine Contractor /APMDC | APMDC |
| Occupational health and safety | The contractor is required to comply with all the precautions as required for the safety of workmen as per the international labour organization (ILO) Convention no.62 as far as those are applicable to the contract. | Mining phase | Mine Contractor /APMDC | APMDC |
| Provision of safety accessories / appliances to each worker | The contractor shall supply all necessary safety appliances such as safety goggles, helmets, safety belts, earplugs, masks etc. to the worker and staff. | Mining phase | Mine Contractor /APMDC | APMDC |
| Safety precautions | Adequate precautions shall be taken to prevent danger from electrical equipment .all machines / equipment used shall confirm to the relevant Indian standards (IS) codes | Mining phase | Mine Contractor /APMDC | APMDC |
| Availability of first aid kit at construction site | A readily available first aid unit including adequate supply of sterilized dressing material and appliances shall be provided as per the requirements under the Factory's Act. | Mining phase | Mine Contractor /APMDC | APMDC |
| Workers health and hygiene | All anti-malarial measures shall be compiled with, including filling up of burrow pits. | Mining phase | Mine Contractor /APMDC | APMDC |

## Table 7.2: Environmental Monitoring Plan for Jerrila Block I Bauxite Mines – Post Project Monitoring

| Component | Project stage | Parameters | Standard | Location | Frequency | Duration | Institutional responsibility | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Section 1.06 mplementation | Section 1.07 upervision |
| Air quality | Mining Operation | SPM, $PM_{10}$, | NAAQS of CPCB | Mine site, habitation and traffic junctions | Once every season- summer, winter, post monsoon for 1 year after operation starts | 24 hr/day for 2 consecutive working days per week for 2 weeks | Pre-approved monitoring agency | APMDC |
| Noise level | Mining Operation | $L_{eq}$ day, $L_{eq}$ night, L10, L50, L90 dB (A) | CPCB noise standards | Mine site, habitation and traffic junctions | Once every season- summer, winter, post monsoon during construction period | Continuous 24 hour reading with a frequency of 10 minutes for 2 non consecutive days per week for 2 weeks | Pre-approved monitoring agency | APMDC |
| Water quality | Mining Operation | Ph, BOD, TSS, TDS, DO, turbidity and O &G | Inland SW & relevant stds. For heavy metals in ground water | All surface and ground water bodies including stop dams | Once every following season- summer, winter and post monsoon | Every season | Pre-approved monitoring agency | APMDC |
| Soil quality | Mining Operations | Heavy metals and oil and grease | Contaminant threshold level given by USEPA | Mines spoil dump sites | At the start and end of mining activities | One time sample | Pre-approved monitoring agency | APMDC |
| Ecology | Pre-Mining | Monitoring of tree felling | As laid out in project detail design | Mines | During tree felling | -- | Pre-approved monitoring agency | APMDC |
| | Mining Operation | Survival rate of rehabilitation plantations side plantation, and other compensate plantation | Survival rate as per the concerned policy guidelines | Mines | Annually | For 3 years after operation starts | Pre-approved monitoring agency | APMDC |

## 7.10 Environmental Performance Indicators

In order to evaluate the effectiveness of EMP measures, certain performance indicators have been identified. These indicators need to be analysed based on the project level data collected during the mining and operation stages of the project. The performance indicators that should be analysed during the mining operation phase have been provided in **Table 7.3** and **Table 7.4** respectively.

**Table 7.3: Key Performance Indicators during pre-mining Phase**

| Environmental issue | Key indicators | Benchmark values / standards |
|---|---|---|
| Ambient air quality | $SO_2$, SPM, PM10, CO, NOx | Baseline values measured during scenario and corresponding NAAQS standards |
| Ambient noise level | $L_{eq}$ day and $L_{eq}$ night calculated based on hourly equivalent noise levels observed | Baseline values measured during pre-project scenario and corresponding NAAQS standards |
| Surface water quality | Ph, TDS, TSS, turbidity, BOD, DO and O&G | Baseline values measured during pre-project scenario river water criteria |
| Soil quality near debris disposal site | Soil contaminants as identified in USEPA or equivalent BIS standards | USEPA soil contaminant threshold limits or equivalent BIS |
| Ground water quality near debris disposal site | Heavy metals and contaminants as per USEPA or equivalent BIS standards | Standards for heavy metals and contaminants as per USEPA or equivalent BIS standards |

**Table 7.4: Key Performance Indicators during Operation Phase**

| Environmental issue | Key indicators | Benchmark values / standards |
|---|---|---|
| Ambient air quality | $SO_2$, SPM, PM10, CO, NOX and HC (non-methane) | NAAQS standards |
| Ambient noise level | $L_{eq}$ day and $L_{eq}$ night calculated based on hourly equivalent noise levels observed | NAAQS standards |
| Surface water quality | Ph, TDS, TSS, turbidity, BOD, DO AND O&G | River water criteria |
| Soil quality near debris disposal site | Soil contaminants as identified in USEPA or equivalent BIS standards | USEPA soil contaminant threshold limits or equivalent BIS standards |
| Ground water quality | Heavy metals and | Standards for heavy metals |

| | | |
|---|---|---|
| near debris disposal site | contaminants as per USEPA or equivalent BIS standards | and contaminants as per USEPA or equivalent BIS standards |
| Compensatory plantation | Survival rates | Target plantations |

## 7.11 EMP Reporting Arrangements

The supervision and evaluation of the EMP are critical activities in implementation of the project. Supervision involves periodic checking to ascertain whether activities are going according to the plans. It provides necessary feedback for project management team to keep the program on schedule.

The supervision and reporting process with respect to implementation status of mitigation measures during mining will initiate from the mining contractor APMDC at the lowest level. The frequency of reporting is at **Table 7.5.**

**Table 7.5: Monitoring and Reporting Process**

| Stage | Reporting parameter | Duration |
|---|---|---|
| **Pre Mining** | Pre-mining stage reporting | Monthly |
| **Mining stage** | Pollution monitoring schedule and reports | As per monitoring plan |
| | Fugitive dust emission | Monthly |
| | Soil erosion locations and drainage measures taken | Quarterly |
| | Reporting for rehabilitation of mining areas | Monthly |
| | Tree Survival reporting of roadside plantation | Annually |
| | Tree Survival reporting of roadside landscape | Annually |
| | Movement of Fauna | Annually |
| | Pollution monitoring | As per monitoring plan |

## 7.12 Institutional Arrangements

During the mining phase of the project, the EMP implementation comprises of the following key activities:

- Implementing various mitigation and enhancement measures within the time frame recommended
- Overseeing the implementation of mitigation and enhancement measures and fine tuning /advocating more measures, if needed, depending on site condition
- Project level monitoring of key performance indicators to evaluate the implementation of EMP measures at the recommended intervals

These activities are to be carried out by various agencies that will be involved in the implementation of the project. It is also to be noted that all these activities will be carried out concurrently or at regular intervals and at different duration and locations. This makes it pertinent that all agencies involved work, in a predefined set-up. The Environment Management Division at APMDC should supervise various activities entrusted upon concerned agencies.

# Chapter 8

## GREENBELT DEVELOPMENT PLAN

In order to minimize the impact of mining on the vegetation outside the mine lease area, it is recommended that adequate protection measures must be implemented. They include assisted regeneration in forest areas and soil and water conservation measures. As mining involves movement of vehicles and increased anthropogenic activities, some of the areas can be fenced by involving local people and educating them about accrued benefits of such activities. Mine dust should be suppressed by regular sprinkling of water on the mine overburden dumps and haul roads. It is essential to create a green belt around the proposed mine lease area and along the haul roads well before the initiation of the mining activities. The green belt will act as a barrier to trap the suspended dust particles and also suppresses air pollutants. It is also important to create a green belt with tall seedlings (>1 m height) of indigenous species so as to establish it with good survival percentage at the earliest. The important shrub species recommended for plantation around the mine lease area in five rows are *Agave americana, Calotropis gigantea, Clerodendrum serratum, C. viscosum, Colebrookea oppositifolia, Dendrocalamus strictus, Flemingia macrophylla, F. strobilifera, Helicteres isora, Indigofera cassioides, Jatropha curcas, Maytenus emarginata, Murraya paniculata, Sarcococca saligna, Spermadictyon suaveolens* and *Woodfordia fruticosa* followed by five rows of tree species, namely, *Albizia chinensis, A. odoratissima, Artocarpus heterophyllus, Bauhinia racemosa, B. semla, Bischofia javanica, Bombax ceiba, Callicarpa tomentosa, Cassia fistula, Cipadessa baccifera, Erythrina stricta, E. suberosa, Ficus racemosa, Garuga pinnata, Gmelina arborea, Grevillea robusta, Lagerstroemia parviflora, Lannea coromandelica, Litsea glutinosaMacaranga peltata, Madhuca longifolia* var. *latifolia, Mallotus philippensis, Mangifera indica, Phyllanthus emblica, Polyalthia cerasoides, Pongamia pinnata, Pterospermum xylocarpum, Syzygium cumini, Tectona grandis, Toona ciliata, Trema orientalis, Wrightia arborea* and *Xylia xylocarpa.*

The total mine lease area is 85 ha. The perimeter of mine lease area is 8, 800 m. The width of the green belt around the mine lease area should be atleast 30 m. To establish a green belt around the mine lease area with five rows of shrubs followed by five rows of tree species with a spacing of 3 m x 3 m, the total area for greenbelt works out to be 26.40 ha (Plate-8). A total budget of Rs. 17.23 lakhs is proposed for immediate plantation before opening the mine area and for subsequent years towards maintenance to sustain various operations of green belt development plan (Table 8.1).

## Table 8.1: BUDGET ESTIMATE
## GREEN BELT DEVELOPMENT PLAN FOR RAISING NURSERY, PLANTATION AND THEIR MAINTENANCE
## (Based on the rates of FSR of Visakhapatnam Circle, A.P. Forest Department 2006-07)
## The base rates have been hiked with an annual enhancement of 10% per year

| S. No. | Details of works | I Year | | II Year | | III Year | | IV Year | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Physical | Financial Rs. In lakhs | Physical | Financial Rs. In lakhs | Physical | Financial Rs. In lakhs | Physical | Financial Rs. In lakhs | Physical | Financial Rs. In lakhs |
| I | **Nursery programme** | | | | | | | | | | |
| | Raising nursery including primary beds, 1100+297=1397 say 1400 seedlings/ha including maintenance and casualty replacement, placement 3mx3m (Equal number of shrubs and trees) | 36960 | 1.31 | 0 | 0 | 0 | 0 | 0 | 0 | 36960 | 1.31 |
| | **Sub total** | **36960** | **39478.00** | **0** | **0** | **0** | **0** | **0** | **0** | **36960** | **1.31** |
| II | **Plantation** | | | | | | | | | | |
| | Advance operations | 26.40 ha | 3.19 | 0 | 0 | 0 | 0 | 0 | 0 | 26.40 ha | 3.19 |
| | Raising of plantations (shrubs/ trees) | 0 | 0 | 26.40 ha | 7.87 | 0 | 0 | 0 | 0 | 26.40 ha | 7.87 |
| | 1st Year maintenance of plantation | 0 | 0 | 0 | 0 | 26.40 ha | 1.68 | 0 | 0 | 26.40 ha | 1.68 |
| | 2ndYear maintenance of plantation | 0 | 0 | 0 | 0 | 0 | 0 | 26.40 ha | 0.93 | 26.40 ha | 0.93 |
| | **Sub total** | **26.40 ha** | **3.19** | **26.40 ha** | **7.87** | **26.40 ha** | **1.68** | **26.40 ha** | **0.93** | **105.60 ha** | **13.67** |
| | **Total** | **36960 bags 26.40 ha** | **4.50** | **26.40 ha** | **7.87** | **26.40 ha** | **1.68** | **26.40 ha** | **0.93** | **36960 bags 105.60 ha** | **14.98** |
| | Add Administrative charges @15% on project cost | | | | | | | | | | 2.25 |
| | **GRAND TOTAL** | | | | | | | | | | **17.23** |

# CHAPTER 9

# LANDSCAPE AND SITE RESTORATION PLAN

## 9.1 Introduction

Landscape and site restoration plan is prepared to restore the project area to natural state or near original state with improved environmental conditions than those during the project area. Since the four mining sites are located in visually aesthetic environment, the sites could be developed into tourism sites providing economy and employment to the people in the nearby areas.

Landscape plan is prepared to add to the landscape and aesthetics of the project site thus reducing the visual impact directly and reduce negative environmental impacts indirectly. Because the project area is near reserved forests, it is also required to take up the project in such a way that, it has lesser effects on the forest Flora & Fauna. It is essential that the plantations would blend completely with the un-touched part of the area; in other words, the plantations should blend with the locals of the villages.

The mined area could be partially filled with the waste material stacked during the project and converted into a water body. The water body acts as a recreational place and other activities like parks, could be developed within the area to add to the recreational value of the site.

## 9.2 Issues during pre-mining and mining project

- The natural drains can be kept un-disturbed by constructing bunds along the drains or convert the drains into swales, which will also add to the landscape. These help in efficient and un-interrupted drainage flow of rain water.
- As the project area has dense drainage pattern, natural drains can be converted into streams; draining points of micro-watershed can be used as small water bodies. These help in rain water harvesting of the runoff. The water body banks and slopes can be planted with small shrubs.

- The water bodies, if constructed before the project, can be used in harvesting the flowing water and, the harvested water can be used during mining activities.
- Avenue plantations can be taken up along the roads passing through the mining area.
- Entire mining site can be surrounded by 'Tree-zone' of 15m width. This will act as buffer to the surrounding area.
- Dense 'Tree-zone' of 15m width should be created around the crushing areas. This would help in reducing noise pollution from the area to the surroundings.
- The area surrounding the facilities provided for the project implementation and along access roads should be covered with plantations to provide better environment within the site area.
- Large-scale plantation should be taken up within the project site apart from mining area to prevent soil erosion into the mined area.
- Areas requiring landscaping on the whole are areas surrounding the project facilities, crushing areas, and along the roads.

## 9.3 Site reclamation of the mining project

### Storage and Preservation of Topsoil

Soils are developed due to complex organic and inorganic processes. In Jerrila area, soils are the products of disintegration and chemical leaching of Khondalite. Preservation and utilization of topsoil is an integral part of dump management. Topsoil in Jerrila Block I deposit will be scrapped by bulldozer and stacked separately for reuse in plantation programme. About 2500 cu m of topsoil will be generated by the time mining ceases in the area. During the proposed plan period, however, 1000 cu m of soil is likely to be collected. It is proposed to stack the same close to the working pit. The soil will be put to use immediately by spreading the same along the barrier zone for Green belt plantation. Also, the soil will be used at other areas where the plantation is proposed around office complex, crusher site, magazine, etc. the soil will be utilized in all the places. The removed top-soil/transported from other places could be spread evenly along the site area to benefit plantations after the project.

**Land Reclamation**

In case of opencast mining, original topography will be disturbed. It is necessary to reclaim the degraded land to its near original topography by back-filling the mined out area with waste material. Restoration, reclamation and rehabilitation of mine-spoiled land would form an integral part of mining operations. The reclamation of land involving back filling of mined out areas, landscaping, soil amelioration and revegetation shall proceed concurrently with mineral extraction as stipulated in the National mineral policy, 1993

During the Plan period about 28.50 ha area will be spoiled by mining and conceptually, a total area of 82 ha area will be degraded. The total waste generation is likely to be 0.21 million tonnes at the end of the plan period and about 0.58 million tonnes at the end of the mining operations in the area. The available waste at the end of first five years is adequate to refill a small part of the pit in the northern part, where the mining would have been completed by the end of the IV year. The entire waste generated will be used at the end of the V year to refill this part. At the end of the mining operations in Block I the mined out area will be refilled with the available muck. This back filled area will be contiguous with the one reclaimed at the end of the V year. The reclaimed area will be 6.09 ha at the end of the 5 years.

**Phased plantation**

The phased afforestation programme includes green belt plantation along the buffer zone around the boundary of the applied area, avenue tree plantation on either side of the mine roads, revegetation of reclaimed areas of the pit. The green belt plantation will begin soon before mining is commenced in the area. About 2250 m length of perimeter of the mining block is proposed for the first five year green belt plantation. The area works out be 16875 sq. m or 1.7 ha. Approximately 3000 trees per year may be planted during the five year period. The other areas ready for plantation shall be site services campus where floral plants and fruit bearing tree saplings may be planted. The toe part of the proposed dumpsite, avenue plantation and rehabilitation of the reclaimed part of the pit may also be taken up. In all 5000 saplings are proposed for annual plantation during the five year period.

It is proposed to create green belt along the peripheries of Block I deposit. All measures will be taken to suppress dust and noise baffling generated during mining operation. Also, steps will be taken to reduce unpleasant and visual impacts and prevent soil erosion and possible land slide. It is also proposed to stabilize and protect old and new waste dumps by creating green belts and providing garland drains around the waste dumps.

The plants selected for plantation should be suitable to the climatology and geography of the project site. Plants selected should be less-water intensive and fast growing in nature. Tall trees, mostly, should be selected for plantations. Shrubs could be selected to add to the aesthetics of the area, mostly after the project completion and during project site reclamation. Herbs local to the area might also be used for plantations.

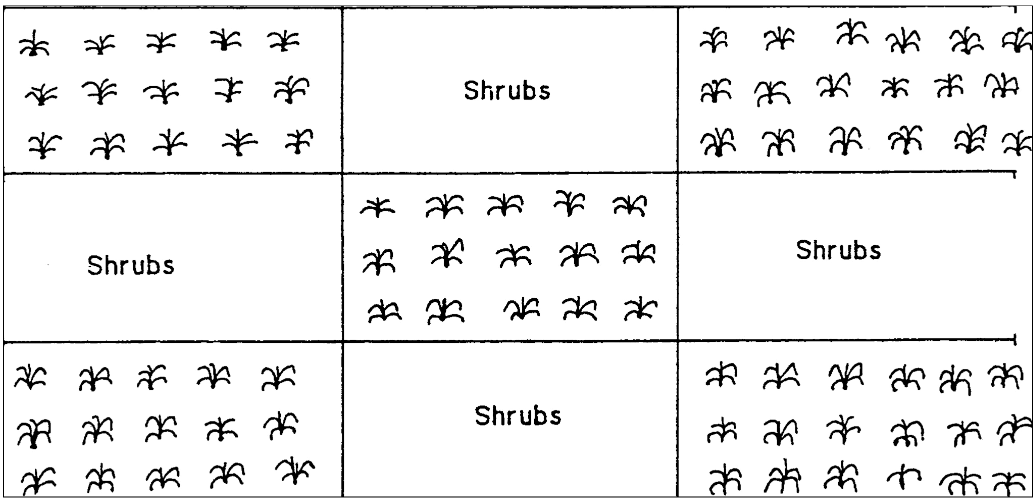
**Stabilization and vegetation of dumps**

The dump accumulated over a period will be progressively used for back filling part of the mined out area. Till such time the material is not used for refilling. The dead part of the dumps will have to be protected from erosion by planting grass on its surface and fast growing trees around the toe of the dump. Garland canals have to be provided at the top and bottom of the dump to prevent the rain water streaming down the dumps and the bottom garland canal will catch the washed dump material and deposit in the siltation tanks through which such silt laden waters will be made silt-free. Similarly, the soil heaps also will be covered with grass

## Costing of the proposals

| Sl. No | Component | | Total Cost in Rs |
|---|---|---|---|
| 1 | Construction of sand bunds along the natural drains | Lump sum | 1000000 |
| 2 | Plantation along the banks and slopes of the water bodies | Rs 6/plant and 2000 plants (assuming) | 12000 |
| 3 | Avenue plantation along the roads | Rs 6/plant and 2000 plants | 12000 |
| 4 | Plantation within the lease area | Rs 6/plant and 3000 plants/ha (80 ha excluding built up and mining area) | 1440000 |
| 5 | Plantation around stock yard | Rs 6/plant and 5000 plants | 30000 |
| 6 | Construction of artificial water body (including filling of mined area) | Lump sum | 1000000 |
| 7 | Construction of recreational facilities around the water body | Lump sum | 500000 |
| **Total Cost** | | | **3994000** |

**Total cost of the project is estimated around Rs 3994000**



**Chapter 10**

# AFFORESTATION PLAN

Afforestation programme in the mined areas has to be taken up to control landslides and soil erosion. Based on field surveys and studies, suitable plant species are recommended based on site specificity of the species for mined area. The plant species suggested for afforestation have one or more reasons for their suitability. Indigenous species are preferable than exotics because they are most likely to fit into a fully functional ecosystem. As a part of revegetation efforts, selection of desirable species adapted to the local environment should be given priority. Deciduous species of more economic importance and which can provide monetary benefits to the local people will be desirable in the long run. Species like *Phyllanthus emblica* (Amla, Usiri), *Terminalia chebula* (Harra, Karaka), *Terminalia bellirica* (Baheda, Tandra, Tadi), *Wrightia arborea* (Pala)*, Madhuca longifolia* var. *latifolia* (Mahua, Ippa), *Buchanania lanzan* (Chironji, Morli), *Diospyros melanoxylon* (Tendu, Tunika, Beedi aaku), *Dendrocalamus strictus* (Bans, Veduru), will give one or other kind of NTFP which will help in improving the livelihood of the people in the long run. When these species establish in disturbed areas, nature itself takes care, if further disturbance is avoided. Seeds or propagules coming from inside or from adjacent forest areas through different dispersal agents get easily established and acclimatize to the environment. This vegetation will help to prevent soil erosion thorough wind and water.

Grasses have the capacity to bind soil particles with very high regenerative capacity and high seed viability. Other annual/perennial herbs also can be used for stabilization. These plants can be multiplied in nursery with ease by vegetative means for large scale planting. *Cassia occidentalis, C. tora, Desmodium gangeticum, D. pulchellum, Flemingia macrophylla, F. strobilifera, Indigofera cassioides, Mimosa pudica, Tephrosia purpuea, T. tinctoria* and *T. villosa* are the other important plant species that can improve soil nitrogen status. All these plants and their seeds can easily be collected from adjacent areas. The plantation has to be done during the 1$^{st}$ year of mining activity. The plantation of grasses along the slopes should be done at about 50 cm x 50 cm interval.

Care should be taken to protect established seedlings and natural regeneration of NTFP species in the area. Soil analysis should be carried out at suitable places to understand the required dosage of the soil amendment/fertilizer/nutrient/micronutrient, etc.

As per the mining lease and plan, extraction of bauxite ore will continue upto 12 years. It is not practicable to suggest a budget for afforestation programme of the mine lease area as the Forest Schedule of Rates keep on changing annually. It is also not possible to presume the area that will be mined per year and the quantum and area of overburden cannot be foreseen. However, taking the total mine lease area into consideration the base budget as on 2006-07 is provided vide Table-45. An annual increment in the budget to the tune of 10% on base rates as per FSR of Visakhapatnam circle, A. P. Forest Department is to be calculated during the implementation. The budget proposed for afforestation programme is Rs. 55.50 lakhs (Table 10.1). Therefore, it is also suggested to the mining authorities to establish a Forest Wing consisting of senior level officers to take care of the afforestation programme during the mining duration.

***Table 10.1: BUDGET FOR AFFORESTATION PLAN (Rs. in lakhs)***

| S. No. | Details of works | I Year | II Year | III Year | IV Year | Total |
|---|---|---|---|---|---|---|
| 1 | Nursery programme | 4.23 | 0 | 0 | 0 | 4.23 |
| 2 | Plantation | | | | | |
| 3 | Advance operations | 10.29 | 0 | 0 | 0 | 10.29 |
| 4 | Raising of plantations (shrubs/ trees) | 0 | 25.34 | 0 | 0 | 25.34 |
| 5 | 1st Year maintenance of plantation | 0 | 0 | 5.40 | 0 | 5.40 |
| 6 | 2ndYear maintenance of plantation | 0 | 0 | 0 | 3.00 | 3.00 |
| 7 | Total (1+3+4+5+6) | 14.52 | 25.34 | 5.40 | 3.00 | 48.26 |
| 8 | Add Administrative charges @15% on project cost | | | | | 7.24 |
| 10 | **GRAND TOTAL (7+8)** | | | | | **55.50** |

## Table 10.1: BUDGET ESTIMATE
## AFFORESTATION PLAN FOR RAISING NURSERY, PLANTATION AND THEIR MAINTENANCE
## (Based on the rates of FSR of Visakhapatnam Circle, A.P. Forest Department 2006-07)
## The base rates have been hiked with an annual enhancement of 10% per year

| S. No. | Details of works | I Year | | II Year | | III Year | | IV Year | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Physical | Financial Rs. In lakhs | Physical | Financial Rs. In lakhs | Physical | Financial Rs. In lakhs | Physical | Financial Rs. In lakhs | Physical | Financial Rs. In lakhs |
| I | **Nursery programme** | | | | | | | | | | |
| | Raising nursery including primary beds, 1100+297=1397 say 1400 seedlings/ha including maintenance and casualty replacement, placement 3mx3m (Equal number of shrubs and trees) | 119000 | 4.23 | 0 | 0 | 0 | 0 | 0 | 0 | 119000 | 4.23 |
| | **Sub total** | **119000** | **4.23** | **0** | **0** | **0** | **0** | **0** | **0** | **119000** | **4.23** |
| II | **Plantation** | | | | | | | | | | |
| | Advance operations | 85 ha | 10.29 | 0 | | 0 | 0 | 0 | 0 | 85 ha | 10.29 |
| | Raising of plantations (shrubs/ trees) | 0 | 0 | 85 ha | 25.34 | 0 | 0 | 0 | 0 | 85 ha | 25.34 |
| | 1st Year maintenance of plantation | 0 | 0 | 0 | 0 | 85 ha | 5.40 | 0 | 0 | 85 ha | 5.40 |
| | 2ndYear maintenance of plantation | 0 | 0 | 0 | 0 | 0 | 0 | 85 ha | 3.00 | 85 ha | 3.00 |
| | **Sub total** | 85 ha | **10.29** | 85 ha | **25.34** | 85 ha | **5.40** | 85 ha | **3.00** | **340 ha** | **44.03** |
| | **Total** | **119000 bags 85 ha** | **14.52** | **85 ha** | **25.34** | **85 ha** | **5.40** | **85 ha** | **3.00** | **119000 bags 340 ha** | **48.26** |
| | Add Administrative charges @15% on project cost | | | | | | | | | | **7.24** |
| | **GRAND TOTAL** | | | | | | | | | | **55.50** |

# Chapter 11

## ECORESTORATION PLAN

The mine site elevation is 850m - 1300 m above msl, which is characterized by savanna vegetation comprising mostly of deciduous tree species. Throughout the location of the mine area, the mean annual rainfall is approximately 1200-1400 mm and the whole area supports deciduous forest species. The dominant species found in the mine lease area is *Phoenix acaulis* and *P. loureirii* as edaphic climax species along with associates.

The delicate balance between the biological environment and the abiotic factors/forces, namely, air, water, soil, climate, topography etc., acting on it should be maintained in order to ensure sustained development of the area. An impairment in any one of these links leads to disturbance in the balance and may prove catastrophic.

The methodology adopted for biological amelioration of the sites under study emphasizes identification of local flora, their utility and role in the economy of rural population. Therefore, a comprehensive field study was conducted to assess the present status of biological components of the environment, to identify the significant impacts of the various operations of mining on the biological environment and to prepare environmental management plan for biological environment to mitigate the adverse impact in respect of mining activity. The pattern of ecological changes after mining is perceived to be changes in land area, particularly mine lease area. The ecorehabilitation plan is essential to ensure mine lease area stabilization after ore extraction. The plan is to ensure restoration of the mine lease area and bring it back to the natural status thus minimizing the adverse impacts.

## 11.1 Mine overburden rehabilitation

The topsoil is collected and stacked separately. The topsoil would be used in plantation programme and waste material will be used for back-filling the mined out area. The dumpsite should be selected on non-mineralized ground. Topsoil and waste material should be kept at separate sites. The overburden should be filled back in such a way that the water drains out into the streams in the same ratio as it is flowing now. Therefore, provision should be made to flow down the rainwater gradually in all natural streams equally so that nowhere gully's are formed eroding the topsoil or towards the other side of the hillock. Therefore, the course of flow should not be changed or modified. If certain quantity of water is required for mining purposes, it may as well be stored to the extent required, as it will help in improving the overall water regime. After the mining is over, the afforestation of the mine site can be tackled with the plantation of suitable species.

The overburdens have to be dumped in trenches dug up for the purpose and be covered with a carpet of grasses and herbs like, *Aristida setacea, Bothrichloa pertusa, Cassia occidentalis, C. tora, Cymbopogan flexuosus, Cynodon dactylon, Desmodium laxiflorum, D. triflorum, Digitaria ciliaris, D. longiflora, Echinochloa colona, Elephantopus scaber, Eleucine indica, Eragrostis ciliaris, Heteropogon contortus, Hyptis suaveolens, Imperata cylindrica, Ischaemum indicum, Mimosa pudica, Paspalum scrobiculatum, Pennisetum hohenackeri, P. polystachion, Setaria intermedia, S. pumila, Sida acuta, S. cordata, Stachytarpheta jamaicensis, Tephrosia purpuea, T. tinctoria, T. villosa, Themeda arundinacea, T. triandra, Thysanolaena maxima* and *Triumfetta rhomboidea;* shrubs like *Agave americana, Ardisia solanacea, Baliospermum montanum, Calotropis gigantea, Carissa carandas, Clerodendrum serratum, C. viscosum, Colebrookea oppositifolia, Dendrocalamus strictus, Flemingia macrophylla, F. strobilifera, Glycosmis mauritiana, Helicteres isora, Indigofera cassioides, Jatropha curcas, Maytenus emarginata, Murraya koenigii, M. paniculata, Phoenix acaulis, Rauvolfia serpentina, Sarcococca saligna, Solanum anguivi, S. erianthum, S. giganteum* (Photo-12), *Urena lobata* and *Woodfordia fruticosa* and trees like, *Acasia chundra, Acer laurianum, Aegle marmelos, Alangium salvifolium, Albizia* *chinensis, A. odoratissima, Anogeissus latifolia, Artocarpus heterophyllus, Bauhinia racemosa, Bixa orellana, Bombax ceiba, Buchanania lanzan, Butea monosperma, Callicarpa tomentosa, Careya arborea, Caryota urens, Cassia fistula, Cassine glauca, Chionanthus ramiflora, Chloroxylon swietenia, Cipadessa baccifera, Cochlospermum religiosum, Dillenia pentagyna, Diospyros melanoxylon, Ficus racemosa, F. reliogiosa, Gardenia latifolia, Garuga pinnata, Gmelina arborea, Haldina cordifolia, Hardwickia binata, Holarrhena pubescens, Holoptelea integrifolia, Lagerstroemia parviflora, Lannea coromandelica, Limonia acidissima, Litsea glutinosa, Madhuca longifolia* var. *latifolia, Mallotus philippensis, Mangifera indica, Nyctanthes arbortristis, Ougeinia oojeinensis, Persea macrantha, Phoenix laureirii, Phyllanthus emblica, Pongamia pinnata, Pterocarpus marsupium, Schleichera oleosa, Semecarpuss anacardium, Sterculia urens, S. villosa, Syzygium cumini, Tamarindus indica, Tectona grandis, Terminalia alata, T. arjuna, T. bellirica, T. chebula, Wrightia arborea, Xylia xylocarpa,* and *Ziziphus rugosa.* It should be ensured that no overburden flows out of the nalas under any circumstances.

## 11.2 Mine area rehabilitation

After exploitation of ore, all hard laterite overburden/wastes should be dumped in the worked out area of the mine and covered by top soils heaped in terraces for reclamation purposes. These terraces created by mining processes should ensure that the terracing should be done with benching not less than 2m wide and not more than 3m height, which will help provide access for revegetation, plantation as well as proper drainage and erosion control (with small benches). The maximum height of OB dump should not exceed 10 m at the end of $5^{th}$ year with slope of $10^{o}$-$15^{o}$. A toe wall should be constructed around the OB dump to arrest sediment and silt flow. A garland trench should be constructed all around the boundary of mine lease area. These trenches and plantation around will help in arresting runoff and preventing soil erosion. The spreading of topsoil on compacted back fill will facilitate the revegetation process, which in turn controls silt flow downstream. Suitable drainage system will have to be provided in the back filled mine area for collecting excess rainwater as per mine plan.

The mine area has to be leveled after extraction of the ore to match the contour of the area. The mine area has to be revegetated with indigenous species of grasses and herbs like *Achyranthes aspera, Alysicarpus monilifer, Andrographis paniculata, Andropogon pumilus, Apluda mutica, Aristida setacea, Boerhavia diffusa, Bothrichloa pertusa, Brachiaria ramosa, B. reptans, occidentalis, C. tora, Cymbopogan flexuosus, Cynodon dactylon, Desmodium laxiflorum, D. triflorum, Digitaria ciliaris, D. longiflora, D. stricta, Dimeria ornithopoda, Drymaria cordata*, *Echinochloa colona, Elephantopus scaber, Eleucine indica, Eragrostis ciliaris, Hackelochloa granularis, Heteropogon contortus, Imperata cylindrica, Ischaemum indicum, Paspalum scrobiculatum, Pennisetum hohenackeri, Setaria intermedia, S. pumila, Sida acuta, S. cordata, S. cordifolia, S. rhombifolia, Stachytarpheta jamaicensis, Tephrosia purpuea, T. tinctoria, T. villosa, Themeda arundinacea, T. triandra* and *Thysanolaena maxima;* shrubs like *Agave americana, Ardisia solanacea, Calotropis gigantean, Carissa carandas, Cassia hirsuta, Clerodendrum serratum, C. viscosum, Colebrookea oppositifolia, Dendrocalamus strictus, Desmodium gangeticum, D. pulchellum, Flemingia macrophylla, F. strobilifera, Glycosmis mauritiana, G. pentaphylla, Helicteres isora, Indigofera cassioides, Jatropha curcas, Melastoma malabathricum, Murraya koenigii, M. paniculata, Phoenix acaulis, Rauvolfia serpentina, Sarcococca saligna, Solanum anguivi, S. erianthum, S. giganteum, Spermadictyon suaveolens, Urena lobata* and *Woodfordia fruticosa*; **Climbing shrubs Wood climbers like** *Acacia sinuata, Asparagus racemosus, Bauhinia vahlii, Calycopteris floribunda, Dioscorea glabra, D. oppositifolia, D. pentaphylla, D. tomentosa, Naravelia zeylania, Passiflora foetida, Pueraria tuberosa* (Photo-10)*, Ventilago maderaspatana* and *Ziziphus oenoplia;* trees like *Acasia chundra, Acer laurianum, Aegle marmelos, Alangium salvifolium, Albizia chinensis, A. odoratissima, Anogeissus latifolia, Artocarpus heterophyllus, Bauhinia racemosa, B. semla, Bixa orellana, Bombax ceiba, Bridelia crenulata, B. retusa, Buchanania lanzan, Butea monosperma, Callicarpa tomentosa, Canthium dicoccum, Careya arborea, Caryota urens, Casearia elliptica, Cassia fistula, Cassine glauca, Chionanthus ramiflora, Chloroxylon swietenia, Cipadessa baccifera, Cordia dichotoma, Dillenia pentagyna, Diospyros melanoxylon, Erythrina stricta, E. suberosa, Ficus racemosa, F. reliogiosaGardenia latifolia, Garuga pinnata, Gmelina arboreaHaldina* *cordifolia, Hardwickia binata, Lagerstroemia parviflora, Lannea coromandelica, Limonia acidissima, Litsea glutinosa, Madhuca longifolia* var. *latifolia, Mallotus philippensis, Mangifera indica, Michelia champaca, Persea macrantha, Phoenix laureirii, P. sylvestris, Phyllanthus emblica, Pongamia pinnata, Pterocarpus marsupium, Schleichera oleosa, Semecarpuss anacardium, Soymida febrifuga, Sterculia urens, S. villosa, Syzygium cumini, Tamarindus indica, Tectona grandis, Terminalia alata, T. arjuna, T. bellirica, T. chebula, Wrightia arborea, Xylia xylocarpa, Zanthoxylum armatum, Ziziphus rugosa* and *Z. maurtiana.*

# Chapter 12

# BIODIVERSITY CONSERVATION AND MANAGEMENT PLAN

## 12.1 Floral diversity

The vegetation (dry savannah) on the ridges invariably consists of herbaceous plants including grasses, which form the dominant community. The savannah vegetation on the hilltops (mine lease area) recorded less species diversity, since it is dominated by the stemless palm, *Phoenix acaulis* and another palm *P. loureirii.* Apart from the floristic diversity, the grasslands play a vital ecological role in conservation of moisture. Forests on the slopes consist of evergreen plants like *Persea macrantha, Anamirta coculus* (Photo-4)*, Cyathea gigantea,* etc.

The diversity values for different life forms like trees, shrubs and herbs showed that the mine lease area is less diverse with regard to diversity of trees and shrubs. There are two important indices to denote the diversity such as Shannon Wiener Index (H’) and Simpson Index (λ). The mine lease area showed Shannon Wiener Index (H’) value as 2.75 for trees, 1.363 for shrubs and 3.123 for herbs and Simpson Index (λ) values as 0.101 for trees, 0.383 for shrubs and 0.061 for herbs (Table 12.1). The study showed that regeneration of most of the woody species recorded in mine lease was very low, *Phoenix loureirii* showing better regeneration with highest IVI value (59.63) (Table 12.2).

**Table 12.1: Comparative account of vegetation parameters within project affected area and surrounding mine lease area of Jerrila blocks**

| Vegetation parameters | Mine lease area | Outside |
|---|---|---|
| **Trees** | | |
| Number of species | 27 | 48 |
| Stand density (Stems /ha) | 1050 | 1360 |
| Stand basal area ($m^2$/ha) | 19.13 | 31.95 |
| Shannon Weiner index (H’) | 2.750 | 3.467 |
| Simpson index (λ) | 0.101 | 0.047 |
| **Tree Saplings** | | |
| Number of species | 11 | 27 |
| Stand density (Stems /100 $m^2$) | 60 | 101 |
| Shannon Weiner index (H’) | 1.829 | 3.180 |
| Simpson index (λ) | 0.253 | 0.048 |

| Shrubs | | |
|---|---|---|
| Number of species | 12 | 26 |
| Stand density (Stems /100 $m^2$) | 280 | 186 |
| Shannon Weiner index (H') | 1.363 | 3.134 |
| Simpson index (λ) | 0.383 | 0.049 |
| **Herbs** | | |
| Number of species | 35 | 54 |
| Stand density (Stems /100 $m^2$) | 2380 | 3000 |
| Shannon Weiner index (H') | 3.123 | 3.391 |
| Simpson index (λ) | 0.061 | 0.049 |

**Table 12.2: Vegetation parameters of tree saplings in project affected area (Mine Lease Area) of Jerrila blocks**

No. of quadrats studied 10, Size of each quadrat 9 $m^2$

| Name of the species | N | D | F | RD | RF | IVI |
|---|---|---|---|---|---|---|
| *Albizia odoratissima* | 1 | 1.11 | 10 | 1.85 | 6.67 | 8.52 |
| *Diospyros montana* | 3 | 3.33 | 10 | 5.56 | 6.67 | 12.22 |
| *Glochidion tomentosum* | 4 | 4.44 | 20 | 7.41 | 13.3 | 20.74 |
| *Kydia calycina* | 2 | 2.22 | 20 | 3.70 | 13.3 | 17.04 |
| *Litsea glutinosa* | 6 | 6.67 | 10 | 11.11 | 6.67 | 17.78 |
| *Mallotus philippensis* | 5 | 5.56 | 10 | 9.26 | 6.67 | 15.93 |
| *Phoenix loureirii* | 25 | 27.78 | 20 | 46.30 | 13.3 | 59.63 |
| *Phyllanthus emblica* | 2 | 2.22 | 10 | 3.70 | 6.67 | 10.37 |
| *Sterculia villosa* | 1 | 1.11 | 10 | 1.85 | 6.67 | 8.52 |
| *Terminalia chebula* | 1 | 1.11 | 10 | 1.85 | 6.67 | 8.52 |
| *Ziziphus rugosa* | 4 | 4.44 | 20 | 7.41 | 13.3 | 20.74 |
| | 54 | | | | | |

Shannon Wiener index ($H' = -\sum pi \ln pi$) = 1.829   Simpson index ($\lambda = \sum pi^2$)= 0.253
N= No. of individuals; D= Density (Stems/ ha.); F=Frequency (%); RD= Relative Density; RF= Relative Frequency; IVI= Importance Value Index.

The density of various trees, lianas, shrubs and herbs varied greatly between the study sites (Table 12.1). This low value of number of species and density in mine lease area among different life forms may be attributed to the site quality and disturbances in the site. Grazing and illicit felling may also be one of the reasons for low species richness and low stand density in the site.

In comparison to the mine lease area, surrounding mine lease area showed better diversity values for all the life forms. The study showed the Shannon Wiener Index (H') values as 3.467 for trees, 3.134 for shrubs and 3.391 for herbs and Simpson Index values as 0.047 for trees, 0.0493 for shrubs and 0.0499 for herbs (Table 12.1). The study showed that the regeneration of most of the woody species recorded outside mine lease area was fairly good. Twenty seven woody species have shown regeneration. *Celastrus paniculatus, Ziziphus rugosa, Mallotus philippensis, Albizia chinensis, Sterculia villosa, Catunaregam spinosa* and *Homalium nepalense* have shown better regeneration with higher IVI values (Table 12.3).

**Table 12.3: Vegetation parameters of tree Saplings in surrounding mine areas of Jerrila blocks**

No. of quadrats studied= 10, Size of each quadrat= 9 $m^2$

| Name of the species | N | D | F | RD | RF | IVI |
|---|---|---|---|---|---|---|
| *Albizia chinensis* | 9 | 10 | 10 | 9.89 | 2.78 | 12.67 |
| *Albizia odoratissima* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Casearia esculenta* | 2 | 2 | 10 | 2.20 | 2.78 | 4.98 |
| *Casearia graveolens* | 2 | 2 | 10 | 2.20 | 2.78 | 4.98 |
| *Cassia fistula* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Cassine glauca* | 2 | 2 | 10 | 2.20 | 2.78 | 4.98 |
| *Catunaregam spinosa* | 5 | 6 | 20 | 5.49 | 5.56 | 11.05 |
| *Cleistanthus patulus* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Ficus hispida* | 4 | 4 | 10 | 4.40 | 2.78 | 7.17 |
| *Gardenia latifolia* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Glochidion tomentosum* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Grewia serrulata* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Grewia tiliaefolia* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Homalium nepalense* | 3 | 3 | 20 | 3.30 | 5.56 | 8.85 |
| *Kydia calycina* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Litsea glutinosa* | 2 | 2 | 10 | 2.20 | 2.78 | 4.98 |
| *Macaranga peltata* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Mallotus philippensis* | 4 | 4 | 30 | 4.40 | 8.33 | 12.73 |
| *Nyctanthus arbortristis* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Phyllanthus emblica* | 2 | 2 | 20 | 2.20 | 5.56 | 7.75 |
| *Pterocarpus marsupium* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Sterculia villosa* | 8 | 9 | 10 | 8.79 | 2.78 | 11.57 |
| *Syzygium cumini* | 4 | 4 | 10 | 4.40 | 2.78 | 7.17 |
| *Vendlandia gamblei* | 3 | 3 | 10 | 3.30 | 2.78 | 6.07 |
| *Ziziphus rugosa* | 7 | 8 | 40 | 7.69 | 11.11 | 18.80 |
| *Bauhinia vahlii* | 3 | 3 | 10 | 3.30 | 2.78 | 6.07 |
| *Celastrus paniculatus* | 20 | 22 | 20 | 21.98 | 5.56 | 27.53 |
| | 91 | 101 | | | | |

Shannon Wiener Index ($H' = -\sum pi \ln pi$) = 3.183; Simpson Index ($\lambda = \sum pi^2$) = 0.0478
N= No. of individuals; D= Density (Stems/ $100m^2$); F=Frequency (%); RD= Relative Density; RF= Relative Frequency; IVI= Importance Value Index

The outside mine area is very important in view of its phytogeography and occurrence of Himalayan, Northeastern and Western Ghats elements in the flora. A few plant species, namely, *Acer laurianum, Achronychia pedunculata, Bischofia javanica, Clematis smilacifolia* (Photo-7), *Cyathea gigantea, Ficus auriculata* (Photo-9), *Gnetum ula, Litsea glutinosa, Melasma avense, Persea macrantha,* etc., common to Himalaya, North India, Assam, Meghalaya and Western Ghats occur on these hills.

Diversity in a forest ecosystem can provide goods and services, while, at the same time sustainable harvesting of forest products would improve food security and nutritional status of the local people, with increased income generation and job opportunities. A forest ecosystem also serves vital ecological functions. Absorption of carbon dioxide and release of oxygen through photosynthesis help control the level of green house gases and create atmosphere conducive to support life systems.

## 12.2 Faunal diversity

The diversity of animal species and their abundance is largely dependent on the availability of suitable habitats. In nature, complex ecological equilibrium is achieved through intricate interactions between different organisms at various trophic levels. The dry deciduous tropical forests in their pristine form are rich abodes of a variety of fauna. Their existence is threatened due to habitat loss because of housing, agriculture, mining and multipurpose irrigation projects. As a result, vast areas of forests are cleared and faunal habitats and their diversity have drastically shrunk.

During the survey 10 species of mammals 82 species of birds, 11 species of reptiles and 24 species of insects have been recorded by direct and indirect methods. Out of these, no species is listed under Schedule I of Indian Wildlife Protection Act (1972) and grouped under vulnerable category (IUCN, 2007). If any animal encountered during the mine operations, must be rescued and released safely into alternate habitats with the help of state forest department. The same procedure should be adapted for other animals whenever they are encountered

However, habitat improvement around the proposed mine area should be adapted by planting suitable plant species under the afforestation programme. The plant species support wildlife for shelter and food. A dense green belt of shrubs and trees of different species must be created around the mine lease area and along the haul roads which acts as an acoustic barrier and absorbs vibrations. Awareness programmes amongst the local people as well as project staff regarding the importance of wild life, their habits and habitats should be conducted.

## 12.3 Aquatic faunal diversity

The survey area forms catchment of Machhakunda reservoir and consists of the watershed of Budugedda. The streams descending from the hills merge with the NE-SW trending valleys forming again an overall dendritic pattern. Springs on the hill slopes feed the perennial streams in the valleys below, which constitute the main water regime of the area. The people around the mine lease areas mainly depend on these seasonal and perennial streams for their daily needs and agriculture. Therefore, the conservation measures recommended should be implemented in *toto* to maintain the *status quo* of the streams in terms of flow and chemistry.

Mine discharges and waste disposal should be carefully planned in such a way that obstructions are not caused to drainage and affect the aquatic faunal diversity. During monsoon, rainfall in the area will be heavy and care needs to be taken to ensure smooth running of mining operations. Localized pits should be created for collection of water, which has to be pumped out. It is suggested that these pits should be constructed at two levels and lined with water proof material to minimize possible seepage. The pits should also be provided with filtration beds to trap sediments and other solid material. Pure water from the second pit should be let out slowly to join the streams, so that sedimentation effects in the streams will be minimal. The drain also should pass through a series of biological and engineering structures like gully plugs, check dams, rock filled dams and gabion structures, etc., to maintain the water to the near normal level before allowing it to flow in to the streams.

The overburden should be filled back in such a way that the water drains out into the streams in the same rate as is flowing now. Provision should be made to allow flow down of rain water gradually in all natural streams so that gullies leading to soil erosion are not formed. Garland trenches should be provided all along the active mine area to prevent soil erosion and siltation of streams. To prevent soil erosion due to rain water flow, soil binding grasses and herbs should be planted as recommended in Catchment Area Treatment Plan.

The ore is proposed to be transported by conveyor belt between blocks to a stack yard and by road to the refinery by trucks. To avoid dust pollution and possible fall of the dust into the streams resulting in change in water chemistry, it is recommended that water be sprinkled at frequent intervals on the haul roads to facilitate dust suppression and prevent its fall into the streams to maintain the water quality.

## 12.4 Conservation and Management Plan for Plant wealth

Several plant species have been reported in and around Jerrila bauxite mine areas. However, these species abundantly occur in the surrounding mine lease areas also. Hence, mining activity may not affect the biodiversity of these species.

Diversity in a forest ecosystem can provide goods and services while, at the same time sustainable harvest of forest products would improve food security and nutritional status of the tribal people, with increased income generation and job opportunities. A forest ecosystem also serves vital ecological functions. Non-timber forest produce (NTFP) species such as medicinal, food and commercial plants have to be planted on the over burden dumps under afforestation programme to compensate the dependence of tribes on forests.

Afforestation programme in the mined areas should be taken up to control landslides and soil erosion. Based on field surveys and studies, suitable plant species have been identified for the purpose and recommended. The plant species suggested for afforestation have one or more reasons for their suitability. Indigenous species are preferable than exotics because they are most likely to fit into a fully functional ecosystem. As a part of revegetation efforts, selection of desirable species adapted to the local environment should be given priority. Deciduous species of more economic importance and which can provide monetary benefits to the local people will be desirable in the long run. Species like *Andrographis paniculata* (Nelavemu, Kalmegh), *Artocarpus heterophyllus* (Panasa, Jackfruit), *Asperagus racemosus* (Pillitegalu, Sathavari), *Buchanania lanzan* (Chironji, Morli), *Caryota urens* (Jeeluga) (Photo-6), *Dendrocalamus strictus* (Veduru, Bans), *Diospyros melanoxylon* (Tendu, Tunika, Beedi aaku), *Jatropha curcus* (Nepalamu, Ratanjot), *Litsea glutinosa* (Naramamidi), *Madhuca longifolia* var. *latifolia* (Ippa, Mahua), *Mangifera indica* (Mamidi, Mango), *Phyllanthus emblica* (Usiri, Amla), *Pongamia pinnata* (Kanuga, Karanj), *Rauvolfia serpentine* (Patalagaruda, Sarpagandhi), *Semecarpus anacardium* (Nallajeedi, marking nut), *Terminalia bellirica* (Tandra, Tadi, Baheda), *Terminalia chebula* (Karaka, Harra) and *Wrightia arborea* (Pala) will give one or other kind of NTFP which will help in improving the livelihood of the people. The sites of plantation should be nearer to the settlements so that the traditional vocation of colleting NTFP remains unaffected. Similarly site specific species like *Albizia odorotissima, Anogeissus latifolia, Buchanania lanzen, Cassia fistula, Cipadessa baccifera, Diospyros melanoxylon, Mallotus philippensis, Phoenix acaulis, Semicarpus anacardium, Terminalia* spp. *Zanthoxylum armatum,* etc. are well suited for afforestation in similar areas with moist conditions. When these species establish in disturbed areas, nature itself takes care, if further disturbance is avoided. Seeds or propagules coming from inside or from adjacent forest areas through different dispersal agents get easily established and acclimatize to the environment. This vegetation will help to prevent soil erosion through wind and water.

Grazing by domestic animals and illicit felling should be prevented by providing suitable alternatives. Sufficient pasture lands should be developed around the mine areas and smoke less chullahs and/or biogas plants should be provided to the tribal people affected by the mining activity to minimize their dependence on the vegetation around.

In order to minimize the impact of mining on the vegetation outside the mine area, adequate protection measures have to be followed. They include assisted regeneration in the forest areas and soil and water conservation measures. As mining involves movement of vehicles and increased anthropogenic activities, mine dust should be suppressed by regular sprinkling of water on the overburden areas, mine hauling areas and on haul roads. A green belt consisting of five rows of shrubs followed by five rows of trees have to be planted (3 m x 3 m spacing) to mitigate dust pollution. The green belt will act as a barrier to trap the suspended dust particles and also to suppress the air pollutants. It is also important to establish a green belt with tall seedlings of indigenous species (>1 m height) so as to create the green belt during the initiation of the project to ensure good survival percentage.

All the plantations suggested above should be undertaken around the mine lease areas nearer to settlements so that the traditional vocation of collecting NTFPs remain unaffected. Forest vegetation is equally important in wildlife management and cattle rearing because herbivorous animals depend mostly on grasses. Hence, fodder yielding plant species should be planted around the mine lease area during the afforestation activity.

## 12.5 Conservation and Management Plan for Wildlife

Large number of rock fill dams and check dams have been proposed around the mine areas to prevent the soil erosion, store sufficient quantity of filtered water in the area, act as water holes for the wildlife. Sufficient number of salt licks should be placed around the water holes, which will supplement the nutritional status required by the wild animals. Proposed massive afforestation programme around the mine areas and along the catchment areas consist of minor forest produce including fruit bearing tress, which will provide food and shelter to the wildlife.

Placement of more efficient trained staff in the proposed wildlife cell will provide better protection to the wildlife of the area. Intense campaign amongst the local people as well as project staff regarding the importance of biodiversity of wildlife, their habits and habitats and the need for their conservation for posterity will help in reducing the incidences of hunting especially during the festival seasons.

The main threats to wildlife will be from the destruction of their habitat because of biotic pressures. The shrub cover and grass lands outside the mine areas provide the much needed corridor to the animals to migrate to other areas, thereby, continuing the genetic diversity. However, the loss of this cover due to construction of haul roads and heavy vehicular movements will restrict the animals' movement to the adjoining areas. Therefore, development of a green belt and massive afforestation programme of fruit bearing and shade bearing plant species around the mine lease areas has been proposed for the free movement of wildlife for their food and shelter.

The conservation and management of wildlife are to conserve the biodiversity of the area, improvement of the habitat by planting of palatable grasses and other indigenous fodder species, eradicating weeds, improvement of water regime, stabilize various slips and streams to reduce and ultimately minimize the silting of streams, control of illicit lopping and grazing. Therefore, the following measures are proposed to protect the wildlife around the mine lease areas:

i. Carry out soil stabilization works in the erosion prone areas by constructing biological and engineering structures along with vegetative spurs to reduce the siltation of streams
ii. Improving water regime by constructing water troughs and water ponds
iii. Reducing the incidence of illicit lopping and firewood removal by supporting and encouraging use of LPG/smokeless chula by households in villages surrounding the mine areas
iv. Sensitizing the involvement of people in conserving and improving ecology of the area by carrying out eco-development works in the surrounding villages to prevent the hunting and effective control on poaching

In order to coordinate all the efforts on one platform it is proposed that a **Forest and Wildlife cell** with wild life professionals and supporting staff has to be constituted, under the direct supervision of wildlife wing of State Forest Department of Andhra Pradesh. Expertise from universities, research originations, NGOs and SHGs has to be drawn and their vivid experience can be made use of for the ultimate benefit of the ecology and society.

Intense campaign has to be launched to create awareness amongst the local people as well as project staff regarding the importance of biodiversity of wildlife, their habits and habitats and the need for their conservation for posterity. Before the mining operations, the project authorities have to establish a "**Forest and Wild Life Management Cell**" consisting of competent professionals to undertake mine dump rehabilitation, management and conservation of wildlife in the proposed mining areas. The Cell should consist of the following officers and staff to mitigate the problem.

i. Deputy Conservator of Forests – 1 Nos.
ii. Forest Range Officers – 3 Nos.
iii. Forest Section Officers – 3 Nos.
iv. Forest Beat Officers – 6 Nos.

Adequate supporting staff will be provided to the cell.

# CHAPTER 13

# SOLID WASTE MANAGEMENT PLAN

## 13.1 Introduction

The waste management plan identifies various wastes that would be generated from the mining operations and suggests possible means of management of the wastes. Operations commonly found in mining projects comprises land clearing, drilling and blasting, excavation, cut-and-fill operation (i.e. earth moving), material storage, handling and transportation of the ore on road/rail surfaces for further processing.

## 13.2 Sources of Waste generation

The different kinds of waste generated during the project are:

- Waste while clearing the area during pre-mining operations
- Over-burden and top soil excavated during mining
- Excavated waste during strengthening / constructing roads, construction/laying of Conveyor belt used for material transportation
- Excavated earth during construction of buildings for various facilities
- Waste generated from crushing operations
- Solid waste generated (dry & wet) from various facilities like administration, training centres, canteens etc.
- Waste generated (liquid & solid) from workshops provided for O&M of the mining equipments.
- Waste generated during mine site clearance during post-mining operations.

## 13.3 Waste Disposal Methods

### 13.3.1 Waste while clearing the area during pre-mining operations

Large amount of waste is generated in the form of felled trees, shrubs and other kinds of ground vegetation. The cleared trees should be transported so that the available timber would be used efficiently and the waste could be transported to the dumping site or can be burnt off. Burning any kind of material (including cut vegetation) should be avoided at the mining site.

### 13.3.2 Over-burden and top soil excavated during mining

**Waste generation**

Detailed exploration of Jerrila Block I bauxite deposit during 1970s by the Geological Survey of India (GSI) showed that the ore is exposed to surface with little overburden over the topsoil. The overburden consists of soil and float ore with clay pockets.

The waste material includes partly altered basement rock, laterite with high silica, iron and low alumina and lithomargic clay. It occurs as intercalations within the bauxite layer and is separate from useful bauxite. It is proposed to dump this waste in such places from where it can be re-handled for backfilling the worked outpit. The total waste likely to be generated at the end of the mining operations is of the order of 0.58 million tonnes including intercalated material and overburden from parts of the deposit. The following conceptual calculations give an idea of the picture of reclamation at the end of the mining in the entire block after 12 years.

The total volume of waste generated would be 0.58 million tones waste i.e. approximately 10 % of the 5.8 million tonnes exploitation. The waste will be adequate to fill and reclaim area of mined outpit, down to an average depth of 10 m (considering average ore thickness), giving allowance for compaction. This is contiguous with the area backfilled at the end of the first five year. The total waste of 0.21million tonnes generated during the first five years will be adequate to fill pit of (300m x 100 m x 10m). The reclaimed area at the end of the first five years will be about 3.0 ha. The remaining part of the pit will be water filled in due course. The soil scraped out of several patches on top of the plateau in advance of mining will be utilized in the plantation programme progressively. The plantation shall be as a green belt, within the 7.5 m wide barrier zone, and on the reclaimed area.

Similarly, the material will be stacked separately at selected sites. The waste dumps will be properly built and terraced. The overall height of the dump will vary around 15 m with steps of 6 m each. Overall slope will be 15 to 20 degrees. Garden drains will be constructed around the dumps. Sump pits will also be dug to collect the silt material. Green belt will be developed on the dumps and peripheral barrier of lease boundary.

It is proposed to quarry about 0.5 million tonnes on average per annum. The proposed production for the first five years is shown below. The average bulk density of the bauxite ore is 2 and that of the intercalated waste as 1.5 m in the computations. As already mentioned, 10% of the run-of-mine material is expected to be waste.  The total extraction of bauxite during the first five years shall be about 2.50 million tonnes with the expected waste generation of 0.21 million tonnes.

The production will on an average be 0.56 million tonnes when the mine is fully developed. It is possible to augment the annual production in case the alumina plant expands its annual capacity.

The Geological Survey of India based on detailed exploration estimated a Total Reserve of 6.8 million tonnes. Assuming that a quantity of 10 % will be left behind in the barrier zone and benches and another 5 % mining losses, the mineable reserve for the entire block is of the order of 5.8 million tonnes. Working at the rate of 0.5 million tonnes per annum the reserve may last for 12 years. However, the possibility of an increase in the production still exists.

**Summary of Production of Bauxite for the period 2008-09 to 2012-13**

| Year | Period | Production of Bauxite (Tonnes) | Production of waste Material (Tonnes) |
|---|---|---|---|
| I | 2008-09 | 452,070 | 37,672 |
| II | 2009-10 | 472,725 | 39,394 |
| III | 2010-11 | 491,175 | 40,931 |
| IV | 2011-12 | 519,975 | 43,331 |
| V | 2012-13 | 571,725 | 47,644 |
| | | 2,507,670 | 208,973 |

Top soil which forms 2 to 3 percent of waste material is scrapped and stacked separately. Loose material in the contact zone of ore with parent rock will also be collected and stacked separately.

**Waste disposal**

The waste material will be stacked in selected waste dump yard in non-mineralised area and will be used for back filling of mined area. The waste dumps will be properly built and terraced. The overall height of the dump will vary from 15 to 20 m with steps of 5 m each. Overall slope will be 15 to 20 degrees. Garden drains will be constructed around the dumps. Sump pits will also be dug to collect the silt material (Figure 13.1).

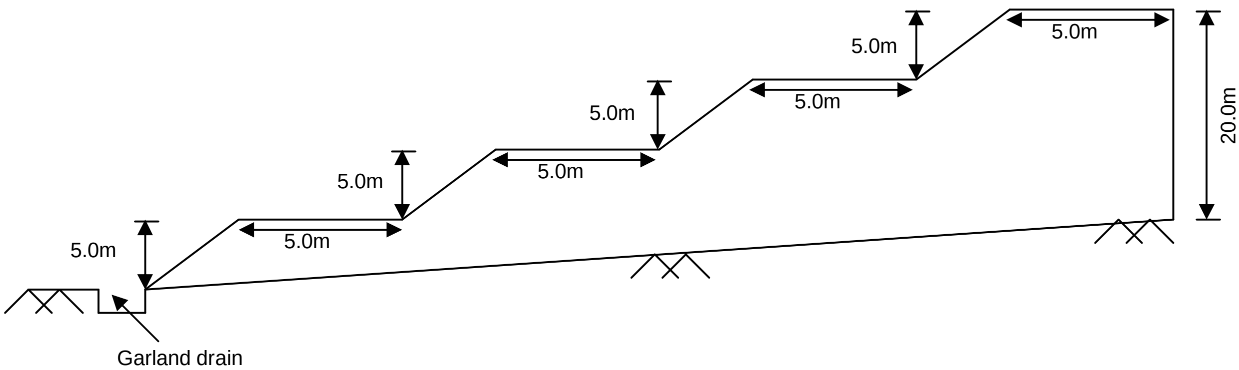
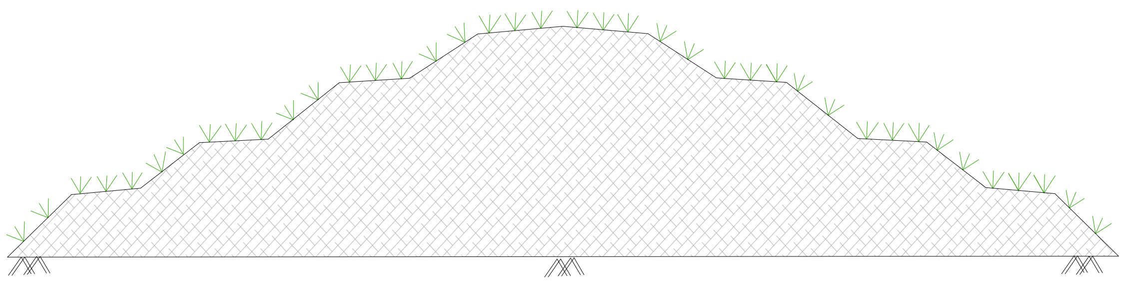



**Figure 13.1: Typical section of waste dump site**

It is suggested that the terraces as and when built will be vegetated by local grass variety. Such a method reduces erosion of the top soil or the over burden material stacked up and also makes the dump yard into a green area. (Figure 13.2)



**Figu**

**re 13.2: Typical side elevation waste dump site**

Once bauxite is fully exploited, the waste material will be back filled in the mined area. Reclaimed land is then subjected to afforestation programme. The top soil, collected and stacked separately, will later be used to cover disturbed areas and cut slopes and also for re-development of borrow areas, landscaping and road-side plantations (Figure 13.3).

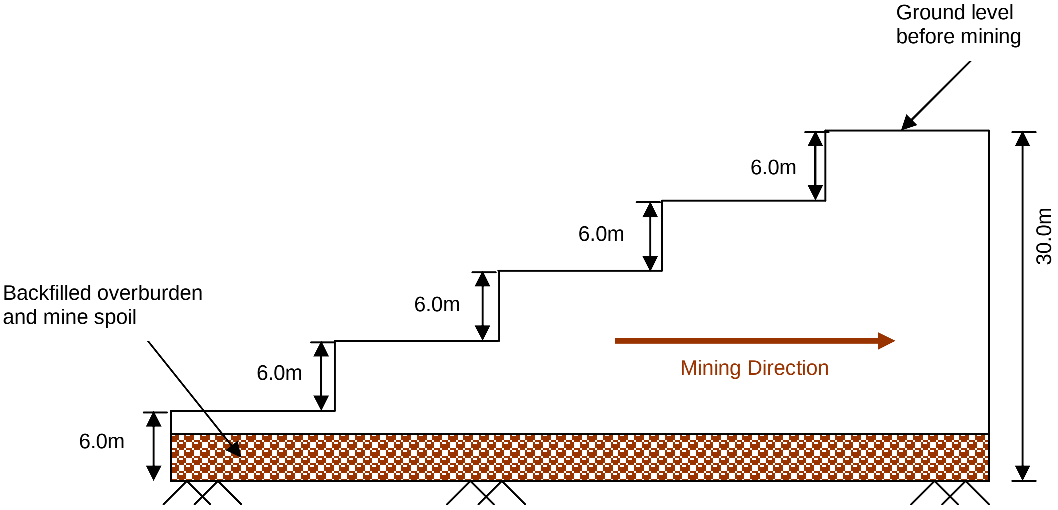



**Figure 13.3: Typical section of Mining area**

### 13.3.3 Excavated waste during strengthening of roads / construction of Conveyor belt for material transportation

During the modification or strengthening of the roads / laying of conveyor the land would be excavated for making a base or foundation of supporting features. The buffer zone would also be levelled in case wherever such requirement is found particularly the obstructions in the chainage of road/ conveyor. Waste generated during the construction is mostly felled trees and debris from excavation. The excavated soil could be used for refilling at the mining site or during construction of various facilities and the trees could be transported to the timber depot where the material could be used efficiently.

### 13.3.4 Excavated waste during construction of buildings for various facilities

Waste generated during the construction is mostly debris from excavation. The excavated soil could be used for refilling at the mining site or during construction of various facilities. Soil can also be used for re-plantation within the proposed green belts.

### 13.3.5 Waste generated from crushing plant

Waste generated from crushing plant is mostly crushed bauxite ore or crushed pieces of other rocks excavated during the mining operations. It is suggested that the crushed waste should be reused wherever possible and un-utilisable should be disposed scientifically at the nearby waste disposal site. Negligent disposal of the waste near the mining area or within the reserved forest area should be avoided.

### 13.3.6 Solid waste generated (dry & wet) from various facilities like administration, training centres, canteens etc and hospital waste from the first-aid centre

Solid waste generated from various facilities like administration, training centres, canteens etc., provided at the mining site and hospital waste from the first-aid centre should be collected, transported and disposed at nearby waste disposal site instead of carelessly spreading it all over the forest area.

### 13.3.7 Waste generated (liquid & solid) from workshops provided for O&M of the mining equipments.

Waste generated from workshops provided for O&M of the mining equipments generally contain oil, grease, metallic substances and other chemicals in liquid form and some solid waste like broken metallic equipments etc. Such waste should be disposed off cautiously without letting it mix with the natural flowing water or ground water thus avoiding contamination of water resource. The waste generated from these workshops could be collected in a storage tank and disposed off to the nearby Hazardous Waste Treatment Plant located at Visakhapatnam.

### 13.3.8 Waste generated during mine site clearance during post-mining operations

Waste generated during post-mining clearance operations should be stabilized appropriately. A major portion of clearance involves back-filling of the entire stocked material into the mined area. This back-filling should be done scientifically and should be stabilized properly so that the mined site reaches to near original state even at a lower ground level.

### 13.4 General suggestions for waste minimisation/management:

- Soil is susceptible to erosion and degradation due to excavation of soil. The same should be planted with grass to keep intact the soil zone
- Oil and fuel spills from mining equipment should be minimized by good O & M practices. Soils contaminated by such spills should be disposed as per norms.
- Use of precautionary measures while excavating at slopes along the traverse length of the conveyor system
- Negligent disposal of waste near the mining area or within the reserved forest area should be avoided.
- Temporary disposal of debris, felled trees or locating labour camps and stockyards and all the other activities beyond the mining areas must be avoided near forest zones.
- During site clearance activity, the removal of debris shall be regular and preferably during non-peak hours and with deployment of more vehicles for the purpose.
- Slurry or similar debris generated in case of any deep excavation activities shall be disposed off such that it does not flow into surface water bodies or form mud puddles in the area.
- All vehicles delivering material from site shall be covered to avoid spillage
- Proper signage should be provided for facilitation of vehicle movement near the area.
- All earthwork material should be protected in such a manner so as to minimize generation of dust
- As soon as mining activity is getting over the surplus earth should be utilized to fill up low-lying areas. In no case, loose earth should be allowed to pile up along the route.

- Excavated overburden should be properly disposed off at locations that doesn't obstruct the natural rainwater flow/runoff
- The activities of dumping overburden should be carried out in a systematic manner taking into consideration the contamination of soil due to interaction with water, downward movement of dumps due to gradient and increasing risk factor for accidents, etc.

## 13.5 Institutional Mechanism

Institutional Mechanism shows the role of various departments/teams in the implementation of the plan.

Various departments involved are:

- Contractor's monitoring team apart from the workers proposed for the activities
- Forest department team
- APMDC team

Contractor's monitoring team should take the responsibility of monitoring all the activities proposed in the waste minimization plan apart from the regular mining activities. It is suggested that there should be a separate team of 3 members for monitoring waste minimisation plan.

Forest department employees also play a vital role in monitoring the entire mining process. The department should depute at least 3 persons for monitoring the mining process of which one person would monitor the waste minimisation activities, the most important being solid waste & hazardous waste management.

APMDC team members should supervise all the activities proposed in the plan along with the major mining activities.

## 13.6 Monitoring Plan

Monitoring plan is necessary for effective implementation of the waste minimisation plan activities and gives various institutional arrangements and performance indicators necessary for monitoring.

**Performance Indicators**

In order to evaluate the effectiveness of EMP measures, certain performance indicators have been identified. These indicators need to be analysed based on the project level data collected during the pre-mining and operation stages of the project. (Table 13.1)

**Table 13.1: Indicators for major activities proposed in the plan**

| S. No | Activity | Indicator |
|---|---|---|
| 1 | Plantations around and over the spoil trenches | • Number of plantations made and survival rate of the plants<br>• Site visit |
| 2 | Regular transportation of solid & hazardous (oil wastes) wastes generated at the site | • Record books maintained for transportation facilities<br>• Record for total quantity transported<br>• Site visit |
| 3 | Regular transportation of cleared grass & trees generated at the site | • Record books maintained for transportation facilities<br>• Record for total quantity transported<br>• Site visit |
| 4 | Proper signage should be provided for facilitation of vehicle movement | • Number of sign boards provided and their locations at the site<br>• Site visit |
| 5 | Reuse of the top soil, over burden and excavated earth | • Record for total quantity generated and reused. |

## 13.7 Budget Details:

**Table 10.2: Budget break-up**

| S. No | Category | | Amount in Rs per yr |
|---|---|---|---|
| 1 | Plantation around the spoil | Lump sum | Rs 10,00,000 |
| 2 | Plantations over the spoil trenches | Lump sum | Rs 30,00,000 |
| 3 | Water pumps (3 Nos) | Rs 100000/pump | Rs 3,00,000 |
| 4 | Transportation for solid waste dumping from the site | Rs 10000/day | Rs 36,50,000 |
| 5 | Transportation of Timber & other tree felling during clearing operation | Lump sum | Rs 5,00,000 |
| 6 | Watch & Ward (10 persons) | Rs 5000/month/person | Rs 6,00,000 |
| 7 | Contingencies | Rs 50000/month | Rs 6, 00, 000 |
| **Total Amount** | | | **Rs 101,70,000** |

**Total** amount required for waste management is **Rs 101.7 lakhs per annum.**

**Total** amount required for waste management is **Rs 505.35 Lakh by the end of five years.**


Solid Waste Management Plan for
Jerrila Bauxite Deposit Block I
Magazine
Crushing Plant
Utilities
Plantations
Top Soil Disposal
Dumping Site
Stores
Office
First Aid Station
Canteen
Workshop

# CHAPTER 14

# SOCIAL MANAGEMENT PLAN

## 14.1 The Requirement for a Plan

The Social Management Plan is required to mitigate the impacts on the local population due to the project activities. Based on the baseline information collected from the primary and secondary sources, a suitable rehabilitation strategy has been formed in order to provide maximum benefits to the population, which is predicted to be deprived from their dependence on the natural resources because majority of the population in the project area are tribal. The social management has been proposed, considering the habitations surrounding the mining for rehabilitation of the persons directly and indirectly affected on account of livelihood dependency.

## 14.2 The Objective of the Plan

The main objective of the plan is to propose suitable mitigation measures for the impacts identified due to mining activity in the adjoining area of the proposed mine site with the aim to create a balance between the free flowing of the proposed mining activity and by providing the necessary mitigation in order to create good living standard /uplift the socio-economic conditions for the project affected population. Thus the plan emphasis for the infrastructure and community development issues for the affected area. The emphasis laid on the areas including the basic needs such as education, health, water and infrastructure etc.

## 14.3 Baseline Conditions

The study of socio-economic component incorporating various facets related to socio-economic conditions in the area is an integral part of EIA, are dealt in previous chapter. The aesthetic environment refers to environmental services of the area, forest, water resource, produce and wildlife, historic and cultural monuments. The study of these parameters forms the basis for identifying, predicting and evaluating the potential impacts due to proposed project activities.

The land acquisition for Jerrila Bauxite Mining Project includes both forest land and revenue land. The village Kondrapalli, which is the nearest habitation would be the one that will be indirectly affected due to proposed mining activities as some of the families are settled near the foothills of the mining area. In-order to protect the interests of these partially affected people (PAF), adequate management for their rehabilitation has to be considered as there is no direct displacement involved in the implementation of the project. Therefore resettlement is not required, except for rehabilitation of those individuals who will be indirectly deprived of their dependence on natural resource

The land affected by mining is only restricted to the mine lease area and the area where the conveyor belt would be laid. The mine lease area have no human settlements, so, the socioeconomic impacts identified are pertaining to their livelihood dependency on forest resources as majority of the population are tribals and dependent on the forest for their daily sustenance.

Accordingly, following are the areas identified for rehabilitation of the population residing close to the mine lease area:

- Provision of wage employment in the mining operations and other related activities
- Infrastructure and amenities development
- Capacity Building for self employment based on NTFP & NRM activities
- Improvement of livelihood opportunities.

The plan also includes institutional and monitoring mechanisms, budget allocation etc.

### 14.3.1 Socio-Economic Features

The details on socio-economic features of the region and impacts are discussed in socio economic environment chapter. The village level studies on socio-economic aspects were carried for 10 km radius from the proposed mining site, while detailed household study was carried out for buffer area of 5 km radius from the proposed Jerrila mining deposit Block I.

The secondary data was generated using sources viz. village directory, census records, district statistical abstracts, official documents, and primary data collection through field observations, interaction, community participation, stakeholders perception and PRA. The total 10 km radius study area comprises of sixty-six villages, from three mandals of

Vishakhapatnam district (2 villages under G. Madugula; 32 villages under GK Veedhi, 24 villages under Chintapalle) and one sub-block, Malkajgiri of Orissa State (8 villages).

The buffer area of 5 km covered for household survey, have 9 villages that fall under Chintapale mandal (234 households consisting of 1162 people); 21 villages under GK Veedhi Mandal (875 households consisting of 4229 people; and one village Kerappale under Malkanjgiri sub district area of Orissa (6 households consisting of only 21 people).

## 14.4 Rehabilitation Strategy

The proposed mining activity has no direct impact on any household or habilitation and thus, no resettlement or displacement is required in this project. But due to certain indirect impacts as assessed by the team and felt by the local people or the project affected population, a rehabilitation package has been formulated to benefit the community to utilize the royalty earned from the mining activity for the local people to improve their lifestyle/ upliftment of the socio-economic status; through various infrastructure development. Based on the baseline of socioeconomic status of the people in the study area, the following packages have been prepared for the PAFs.

### 14.4.1 Community Development Initiatives

The majority of the population in the study area belongs to the Schedule Tribes (ST) ethnic group and their economy is agriculture and forest based. The income level is very less in the area (Rs. 6000-8000/annum) Based on their life style and traditional knowledge to support their livelihoods and as per their skills certain community development initiatives have been suggested.

#### 14.4.1.1 Entrepreneurship and Skill development

The identification and skill for tribal people is essential for improving their income generating capacity. This activity shall be generated through identified NTFP utilization or any wage based activity. Thus, Potential available for skill oriented training to develop their trademanship and establishing unit has been proposed to be 2-3 lakhs/person/unit.

The wage employment target group is part of the non-worker population, educated unemployed, marginal cultivators and marginal household workers. The self employment category potential available for the rehabilitation would be cultivators, SHGs, educated unemployed, main workers, marginal workers and household workers.

**Training**

The survey data reveals equal number of population as worker and non-worker population, i.e 48 – 52 %. The non-worker population includes children and women. Thus the potential workers group of unemployed youth and tribal women shall be trained for various skills to promote self employment based on the natural resource as skills required for employment related to mining activities shall be identified in the area through cluster analysis. Accordingly, the population for skill development for various training shall be recommended on natural source base such as handicrafts, broom making, adda leaf plate making and honey processing etc., depending on their choice and based on the local skills such as vocational training courses, like ITI for technical training, skills for reclamation of the site shall also be identified and organized by APMDC through identified training institute nearby.

The total target groups identified for training are 1500 for wage employment and 500 for self employment. Accordingly, the funds required would be Rs. 75,00,000/- and Rs. 10,00,000/- respectively.

**14.4.1.2 Employment**

The project authorities shall assure employment to project affected families on priority basis during the mining and restoration activity based on capacity of unskilled and skilled workmanship available. Apart from this, the affected families shall be given financial assistance for starting some gainful occupation/ getting training to facilitate secondary employment in the region based on their willingness and resource available. The Project authorities will also consider to award petty contracts to the eligible Project Affected Families (PAFs) on priority basis.

**14.4.1.3 Self – Employment**

Self employment through development of entrepreneurship with natural resource based potential such as Minor Forest Produce (MFP) and promotions of vocational training for the local people through enterprises shall be taken up by the project authority. The activities identified for MFP and Micro enterprise development are as below:

**Utilization of Minor Forest Produce (MFP)**

It is clear from occupational pattern that more than 50% of population falls in the non-worker category. The women occupy the major population and are marginal agricultural labour. The women between 15 to 45 years of age are target group for MFP activities as 40 to 60 % of women population can be benefitted from NTFP related activities. In addition, youth can also be trained in these activities. The minor forest produce based activities are mainly related to collection of local forest resources, their processing and value addition for marketing with effective market mechanism.

Careful identification of alternative livelihoods is very important when dealing with project affected people of ethnic tribal and rural areas within the project area. The availability of raw material, financial resources, types of markets and the nature of target groups have to be carefully assessed before suggesting and implementing the micro enterprises. The cluster base approach shall be adopted for effective implementation.

The region is rich with Adda, Bettlenut and banana, sisal fibre, fruits like guava, pineapple, mango besides various kinds of herbs. Most of the villages do not have power supply and the tribal people heavily depends on wood for cooking, lighting and other heating purposes and thus assistance of LPG or Solar Heating or fuelwood plantation activities shall be promoted. Majority of the people are very poor and cannot invest substantial amounts for micro-enterprises and Marketing. Thus for micro enterprise it is suggested that option for low investment with simple technology for easy livelihood opportunity shall be promoted which has established market and market potential.

The most potential target groups for such activities are the self help groups (SHGs) educated unemployed youth and marginal farmers. But all of them require skill based training and entrepreneurship development programme with effective marketing mechanism for long term sustainability. The potential natural resource base, raw material demand, investment range and marketability shall be assured and an identified training & marketing institution shall be assigned with regular monitoring mechanism for effective implementation by the project authority.

The few identified areas are Tamarind Briquetting, Leaf plates and cup making, Sisal fibre Extraction, Jack fruit chips, Herbal Mosquito repellant, Amla Processing, Banana Fibering, Fruit Pulp making, Vermicompost, Bio-pesticides Neem,. The project costs, market, target groups and source of technology is given in **Table 14.1**. The **Table 14.2** shows the cost for such development for an average of 175 micro-entrepreneurs to benefit atleast 905 population in the study area. The cost estimated @ present rate for such development would be **Rs. 2.16 Crores**.

**Table 14.1: Project Cost for Activities based on Forest based resources**

| S.No | Name of the Profile | Project Cost (In Rs.) | No. of Units Suggested' | Employment per unit | Total Employment per profile | Total Investment per profile (In Rs.) |
|---|---|---|---|---|---|---|
| | | **A** | **B** | **C** | **Bx C** | **A x B** |
| 1 | Tamarind Briquetting | 57,800 | 25 | 5 | 125 | 1445000 |
| 2 | Leaf Plates Making | 244000 | 20 | 6 | 120 | 4880000 |
| 3 | Sisal Fiber Extraction | 101500 | 20 | 5 | 100 | 2030000 |
| 4 | Jack Fruit Chips | 43,400 | 20 | 3 | 60 | 868000 |
| 5 | Herbal Mosquito Repellants | 200700 | 10 | 8 | 80 | 2007000 |
| 6 | Amla Processing | 163700 | 10 | 6 | 60 | 1637000 |
| 7 | Banana Fibering | 101500 | 10 | 4 | 40 | 1015000 |
| 8 | Fruit Pulp Making | 69,300 | 10 | 4 | 40 | 693000 |
| 9 | Vermicomposting | 121600 | 20 | 5 | 100 | 2432000 |
| 10 | Bio-Pesticides - Neem | 376200 | 10 | 10 | 100 | 3762000 |
| 11 | Palm Fiber | 45,900 | 20 | 4 | 80 | 918000 |
| | **Grand Total** | | **175** | **64** | **905** | **21627000** |

*****worked out @ current rates (2008)

**Table 14.2: Suggested Micro Enterprises based on Local Forest Resources**

| S. No. | Name of the Profile | Project Cost | Market | Target Group | Source of Tech. |
|---|---|---|---|---|---|
| 1 | Tamarind Briquetting | 57,800 | In the regions where tamarind crop is grown abundantly, the raw fruit has to be dried and briqetted before selling it to the wholesalers and traders as the demand for it in such areas is very high | Women, Self help ghroups, Marginal farmers | Shri Industries, Ichankarangi, Sholapur, Maharashtra |
| 2. | Leaf Plates Making | 2,44,00 | The leaf Plates and cups are having good demand in rural areas of South India due to their traditional and aesthetic appeal. Moreover the Government also encouraging of eco friendly products. | Educated Unemployed Youth, SHGs | M/s Annapurna Industries, Hyderabad |
| 3 | Sisal Fiber Extraction | 101500 | Because of its multi utility in Paper making, Yarn Making and other binding ropes the demand for the product is very high. As sisal is grown in rural areas the fiber extraction unit is highly viable. | Marginal Farmers, SHGs | KVIC, APKVIB |
| 4 | Jack Fruit Chips | 43,400 | The chips are having good demand especially in the South Indian States like Kerala, Andhra Pradesh and Tamil Nadu. Due to their low calorie content they are also becoming popular in Europian Countries, as there is tremendous export potential. | Women, SHGs, Educated unemployed youth | Shri Industries, Ichankarangi, Sholapur, Maharashtra |
| 5 | Herbal Mosquito Repellants | 2,00,700 | The herbal mosquito repellents are eco-friendly and do not give any side effects. Consumers especially in urban areas are in lined to purchase such eco friendly herbal products. As such the market for such products is growing rapidly. | Educated Unemployed youth, SHGs | GIAN, Ahmedabad, Gujarat |
| 6. | Amla Processing | 1,63,700 | Amla pulp is having good demand with Ayurvedic Medicine manufacturing Industries, Non-edible oil making units and also pickle making industries. There is a good demand in Andhra Pradesh as there is good concentration of Ayurvedic industries. | Educated unemployed youth, Marginal farmers | Shri Industries, Ichankarangi, Sholapur, Maharashtra |
| 7 | Banana Fibering | 1,01,500 | Bananas are grown in rural India as good omen & the fiber from them is becoming most important raw material to ever expending market for paper & cloth manufacturers, which are also eco friendly. | Marginal Farmers, SHGs | KVK, Rajahmundry, AP |
| 8. | Fruit Pulp Making | 69,300 | In coastal areas where availability of fruits is high and industries like mango jelly making, pineapple and fruit juices are heavily concentrated the market for fruit pulp is very high. Since it requires minimum investment the project is also financially viable | Women SHGs/ Marginal Farmers | Shri Industries, Ichankarangi, Sholapur, Maharashtra |
| 9 | Vermi | 1,21,600 | The demand for the Vermicompost is increasing since late nineties with | Marginal | KVIC/ APKVIB |

| | | | | | |
|---|---|---|---|---|---|
| | composting | | increasing awareness among the farming community. Due to low price and easy availability farmers are opting for vermicompost than synthetic fertilizers. If this facility is available in important centres of tribal areas, tribal farmers may sell the product at value addition. | Farmers/ SHGs | |
| 10 | Bio-Pesticides - Neem | 3,76,200 | There is tremendous scope for using Neem products in organic farming. Neem Pesticide consumption has doubled in tea-estates during last few years. This was due to insistence of importing countries on pesticide residues. The market for pesticides will increase, as the farmers become aware of benefits and also due importers insistence on residues. | Marginal Farmers/ Educated unemployed youth | CREDA, Hyderabad |
| 11 | Palm Fiber | 45,900 | Palm is used in many fields. It has great demand in India. The rural entrepreneurs who live in tropical areas where growing of palm is high can start a palm fiber extraction unit as it has good marketability. | Marginal Farmers/ SHGs | KVIC/ APKVIB |

#### 14.4.1.4 Promotion of various economic activities

Economic rehabilitation would be done through promotion of various economic activities such as agriculture, horticulture, animal husbandry, cottage and small-scale Industries etc. These occupations besides meeting the food requirement of the affected household are likely to be helpful in uplifting their economic condition. In general, the main crops found in the region are coffee, rice, and ragi. The yields of these crops are very low, due to traditional farming practices. Therefore providing the improved eco-friendly technology and quality planting material to improve the production through organic farming and improved irrigation facility is proposed. An allocation of Rs. 50, 00,000/- is proposed for such activities.

#### 14.4.1.5 Grants for SHGs

Grants to Self Help Groups for utilization of local resources potential for manufacturing and income generation. This is also for enhancing the productivity of existing agriculture, horticulture, animal husbandry, fisheries and allied small scale industries. Rs. 40 lakhs is allocated to SHGs.

## 14.5 Infrastructure Development

The community development strategy would be targeted to address the needs of the twenty villages within the study area. The types of activities envisaged include education, water supply, health facilities, housing and transport. Other facilities like market centre and community recreation centres at few locations are also proposed.

### 2.5.1 Community infrastructure

#### 14.5.1.1 Education facilities

There are only primary schools and 1 middle school in the region and there is no higher secondary school. An amount of Rs. 48 lakhs for school building (40000 sft x Rs. 1200) and Rs. 20 Lakhs for operational costs @ current rate has been proposed for running higher secondary school upto junior college level in the study area village. A degree college at the cost of 200 lakhs has been proposed at Jerrila. Proposal of an ITI at the cost of Rs 100 lakhs has been made.

#### 14.5.1.2 Water Supply Facilities

Drinking water is the main problem in this area .The accessible water is only through natural springs, to the people. There are only few handpumps in the region. Provision to provide 31 hand pumps in the villages, at a cost of Rs. 62,00,000/- and Water tanks connection with an additional outlay of 62,00,000/- for 31 over ground tank of 750 KLD each in the affected village is proposed.

#### 14.5.1.3 Health Facilities

There are 3 villages in the region having 7 government run public health centre and a sub center for the entire 10 km study area. There are very few health centre facilities in 5 km buffer area, and no specific facilities for Maternity care in the region. It has been proposed for health care facility, and a mobile hospitals to cater the emergency in the region with proposed cost of Rs 1,78,00,000/-. A Hospital at Jerrila and clinics at 5 locations each at Kondrapalle (Central), Mondigedda, (easter part) Pebbampalle (wester part), Kudumulu (northern area), and nadimiveedhi (southern part) are suggested.

#### 14.5.1.4 Power

Provision shall be made for electrification for the rehabilitated villages. The cost for the same shall be made from a provision for Rs. 100,00,000/-

#### 14.5.1.5 Sanitation and Sewerage

Proper Sanitation and sewerage facilities shall be provided at the new site. The cost for the facilities shall be made from the provision for Rs. 50,00,000/-.

#### 14.5.1.6 Livestock

Development of piggery, goat rearing, sheep rearing and milch animal calves is one of the activity that supplement income for the community. Traditionally, the community has inherent skills in raising the livestock. However, due to search for employments opportunities, livestock rearing is not given enough importance. To promote animal husbandry based activity has been proposed. Fodder supply for the affected family cattle is included under livestock promotion, considering the dependency of grass collection time from the proposed mine area. An amount of Rs. 50 lakhs have been suggested for this purpose.

#### 14.5.1.7 Food Security

The food and grain banks are proposed for ensuring food security in lean period. This is to avoid the middle men exploitation and to drive away the food insecurity feelings. Overall this is for improving the nutritional status and the income levels of people. Estimated cost for the implementation of the project would be Rs. 100. Lakhs.

#### 14.5.1.8 Village Solar Energy

Provision of Solar energy systems viz., solar street lamps and portable lamps are proposed in the village areas. This is particularly for the use of discretely located villages where ever needed with the cost of Rs. 25 lakh. Necessary care may be taken for the maintenance of the established solar assets through skill based training for unemployed youths in this area for long sustainability as the concept of solar and technicality require special skills.

#### 14.5.1.9 Transport facilities

Facilities for local transport should be arranged with more number of bus facilities village, presently only two meet the public transport needs of the area. More bus facility to the interior villages is essential to promote connectivity. Rs. 80.00 lakhs for atleast 8 buses to run on self employment mode is suggested.

#### 14.5.1.10 Community Halls

Community halls for organizing village meetings and functions to the community to maintain the unity. The cost of construction is estimated to be around Rs. 93 lakhs.

#### 14.5.1.11 Market Linkage Development

Effective market and mechanism to link for the sale of the Produce is required for which an outlay of Rs. 50 lakhs at Jerrila, Viravaram, Lothogedda, Nimmimadipalem and Turmamidi has been proposed for a market place, with the required infrastructure facilities.

#### 14.5.1.12 Recreation & Sports Centre

One Recreational centre at the cost of Rs. 20.00 lakhs including library and sports facilities, has been proposed. Additional number of centre shall be increased based on the requirement and development process.

#### 14.5.1.13 Roads

At present the villages in the vicinity of the project site are connected by kuchcha road .The kuccha road shall be converted to pucca road. A cost of Rs. 50 lakhs is proposed for the same.

### 14.5.2 Household Infrastructure

#### 14.5.2.1 Housing Facilities

The housing facility considering future demand and provision of pucca homes for 500 @ Rs. 1.50 lakhs/- is made for the partially affected families.

#### 14.5.2.2 Provision of Improved Chulla

Improved chulla shall be provided *to reduce the* dependency on firewood. Allocation of Rs. 50 lakhs has been suggested with monitoring mechanism.

#### 14.5.2.3 Cattle Sheds

Each household has an average of 1 pair of cows, 2-3 goats. A lump sum grant of Rs. 2000/- shall be given to each family for the construction of cattle sheds. Allocation of Rs. 20 lakhs for 1000 household in 5 km area has been proposed.

#### 14.5.2.4 Dry Latrines

To ensure proper sanitation facilities, each household shall be provided with low cost dry latrines with proper disposal mechanism with long run sustainability. One such unit is expected at the cost Rs. 2500/-. Therefore, an outlay of Rs. 25,00, 000/- is suggested to ensure for at least 1000 such locations.

## 14.6 Institutional Mechanisms

### 14.6.1 Social Management and Rehabilitation Committee

A Social Management and Rehabilitation Committee shall be constituted in order to sensitize implementation of Rehabilitation activities, administer financial flow, prioritize activities, advise in project implementation mechanism of identified quantifiable criteria and indicators, monitoring and evaluation. The committee would decide upon, various economic rehabilitation packages and training programmes from time to time, keeping in mind the people need and ensure people participation for various identified schemes. The committee shall consist of:

| | | |
|---|---|---|
| Chairman | : | (From District Administration) |
| Member | : | GM/Chief Engineer (Projects), APMDC. |
| Member | : | Local MLA |
| Member | : | Nominee of Revenue Department |
| Member | : | Nominee of Forest Department |
| Member | : | Representative of Project Affected Families and CBOs |
| Member | : | Officer In-charge (Environment), APMDC |

### 14.6.2 Project Monitoring and Reporting Procedure

Social Management and Rehabilitation committee meetings shall be hold every six months to ensure incorporation of preference of the PAFs and resolve logistic problems in plan implementation. The Potential Evaluation Indicators for monitoring would be:

- Task completion as per schedule
- Identification of conflict among stakeholders, and its resolution
- Awareness of PAFs and their active and level involvement in overall development and livelihood improvement and their quality of life

### 14.6.3 Plan Implementation

A Project Coordinator on behalf of Social Management and rehabilitation committee will coordinate the proposed Social Management Plan. Various team led by Project Managers shall be constituted to look after activities such as:

- Land acquisition
- development of residential facilities and basic amenities at relocated site
- Economic Rehabilitation through NTFP projects.
- Economic Rehabilitation through wage and self employment schemes
- Physical rehabilitation by provision of Infrastructure & amenities.
- Livelihood Initiative programme

## 14.7. Cost Analysis – Economic Aspects

| No. | Item | Unit | Rate (Rs.) | Qty. | Total Cost (Rs. Lakhs) |
|---|---|---|---|---|---|
| **[A] Economic Rehabilitation** | | | | | |
| 1. | Training for wage employement | Persons | Rs. 0.05 L | 1500 | Rs. 75.00 |
| 2 | Training for Self Employment | Persons | Rs. 0.02 L | 500 | Rs. 10.00 |
| 3. | Support to other activities | LS | | | Rs. 50.00 |
| 4 | Grant to SHGs for value addition in Agriculture and Horticulture | SHGs | Rs. 1.00L | 100 | Rs. 100.00 |
| 5. | Self Employment –NTFP | Persons | | 175 | Rs. 216.27 |
| | | | | **Total [A]** | **Rs. 391.27** |
| **[B] Infrastructure** | | | | | |
| **Community Level** | | | | | |
| 1. | Power supply | LS | | | Rs. 100.00 |
| 2. | Sanitation – Sewerage | LS | | | Rs. 55.00 |
| 3. | Community Halls | Villages | Rs.3.00 L | 31 | Rs. 93.00 |
| 4. | Market Centre | LS | Rs. 10.00 L | 5 | Rs. 50.00 |
| 5. | (i) Educational Building | sft | Rs. 1200 | 40000 | Rs. 48.00 |
| | (ii) Operational School cost | LS | | | Rs. 20.00 |
| | (iii) Degree College | | | | Rs. 200.00 |
| | (iv) ITI/Technical Training | | | | Rs. 100.00 |
| 6. | (i) Water Supply – Tanks | Nos. | Rs. 2.00 | 31.00 | Rs. 62.00 |
| | (ii) Water Supply - handpumps | Nos. | Rs. 2.00 | 31.00 | Rs. 62.00 |
| 7. | (i) Health Facilities | Sft. | Rs. 1200 | 40000 | Rs. 48.00 |
| | (ii) Mobile Dispensaries | Nos | Rs. 10.00 L | 5 | Rs. 50.00 |
| | (iii) Local Clinics | Nos | Rs. 10.00 | 5 | Rs. 25.00 |
| | (iv) Operational expenses | LS | | | Rs. 30.00 |
| 8. | Transport Facilities | Nos | Rs. 10.00 L | 8 | Rs. 80.00 |
| 9. | Solar energy / lighting systems | Nos | Rs. 0.25 L | 100 | Rs. 25.00 |
| 10. | Livestock development | Nos | Rs. 0.50 L | 100 | Rs. 50.00 |
| 11. | Food Security | Families | Rs. 0.5 L | 200 | Rs. 100.00 |
| 12. | Recreation and Sports | LS | | | Rs. 20.00 |
| 13. | Approach Road | LS | | | Rs. 50.00 |
| | **Household Level** | | | | |
| 1. | Housing - Pucca Houses | nos | 1.5 Lakh | 500 | Rs. 750.00 |
| 2. | Dry Latrines | Family | Rs. 0.025 L | 1000 | Rs. 25.00 |
| 3. | Cattle Sheds | Family | Rs. 0.02 L | 1000 | Rs. 20.00 |
| 4. | Improved Chulla | | Rs. 0.05 L | 1000 | Rs. 50.00 |
| | | | **Total [B]** | | Rs. 2133.00 |
| | | | | **[A] + [B]** | **Rs. 2524.27** |
| [C] | **Plan Implementation, Monitoring and Appraisal** | | | | **Rs. 200.00** |
| | | | **Grand Total** | | **Rs. 2724.27** |

*LS – Lump sum, sft – sq. ft., Nos – Numbers, SHG – Self Help Group

**Appendix 1**

**COMMUNITY INTERACTION**

**Name of Villages** : Annavaram, Nimmapadu, Lothugedda, Jerrila, Balapam

**Date of Visit** : 07.03.08, 11.00 am – 5 PM

**Participants**:

| Agency | Representatives |
|---|---|
| APITCO (ICFRE Representatives) | K. P. Rangacharyalu<br>Gopal Krishna |
| | Community based Organizations<br>Jerrila |

Mr. K. P. Rangacharyulu briefed about Bauxite mining activity to be initiated at Jerrila mine area, and informed the purpose of interaction with the community and requested for comments and their expectations from the mining authorities

**Existing situation**

- There are around 120 families, mainly occupied in agricultural activities, as agricultural laborers, NTFP collection and in shifting cultivation.
- The average land holdings are 1-4 acres. Their agricultural crops include paddy, coffee, rajma, millets, pulses
- As per the discussion their average income is Rs. 3000 to Rs. 8000 per annum. There is rarely any alternative employment during lean season of agriculture. Few people get small petty jobs as labour in construction activities in near by towns.
- They have developed their own village level development plan, identified their problems and prioritized them. They work collectively to solve their problems. The major concern of the community includes infrastructure, accessibility, health, water quality and education.
- Drinking water is a major problem and diseases viz., diarrhea, malaria are very common. There is strong prevalence of pileria. Women face severe gynacological problems and lack proper maternity care. They are mainly dependent on traditional medicines.

- They have Integrated Tribal Development Agency school and manage their own alternative schools.

- Women play active role in running the house with their own income from agriculture and NTFP collection. They also play active role in community development and are enthusiastic for more education and income generation activities.

- There are active SHGs who have developed opportunities, establishbank linkages for running Kirana stores and leaf plate making, rajma processing, fruit vending katechu and fruits of medicinal importance like amla and karrakaiya.

- But the community is not aware about the proposed mining activity.

- They have demanded for proper employment opportunity, infrastructure facility, hospital, school etc.

**Annexure**

**Training module for Entrepreneurship Development of Youth**

**[A]** **Objective:** To identify and make available the potential livelihood options for tribal youth between the age group of 18-30 in the project villages and train them in skills according to the market requirements by working towards achieving the goals self-employment and improve livelihood.

**[B]** **Scope**

- To make them aware about the local natural resource base market potential.
- To establish Market oriented, demand driven livelihood opportunities through trainings
- To deliver appropriate training programmes for the tribal youth to enhance their employment generation
- Provide employment through Training & Escort Services for group and individual enterprises
- Establish bank linkages for financial support
- Establish market facility

**[C]** **Methodology**

- Survey for identifying potential livelihood options
- Finalization of typical skill training programme based on Market scanning
- Awareness creation for potential livelihood options through civil society organizations
- Selection of right beneficiaries for skill development of selected livelihood options
- Designing skill training module with required syllabus including orientation on Entrepreneurship
- Organizing professional skill training in selected trades for a duration of 2-3 months covering 6 hours a day by professional trainer
- Monitoring training programmes periodically to deliver required outputs
- Information about market and market rate
- Develop network with various market available

**[D]** **Coverage**

- They have ITDA school and manage their own alternative schools
- Proposes to organize training programmes in all Tribal concentrated Mandals

- Number of programmes to be organized depends on local market demand on livelihood options, need for skill training.

**[E] Allocation**

- Rs.5000 /- per candidate per month inclusive of Stipend to the trainees @ Rs.1500 /- PM
- A minimum number of 40 candidates are required for imparting quality training in a batch

**[F] Expected Project Output**

- Skill up gradation in selected livelihood options
- Creation of **self** and **wage employment opportunities** to **Tribal Youth**
- Confidence building among various stake holders including banks, beneficiaries, civil society organizations for developing positive thinking
- Contributes to build sustained socio-economic empowered society by of poverty alleviation among tribal youth
- Assured market information and market for the produce .

## [G] Periodical monitoring mechanism

## [H] Suggested Trades

As per the local demand and abilities of candidate to learn technical and managerial skills, the following trades can be even provided skill development programs organized to suits demand for livelihood earnings.

### Self – Employment Orientated

| S. No. | Trade | Target Group | Qualification | Duration |
|---|---|---|---|---|
| 1. | Mine Machine & Mine operations | Unemployed & tribal youth | $8^{th}$ & above | 2 months |
| 2. | Carpentry | Tribal Youth | $8^{th}$ & above | 2 months |
| 7. | Plumber | Tribal Youth | $8^{th}$ & above | 2 months |
| 3. | Cement Bricks & Other Construction Material | Un-employed Youth & Tribal Women | $8^{th}$ & above | 3 months |
| 4. | Construction activities | Tribal Youth | $8^{th}$ & above | 2 months |
| 5. | Heavy Vehicle Driving | Tribal Youth | $8^{th}$ & above | 2 months |
| 6. | Four Wheeler Driving | Un-employed Youth | SSC & above | 3 months |
| 7. | Automobile Repairs & Services (Three Wheeler) | Un-employed Youth | SSC & above | 3 months |
| 8. | Computers - Desk | Un-employed | SSC & above | 3 months |

| | | | | |
|---|---|---|---|---|
| | Top Printing | Youth | | |
| 9. | Consumer Electronics Repair | Un-employed Youth | SSC & above | 3 months |
| 10. | Computer Hardware | Un-employed Youth | SSC & above | 3 months |
| 11 | Drawing & Painting | Un-employed Youth | SSC & above | 3 months |
| 12. | Honey Bee Keeping Gum Karia, Amla | Tribal Youth | $8^{th}$ & above | 2 months |
| 13. | Coffee Processing | Un-employed Youth | $8^{th}$ & above | 3 months |
| 14. | Spices Grinding (Turmeric, Chilli & Masala, Kali Mirch powders, etc.) | Un-employed Youth | $8^{th}$ & above | 3 months |
| 15. | Indl. Sewing Machine Operators | Un-employed Youth | $8^{th}$ & above | 3 months |

**NTFP based Self Employment**

| S. No. | Trade | Target Group | Qualification | Duration |
|---|---|---|---|---|
| 1. | Palm Fibre Bags & Goods Manufacture | Tribal Women | $8^{th}$ & above | 2 months |
| 2. | Plumber | Tribal Youth | $8^{th}$ & above | 2 months |
| 3. | Book Binding | Tribal Women | $8^{th}$ & above | 2 months |
| 4. | Tailoring | Tribal Women | $8^{th}$ & above | 2 months |
| 5. | Rexine Bag making | Tribal Women | $8^{th}$ & above | 2 months |
| 6. | Mango Jelly (Alma Processing, De-hydration) | Tribal Women | $8^{th}$ & above | 2 months |
| 7. | Tamarind Processing | Tribal Women | $8^{th}$ & above | 2 months |
| 8. | Spices Grinding (Turmeric, Chilli & Masala, Kali Mirch powder etc.) | Tribal Women | $8^{th}$ & above | 3 months |
| 9. | Cement Bricks & Other Construction Material | Tribal Women | $8^{th}$ & above | 3 months |

**Career Based Job – Employment Opportunities**

| Sl. No. | Trade | Target Group | Qualification | Duration |
|---|---|---|---|---|
| 1. | Medical Lab Technology | Un-employed Youth | SSC & above | 3 months |
| 2. | Multipurpose Mechanism (Motor rewinding, Hand pump mechanism & Plumbing, Domestic electrical appliances servicing, Gas stove mechanism.) | Un-employed Youth | $8^{th}$ & above | 3 months |
| 3. | Masons | Un-employed Youth & Tribal Women | $8^{th}$ & above | 3 months |
| 4. | Pre-Primary Teacher Training Montessori Methods | Tribal Women | SSC & above | 3 months |
| 5. | Community Health Assistants | Tribal Women | SSC & above | 3 months |
| 6. | Health Care Assistants, Dai | Tribal Women | SSC & above | 3 months |
| 7. | Industrial Semi Skilled workers | Tribal Youth | SSC & above | 3 months |
| 8. | Capacity Building – Herbal medicinal practioners | Tribal Youth | SSC & above | 3 months |
| 9. | Land Survey Methodologies | Tribal Youth | SSC & above | 3 months |

# Chapter 15

# HUMAN HEALTH MANAGEMENT PLAN

## 15.1 Preamble

The health management plan targets towards overall improvement and maintenance in the health conditions of people living in the nearby villages of the mining site and within the study area. Secondly, the plan also targets to provide facilities for the influx of migratory workers and deputed project staff of APMDC. The plan aims to address issues such as provision of health and medical facilities to the target population; emergency needs of the workers, occupational health problems encountered during mining and other operation phases.

The present plan comprises general guidelines and impact of mining, details on field investigations such as existing health facilities, details of target population, delineation of proactive strategy for vector control, delineation of public and occupational health facilities (hospital, health clinics, first aid centres and mobile dispensaries), analysis of post implementation scenario, design of health delivery systems envisaged, integration with existing facilities, infrastructure and manpower requirements, feasibility in implementation and development of administrative guidance for implementation of such activities.

Delineation of monitoring mechanisms for implementation of health management plan, institutional analysis for reorienting activity within existing administrative setup, mode of payment schedule and appraisal of plans are some of the elements covered in the plan.

## 15.2 Mining and Human Health

A range of unintended impacts invariably accompanies the intended development objectives of mines. The health inequity is a prime issue of concern and thereby, informed action could protect vulnerable groups against increased health risks and ensure a more equitable distribution of health benefits.

Through a socio-environment perspective, human health is defined as “a state of complete physical, mental and social well-being, and not merely the absence of diseases and infirmity”. The preservation of human health can only be ensured if all the affected communities have an opportunity to consider how a mining activity and operation will affect their own health, and to participate fully in the planning, assessment and the decision making process. Hence considerations should always be included along with economic, environmental and social issues in the decision making on mines.

## 15.3 Existing disease pattern and medical facilities

Field survey was carried out near the proposed mining site and in the surrounding villages to assess the pre-project human health status and prevalent diseases.

The study area is sparsely populated with villages. The data on prevalence of major diseases in the study area were collected from Primary Health Centres (PHC), village Panchayat offices. Primary data was also collected by interviewing local people. In Jerilla area there are four Mandals. In the villages in the study area there are only 10 medical facilities with the primary health centres located at Jerilla, Kotagunalu, Annavaram, and Meduru. Subcentres are located at Killamkota, Jerilla and Eskapalli. Other centres located at Vanabarangi, Panaspalle, Turumandi, and Killamkota. The nearest location would be Chintapalle which is the mandal headquarters is in the southeast part of the study area.

The prevalent diseases are acute pilaria, malaria, respiratory infections, diarrhea, skin diseases and gyenic problems. Pilaria and Malaria is prevalent in most of the villages.

Initial health assessment reveals that there is no specific health hazard in study area.

## 15.4 Health Hazard Potential of Proposed Project

Mining areas, since past, have been a major source of concern to cause health impacts. The main negative impacts in such cases are development of water born diseases, water pollution due to mining, issues related human settlements and health.

### 15.4.1 Exposure to localized dust

The population would be exposed to localized dust due to mining activity as perceived by various stakeholders and community based organizations. General impacts of such exposure would be dust allergies and respiratory problems.

### 15.4.2 Water Borne Diseases

Water-borne diseases are infectious diseases spread primarily through contaminated water. Though these diseases are spread either directly or through flies or filth, water is the chief medium for spread of these diseases and hence they are termed as water-borne diseases.

Most intestinal (enteric) diseases are infectious and are transmitted through faecal waste. Pathogens – which include virus, bacteria, protozoa, and parasitic worms. These are disease producing agents found in the faeces of infected persons. These diseases are more prevalent in rural areas with poor sanitary conditions. These pathogens travel through water sources and interfuses directly through persons handling food and water. Since these diseases are highly infectious, extreme care and hygiene should be maintained by people looking after an infected patient. Hepatitis, cholera, dysentery, and typhoid are the more common water-borne diseases

Exposure to polluted water can cause diarrhea, skin irritation, respiratory problems, and other diseases, depending on the pollutant that is in the water body. Stagnant water and other untreated water provide a habitat for the mosquito and a host of other parasites and insects that cause a large number of diseases. Among these, malaria is undoubtedly the most widely distributed and causes most damage to human health.

The existing public health network does not have the specific facilities for the treatment of some of the above diseases and needs up-gradation. The availability and quality of biological products and services, such as vaccines and screening tests are also not assured.

### 15.4.3 Water Pollution

With the initiation of mining activity the iron content in the local water bodies will increase due to geological formations at project site. Iron content ranges from 13 to 15% in the local rocks which if mixed with water may become dangerous health hazard.

The levels of iron should be monitored periodically at the mining site to determine any possibility of iron buildup. It is proposed to utilize water for consumption, treatment for iron removal should be undertaken if such build up is observed. High iron content above prescribed threshold limits leads to gall bladder and thyroid problems. However there is no possibility of leaching of other minerals to nearby water bodies at mining site as evident from details of geological formation and water quality analysis carried out at mining site.

## 15.5 Strategy for Mitigation of Potential Health Impacts

Health maintenance and sickness prevention planning should be assured early in the course of project planning. With this view in mind mitigation measures are recommended to prevent following possible health impacts at different stages of development based on specific guidelines.

### 15.5.1 Health Management at in vicinity of mining site

The survey reveals that starting of mining activity may involve attention to the villages like Kondarupalli, Rallagedda. It has been observed that the inhabitants of nearby effected villages in the vicinity of project site are prone to diseases like malaria. High cases of pilaria are also observed in the study region. There is no existing medical facility in these villages and the people will go to Primary Health Centre at Jerilla for minor and major illness which is at distance of 4 Kilometers.

A community which has potential to become is disorganized and where ordinary personal and family health care may become a problem and will have a higher prevalence of diseases related to poor hygiene, such as diarrhea, and to infestations by parasites. These problems are accentuated by conditions of under development.

#### 15.5.1.1 Psychosis associated with project impact

A higher incidence of psychological disorders is expected due to the fear of loss of surroundings, life style, traditional rites and possessions.

It is proposed to inform the community about the impacts so as to avoid negative surprises that would have to be dealt with a short notice. A referral system shall be made available to help or treat individuals who are psychologically disturbed by project activities. Special local committees could serve for both communication objective and help to identify and counsel disturbed individuals.

## 15.6 Design of Health Management Systems

### 15.6.1 Infrastructure Facilities for health management

It is proposed that project hospital facilities must be extended to rehabilitated population, population in the nearby villages and to the labourers during construction and operation period. Onsite preliminary treatment facilities have to be provided at mining site (as per DGMS norms) for immediate dispensing. For this purpose, project hospital must conduct time to time health checkups for the locals and to the miners. First aid facilities at various locations and permanent camp near mining site so as to meet occupational disasters shall be provided. This would be extremely helpful for easy shifting of critically ill patients to the nearby hospital/ clinic.

### 15.6.2 Measures for health management

The measures for health management in nearby villages, and at mining site have been deliberated upon in earlier sections. However the following additional measures shall also be undertaken to mitigate the adverse impacts, if any, on health of population residing close to proposed mining site:

**Pre mining and Conveyor Construction/laying Phase**

- Design of dispensers for chemical application shall be attached to or incorporated in to regulating structures and metal rakes
- Periodical medical examination and vaccination of mining workers shall be carried out to avoid exotic/ contagious diseases
- Free medical check up camps furnished with preliminary first aid facility shall be provided at project site
- Adequate hygiene condition and proper sanitary facilities and supply of safe drinking water shall be provided
- Monitoring, vaccination, treatment of local population and elimination and control of endemic diseases shall be carried out on regular basis
- Periodic survey of prevailing diseases should be done in order to facilitate assessment of change in pattern of diseases

**Operational Phase:**

- Periodical Spraying the water logged areas at mining site with appropriate insecticides shall be undertaken
- Regular monitoring of health on long term basis should be carried out. This will help to evaluate the disease pattern changes and also the efficiency of control programmes. This implementation of amendments would enable a more accurate prediction in the future. For short term health effects, however, monitoring cold also serve as warning system
- Drinking water samples shall be analysed for the parameters stipulated in drinking water standards
- The concentration of metals especially iron in nearby water bodies must be analysed
- Surveillance, screening and treatment of infected persons shall be done on regular basis
- Health education and awareness among the public shall be promoted

### 15.6.3 Integration with existing health schemes

In addition to the needs of target population, the mode of execution of the proposed health plan would also facilitate various state run health programmes in the region. The facilities created need to be harnessed in a direction such as to work towards various healths welfare schemes. For instance, the programmes such as vaccination, immunization, family planning and Aids control.

## 15.7 Plan Implementation

The doctors in-charge of project hospital would evaluate/ monitor both financial and administrative aspects of the plan. A Hospital at Jerilla and clinics at 5 locations each at Kondrapalle in central part of buffer area, Mondigedda in the eastern portion, Pebbampalle in western portion, Kudumulu in the northern area, and Nadimiveedhi in the southern part are suggested.

## 15.8 Economic Cost Analysis

The costs for the proposed human health systems comprise of recurring costs including purchase of medicines, costs incurred for implementation of various government schemes, and miscellaneous expenditure. Costs are taken in Lump sum of Rs. 150 Lakhs for implementation of Health Management Plan included in the Social Plan.

### 15.9 Salient Remarks and recommendations

Salient recommendations for smooth implementation of the health management plan are delineated below:

- Health facilities at mining site as pet Director General Mine Safety (DGMS) for solving health problems should be made available prior to mining operation
- Project authorities should ensure frequent meetings with the implementation and monitoring committees and teams to enable smooth implementation of health plan
- Project authorities should seek advice and help of local NGOs and other registered welfare bodies in the area. Their participation and involvement in the proposed health schemes would go a long way in confidence building.

# CHAPTER 16

# RISK ASSESSMENT AND DISASTER MANAGEMENT PLAN

## 16.1 Introduction

Mining and allied activities are associated with several potential hazards both to the employees and the public at large. A worker in a mine should be able to work under conditions that are adequately safe and healthy. At the same time the environmental conditions should be such as not to impair his working efficiency. The various safeguards to be taken to ensure the safety of the mine and that of employees are provided in the Mines Act, 1952.

## 16.2 Identification of Hazards

There are various factors, which can cause disaster in the mines. These hazards are as follows:

- Drilling;
- Blasting;
- Overburden handling;
- Heavy Machinery; and
- Explosives storage.

### 16.2.1 Drilling and Blasting

Most of the accidents from blasting occur due to the projectiles, as they may some times go even beyond the danger zone, mainly due to over charging of the shot holes as a result of certain special features of the local ground. Flying rocks are encountered during initial and final blasting operations. Vibrations also lead to displacement of adjoining areas. Dust and noise are also problems commonly encountered during blasting operations.

### 16.2.2 Overburden Handling

The overburden dumps may cause landslides. High overburden dumps created at the quarry edge may cause sliding of the overburden dump or may cause failure of the pit slope due to excessive loading, thereby causing loss of life and property. Siltation of surface water may also cause run-off from overburden dumps.

### 16.2.3 Heavy Machinery

Most of the accidents during transport of dumpers, trucks, proclains, ripper dozers and other heavy vehicles are often attributable to mechanical failures and human errors.

## 16.3 Disaster Management

### 16.3.1 Measures Suggested to Avoid Accidents due to Blasting

- Shots shall not be fired except during the hours of day light or until adequate provision is made for artificial lighting and the holes charged on a particular day shall be fired on the same day;
- Shots, if fired after hours of daylight, should be muffled so that the flying fragments from the blasting material do not project beyond a distance of 10 m from the place of blasting;
- Adequate shelters or other protective structures shall be provided to the workers at all times;
- The shot fired shall give sufficient warning by effective signal over the entire area falling within a radius of 500-m;
- Where any permanent building or structure is damaged within the danger zone, the aggregate maximum change in all the holes fired at any particular time shall not exceed 2 kg;
- If a single shot exploder is used or if blasting is done with ordinary detonator, the shot-firer shall not fire more than fifty shots in one shift, but if multishot

exploder is used, the number can go up to eighty;

- During the approach and progress of an electrical storm, adequate precaution shall be taken;
- No shot hole shall be drilled in the overburden above the underground galleries.

### 16.3.2 Measures to Prevent the Danger of Overburden

- A stone wall should be built around the toe of each active dump at a distance of about 50-m from the toe;

To prevent the failure of overburden slopes, especially during the rainy season, the following precautions shall be taken:

- Proper terracing of the dump slopes, with a maximum dump height of 10 meters should be maintained;
- In flat areas where the dumping operations have come to an end, the slope angle should be flattened by about $5^o$ lower than the angle of repose, which varies from site to site but not less than $25^o$;
- Planting vegetation as early as possible over the overburden dump slopes;
- Provide drainage channels along the overburden dump toe for additional protection, in such a way that a distance of 15-m should be maintained left between the overburden dump and the bench; and
- If a mine is abandoned, the bench and overburden dump should be separated from each other by digging a trench of 6 to 10 m width.

### 16.3.3 Measures to Prevent Accidents Due to Trucks and Dumpers

- All transportation within the main working area should be carried out under the direct supervision and control of the management;
- The vehicles must be maintained in good repairs and checked thoroughly at least once a week by a competent person authorized for this purpose by the management;

- Broad signs should be provided at each and every turning point specially for the guidance of the drivers at night;
- To avoid dangers while reversing the trackless vehicles, especially at the embankment and tripping points, all areas for reversing of lorries should, as far as possible, be made man free, and there should be a light and sound device to indicate reversing of trucks; and
- A statutory provision of the fence, constant education, training etc will go a long way in reducing the incidence of such accidents.

## 16.4 Storage of Fuels and Explosive Materials

The explosives will be stored in a magazine of 25-T capacity.

Based on the study of accidents in chemical industry in India over a few decades, a specific legislation was enacted and enforced by the Government of India (GoI) in 1989 in conjunction with Environment Protection Act, 1986, referred to as “GoI rules 1989”. These rules are for the purpose of identifying major hazardous installations applying certain criteria on toxic, flammable and explosive properties of chemicals.

Besides, the criteria and list of hazardous substances with their threshold quantities are provided in part II of schedule I of the rules.

Schedule-II of the rules sets out the threshold quantities for isolated storage units.

Schedule-III gives a list of hazardous chemicals with their threshold quantities. In this schedule different chemicals are classified into different sub groups viz. Group 1 - Toxic substances, Group 2 - Toxic substances, Group 3 - Highly reactive substances, Group 4 - Explosive substances and Group 5 - Flammable substances.

Schedule-IV of the rules indicates various operations, which are hazardous during production, processing or treatment of organic and inorganic chemicals.

The of storage of flammable and explosive materials used in mines to determine the Threshold quantities as notified GOI Rules 1989 and the applicable rules are identified. The results are summarized in **Table-6.1**. The major hazardous materials stored and used in the mines are Diesel, Ammonium nitrate and Nitroglycerine.

**Table 16.1: Applicability of GoI rules to hazardous materials storage**

| Sl. No. | Chemical | Annual Requirement/storage | Listed in Schedule No. | Threshold Qty as per GoI Rules (application of rules) |
|---|---|---|---|---|
| 1 | Diesel | 40 KL<br>(10 KL storage) | 1(2) | ***(5, 7-9, 13 - 15 10 - 12)***<br>25 MT 200 MT |
| 2 | Ammonium Nitrate | 540 T<br>(25 T Magazine) | 1(2) | ***(4,5 7-9 10 - 15)***<br>350 T 2500 T |

The storages of all hazardous materials in the mines are much less, when compared with threshold storage quantities. It is advised to follow the Indian Explosive Act and Rules 1983 for handling of explosives.

## 16.5 Occupational Safety and Health Management

**Occupational safety and health is very closely related to productivity and good employer-employee relationship. The main factors of occupational health in mine are fugitive dust and noise. Safety of employee during blasting operation and maintenance of mining equipment and handling of explosive materials are taken care of as per Mine Regulations, 1961. To avoid any adverse effects on the health of workers due to dust, heat, noise and vibration, sufficient measures have been proposed in the mining project. These include:**

- Effective de-dusting system in the crusher house;
- Provision of wet drilling and dust collectors;
- Provision of rest shelters for mine workers with amenities like drinking water, fans, toilets etc;
- Provision of personal protection devices to the workers;
- Rotation of workers exposed to noise premises;
- Closed control room in crusher house with proper ventilation;
- Dust suppression of haul road; and

- First-aid facilities in the mining area.

Occupational Health Survey of the employees should be carried out at regular intervals. It is proposed to provide a separate occupational health centre as an integral part of Department of environment and safety. This centre will essentially have facilities, for audiometry, lung function testing, respirable dust and noise exposure assessment.

**Table 4.1: Floristic composition of project affected area (Mine Lease Area)**

| Sl. No | Family | Genera | Species |
|---|---|---|---|
| 1 | Rubiaceae | 6 | 6 |
| 2 | Euphorbiaceae | 3 | 3 |
| 3 | Acanthaceae | 2 | 2 |
| 4 | Asteraceae | 2 | 2 |
| 5 | Fabaceae | 2 | 2 |
| 6 | Flacourtiaceae | 2 | 2 |
| 7 | Lamiaceae | 2 | 2 |
| 8 | Rhamnaceae | 2 | 2 |
| 9 | Tiliaceae | 2 | 2 |
| 10 | Combretaceae | 1 | 2 |
| 11 | Mimosaceae | 1 | 2 |
| 12 | Anacardiaceae | 1 | 1 |
| 13 | Arecaceae | 1 | 1 |
| 14 | Bambusaceae | 1 | 1 |
| 15 | Caesalpiniaceae | 1 | 1 |
| 16 | Celastraceae | 1 | 1 |
| 17 | Dioscoreaceae | 1 | 1 |
| 18 | Ebenaceae | 1 | 1 |
| 19 | Lauraceae | 1 | 1 |
| 20 | Lythraceae | 1 | 1 |
| 21 | Malvaceae | 1 | 1 |
| 22 | Meliaceae | 1 | 1 |
| 23 | Menispermaceae | 1 | 1 |
| 24 | Ranunculaceae | 1 | 1 |
| 25 | Solanaceae | 1 | 1 |
| 26 | Sterculiaceae | 1 | 1 |
| 27 | Urticaceae | 1 | 1 |
| | **Total** | **41** | **43** |

## Table 4.2: Flora of project affected area (Mine Lease Area)

| Sl. No | Botanical name | Family | Habit |
|---|---|---|---|
| 1. | *Albizia chinensis* (Osbeck) Merr. | Mimosaceae | Tree |
| 2. | *Albizia odoratissima* (L.f.) Benth. | Mimosaceae | Tree |
| 3. | *Bauhinia vahlii* Wight & Arn. | Caesalpiniaceae | Woody climber |
| 4. | *Bridelia retusa* (L.) Spreng. | Euphorbiaceae | Tree |
| 5. | *Buchanania lanzan* Spr. | Anacardiaceae | Tree |
| 6. | *Casearia graveolens* Dalz. | Flacourtiaceae | Tree |
| 7. | *Cassine glauca* (Roxb.) Kuntze | Celastraceae | Tree |
| 8. | *Catunaregam spinosa* (Thunb.) Tirvengadum | Rubiaceae | Tree |
| 9. | *Chromolaena odorata* (L.) King & Robinson | Asteraceae | Shrub |
| 10. | *Cipadessa baccifera* (Roth) Miq. | Meliaceae | Tree |
| 11. | *Cissampelos pareira* L. | Menispermaceae | Climbing shrub |
| 12. | *Colebrookea oppositifolia* J. E. Smith | Lamiaceae | Shrub |
| 13. | *Debregeasia longifolia* (Burm. f.) Wedd. | Urticaceae | Shrub |
| 14. | *Dendrocalamus strictus* (Roxb.) Nees | Bambusaceae | Shrub |
| 15. | *Dioscorea oppositifolia* L. | Dioscoreaceae | Climbing Shrub |
| 16. | *Diospyros montana* Roxb. | Ebenaceae | Tree |
| 17. | *Gardenia latifolia* Ait. | Rubiaceae | Tree |
| 18. | *Gnaphalium luteo-album* L. | Asteraceae | Herb |
| 19. | *Grewia tiliaefolia* Vahl | Tiliaceae | Tree |
| 20. | *Hemigraphis latebrosa* (Heyne ex Roth) Nees | Acanthaceae | Herb |
| 21. | *Homalium nepalense* Benth. | Flacourtiaceae | Tree |
| 22. | *Knoxia sumatrensis* (Retz.) DC. | Rubiaceae | Herb |
| 23. | *Kydia calycina* Roxb. | Malvaceae | Tree |
| 24. | *Lepidagathis fasciculata* (Retz.) Nees | Acanthaceae | Herb |
| 25. | *Macaranga peltata* (Roxb.) Muell.-Arg. | Euphorbiaceae | Tree |
| 26. | *Mallotus philippensis* (Lam.)Muell.-Arg. | Euphorbiaceae | Tree |
| 27. | *Naravelia zeylania* (L.) DC. | Ranunculaceae | Climbing shrub |
| 28. | *Neolitsea foliosa* (Nees) Gamble | Lauraceae | Tree |
| 29. | *Ougeinia oojeinensis* (Roxb.) Hochr. | Fabaceae | Tree |
| 30. | *Pavetta tomentosa* (Roxb.) J.E.Smith | Rubiaceae | Shrub |
| 31. | *Phoenix acaulis* Roxb. Ex Buch.- Ham. | Arecaceae | Shrub |
| 32. | *Pogostemon bengalensis* (Burm.f.) O.Kuntze | Lamiaceae | Shrub |
| 33. | *Pterocarpus marsupium* Roxb. | Fabaceae | Tree |
| 34. | *Richardia brasiliensis* Gomes | Rubiaceae | Herb |
| 35. | *Rubia cordifolia* L. | Rubiaceae | Herb |
| 36. | *Solanum erianthum* D.Don | Solanaceae | Shrub |
| 37. | *Sterculia villosa* Roxb. ex DC. | Sterculiaceae | Tree |
| 38. | *Terminalia bellerica* (Gaertn.) Roxb. | Combretaceae | Tree |
| 39. | *Terminalia chebula* Retz. | Combretaceae | Tree |
| 40. | *Triumfetta rhomboidea* Jacq. | Tiliaceae | Herb |
| 41. | *Ventilago maderaspatana* Geartn. | Rhamnaceae | Woody climber |
| 42. | *Woodfordia fruticosa* Kurz | Lythraceae | Shrub |
| 43. | *Ziziphus rugosa* Lam. | Rhamnaceae | Tree |

**Table 4.3: Medicinal plants recorded in the project affected area (Mine Lease Area)**

| Sl. No | Botanical name |
|---|---|
| 1. | *Casearia graveolens* Dalz. |
| 2. | *Catunaregam spinosa* (Thunb.) Tirvengadum |
| 3. | *Chromolaena odorata* (L.) King & Robinson |
| 4. | *Cissampelos pareira* L. |
| 5. | *Gardenia latifolia* Ait. |
| 6. | *Mallotus philippensis* (Lam.)Muell.-Arg. |
| 7. | *Naravelia zeylania* (L.) DC. |
| 8. | *Neolitsea foliosa* (Nees) Gamble |
| 9. | *Pterocarpus marsupium* Roxb. |
| 10. | *Rubia cordifolia* L. |
| 11. | *Terminalia bellerica* (Gaertn.) Roxb. |
| 12. | *Terminalia chebula* Retz. |
| 13. | *Woodfordia fruticosa* Kurz |

**Table 4.4: Timber yielding plants recorded in the project affected area (Mine Lease Area)**

| Sl. No | Botanical name |
|---|---|
| 1 | *Albizia chinensis* (Osbeck) Merr. |
| 2 | *Albizia odoratissima* (L.f.) Benth. |
| 3 | *Bridelia retusa* (L.) Spreng. |
| 4 | *Cassine glauca* (Roxb.) Kuntze |
| 5 | *Diospyros montana* Roxb. |
| 6 | *Grewia tiliaefolia* Vahl |
| 7 | *Kydia calycina* Roxb. |
| 8 | *Ougeinia oojeinensis* (Roxb.) Hochr. |
| 9 | *Pterocarpus marsupium* Roxb. |
| 10 | *Terminalia bellerica* (Gaertn.) Roxb. |
| 11 | *Terminalia chebula* Retz. |

**Table 4.5: Food plants recorded in the project affected area (Mine Lease Area)**

| Sl. No | Botanical name |
|---|---|
| 1. | *Bauhinia vahlii* Wight & Arn. |
| 2. | *Buchanania lanzan* Spr. |
| 3. | *Dendrocalamus strictus* (Roxb.) Nees |
| 4. | *Dioscorea oppositifolia* L. |
| 5. | *Grewia tiliaefolia* Vahl |
| 6. | *Phoenix acaulis* Roxb. Ex Buch.- Ham. |
| 7. | *Sterculia villosa* Roxb. ex DC. |
| 8. | *Ziziphus rugosa* Lam. |

**Table 4.6: Fodder plants recorded in the project affected area (Mine Lease Area)**

| Sl. No | Botanical name |
|---|---|
| 1. | *Albizia chinensis* (Osbeck) Merr. |
| 2. | *Dendrocalamus strictus* (Roxb.) Nees |
| 3. | *Terminalia chebula* Retz. |

**Table 4.7: Fuel plants recorded in the project affected area (Mine Lease Area)**

| Sl. No | Botanical name |
|---|---|
| 1. | *Albizia chinensis* (Osbeck) Merr. |
| 2. | *Albizia odoratissima* (L.f.) Benth. |
| 3. | *Bridelia retusa* (L.) Spreng. |
| 4. | *Buchanania lanzan* Spr. |
| 5. | *Casearia graveolens* Dalz. |
| 6. | *Cassine glauca* (Roxb.) Kuntze |
| 7. | *Catunaregam spinosa* (Thunb.) Tirvengadum |
| 8. | *Cipadessa baccifera* (Roth) Miq. |
| 9. | *Dendrocalamus strictus* (Roxb.) Nees |
| 10. | *Diospyros montana* Roxb. |
| 11. | *Gardenia latifolia* Ait. |
| 12. | *Grewia tiliaefolia* Vahl |
| 13. | *Homalium nepalense* Benth. |
| 14. | *Kydia calycina* Roxb. |
| 15. | *Mallotus philippensis* (Lam.)Muell.-Arg. |
| 16. | *Ougeinia oojeinensis* (Roxb.) Hochr. |
| 17. | *Pavetta tomentosa* (Roxb.) J.E.Smith |
| 18. | *Terminalia chebula* Retz. |
| 19. | *Woodfordia fruticosa* Kurz |
| 20. | *Ziziphus rugosa* Lam. |

**Table 4.8: Commercially important plants recorded in the project affected area (Mine Lease Area)**

| Sl. No | Botanical name |
|---|---|
| 1. | *Bauhinia vahlii* Wight & Arn. |
| 2. | *Buchanania lanzan* Spr. |
| 3. | *Dendrocalamus strictus* (Roxb.) Nees |
| 4. | *Phoenix acaulis* Roxb. Ex Buch.- Ham. |
| 5. | *Pterocarpus marsupium* Roxb. |
| 6. | *Sterculia villosa* Roxb. ex DC. |
| 7. | *Terminalia bellerica* (Gaertn.) Roxb. |
| 8. | *Terminalia chebula* Retz. |

**Table 4.9: Floristic composition of surrounding mine lease area of Jerrila blocks**

| No. | Family | Genera | Species |
|---|---|---|---|
| 1. | Poaceae | 30 | 39 |
| 2. | Fabaceae | 21 | 36 |
| 3. | Asteraceae | 23 | 25 |
| 4. | Euphorbiaceae | 14 | 24 |
| 5. | Acanthaceae | 14 | 22 |
| 6. | Rubiaceae | 18 | 21 |
| 7. | Moraceae | 3 | 13 |
| 8. | Rutaceae | 9 | 11 |
| 9. | Caesalpiniaceae | 5 | 11 |
| 10. | Lamiaceae | 8 | 10 |
| 11. | Mimosaceae | 5 | 10 |
| 12. | Verbenaceae | 7 | 9 |
| 13. | Apocynaceae | 8 | 8 |
| 14. | Orchidaceae | 7 | 8 |
| 15. | Malvaceae | 5 | 8 |
| 16. | Solanaceae | 3 | 8 |
| 17. | Convolvulaceae | 5 | 7 |
| 18. | Combretaceae | 4 | 7 |
| 19. | Araceae | 6 | 6 |
| 20. | Asclepiadaceae | 6 | 6 |
| 21. | Meliaceae | 6 | 6 |
| 22. | Menispemaceae | 6 | 6 |
| 23. | Scrophulariaceae | 6 | 6 |
| 24. | Sterculiaceae | 5 | 6 |
| 25. | Cyperaceae | 4 | 6 |
| 26. | Anacardiaceae | 5 | 5 |
| 27. | Arecaceae | 3 | 5 |
| 28. | Flacourtiaceae | 3 | 5 |
| 29. | Lauraceae | 3 | 5 |
| 30. | Rhamnaceae | 3 | 5 |
| 31. | Tiliaceae | 2 | 5 |
| 32. | Cucurbitaceae | 4 | 4 |
| 33. | Amaranthaceae | 3 | 4 |
| 34. | Loranthaceae | 3 | 4 |
| 35. | Zingiberaceae | 3 | 4 |
| 36. | Oleaceae | 2 | 4 |
| 37. | Dioscoreaceae | 1 | 4 |
| 38. | Ebenaceae | 1 | 4 |
| 39. | Celastraceae | 3 | 3 |

| | | | |
|---|---|---|---|
| 40. | Melastomataceae | 3 | 3 |
| 41. | Commelinaceae | 2 | 3 |
| 42. | Myrtaceae | 2 | 3 |
| 43. | Rananculaceae | 2 | 3 |
| 44. | Annonaceae | 2 | 2 |
| 45. | Apiaceae | 2 | 2 |
| 46. | Bambusaceae | 2 | 2 |
| 47. | Bignoniaceae | 2 | 2 |
| 48. | Boraginaceae | 2 | 2 |
| 49. | Burseraceae | 2 | 2 |
| 50. | Caryophyllaceae | 2 | 2 |
| 51. | Liliaceae | 2 | 2 |
| 52. | Lythraceae | 2 | 2 |
| 53. | Myrsinaceae | 2 | 2 |
| 54. | Nyctaginaceae | 2 | 2 |
| 55. | Piperaceae | 2 | 2 |
| 56. | Sapindaceae | 2 | 2 |
| 57. | Sapotaceae | 2 | 2 |
| 58. | Ulmaceae | 2 | 2 |
| 59. | Urticaceae | 2 | 2 |
| 60. | Vitaceae | 2 | 2 |
| 61. | Adiantaceae | 1 | 2 |
| 62. | Leeaceae | 1 | 2 |
| 63. | Smilacaceae | 1 | 2 |
| 64. | Aceraceae | 1 | 1 |
| 65. | Agavaceae | 1 | 1 |
| 66. | Alangiaceae | 1 | 1 |
| 67. | Amarilladaceae | 1 | 1 |
| 68. | Araliaceae | 1 | 1 |
| 69. | Barringtoniaceae | 1 | 1 |
| 70. | Bischofiaceae | 1 | 1 |
| 71. | Bixaceae | 1 | 1 |
| 72. | Bombacaceae | 1 | 1 |
| 73. | Buxaceae | 1 | 1 |
| 74. | Capparaceae | 1 | 1 |
| 75. | Cochlospermaceae | 1 | 1 |
| 76. | Costaceae | 1 | 1 |
| 77. | Crassulaceae | 1 | 1 |
| 78. | Cyathiaceae | 1 | 1 |
| 79. | Dennstaedtiaceae | 1 | 1 |
| 80. | Dilleniaceae | 1 | 1 |
| 81. | Elaeocarpaceae | 1 | 1 |

| | | | |
|---|---|---|---|
| 82. | Eriocaulaceae | 1 | 1 |
| 83. | Flindersiaceae | 1 | 1 |
| 84. | Gentianaceae | 1 | 1 |
| 85. | Gnetaceae | 1 | 1 |
| 86. | Haemodoraceae | 1 | 1 |
| 87. | Hemionitidaceae | 1 | 1 |
| 88. | Hydrophyllaceae | 1 | 1 |
| 89. | Hypericaceae | 1 | 1 |
| 90. | Hypoxidaceae | 1 | 1 |
| 91. | Lobeliaceae | 1 | 1 |
| 92. | Magnoliaceae | 1 | 1 |
| 93. | Malpighiaceae | 1 | 1 |
| 94. | Marantaceae | 1 | 1 |
| 95. | Moringaceae | 1 | 1 |
| 96. | Musaceae | 1 | 1 |
| 97. | Notholaenaceae | 1 | 1 |
| 98. | Nyctanthaceae | 1 | 1 |
| 99. | Olacaceae | 1 | 1 |
| 100. | Opiliaceae | 1 | 1 |
| 101. | Oxalidaceae | 1 | 1 |
| 102. | Papavaraceae | 1 | 1 |
| 103. | Passifloraceae | 1 | 1 |
| 104. | Pittosporaceae | 1 | 1 |
| 105. | Plumbaginaceae | 1 | 1 |
| 106. | Polygalaceae | 1 | 1 |
| 107. | Polygonaceae | 1 | 1 |
| 108. | Proteaceae | 1 | 1 |
| 109. | Rosaceae | 1 | 1 |
| 110. | Santalaceae | 1 | 1 |
| 111. | Stemonaceae | 1 | 1 |
| 112. | Taccaceae | 1 | 1 |
| 113. | Xyridaceae | 1 | 1 |
| | | 363 | 482 |

**Table 4.10: Flora of surrounding mine lease area of Jerrila blocks**

| Sl. No | Botanical name | Family | Habit |
|---|---|---|---|
| 44. | *Acacia caesia* (L.) Willd. | Mimosaceae | Woody climber |
| 45. | *Acacia pennata* (L.) Willd. | Mimosaceae | Wood climber |
| 46. | *Acacia sinuata* (Lour.) Merr. | Mimosaceae | Woody climber |
| 47. | *Acacia torta* (Roxb.) Craib | Mimosaceae | Wood climber |
| 48. | *Acalypha indica* L. | Euphorbiaceae | Herb |
| 49. | *Acampe praemorsa* (Roxb.) Blatter & Mc Cann. | Orchidaceae | Epiphytic herb |
| 50. | *Acasia chundra* (Roxb.ex Rottl.) Willd. | Mimosaceae | Tree |
| 51. | *Acer laurianum* Hassk. | Aceraceae | Tree |
| 52. | *Achyranthes aspera* L. | Amaranthaceae | Herb |
| 53. | *Acrocarpus fraxinifolius* Wight & Arn. | Caesalpiniaceae | Tree |
| 54. | *Acronychia pedunculata* (L.) Miq. | Rutaceae | Tree |
| 55. | *Adiantum caudatum* L. | Adiantaceae | Fern |
| 56. | *Adiantum philippense* L. | Adiantaceae | Fern |
| 57. | *Aegle marmelos* (L.) Correa | Rutaceae | Tree |
| 58. | *Aerva sanguinolenta* (L.) Bl. | Amaranthaceae | Herb |
| 59. | *Agave americana* L. | Agavaceae | Shrub |
| 60. | *Ageratina adenophora* (Spreng.) King &Robinson | Asteraceae | Shrub |
| 61. | *Ageratum conyzoides* L. | Asteraceae | Herb |
| 62. | *Alangium salvifolium* (L.f.) Wang. | Alangiaceae | Tree |
| 63. | *Albizia chinensis* (Osbeck) Merr. | Mimosaceae | Tree |
| 64. | *Albizia odoratissima* (L.f.) Benth. | Mimosaceae | Tree |
| 65. | *Alocacia fornicata* (Roxb.) Schott | Araceae | Herb |
| 66. | *Alpinia malaccensis* (Burm. f.) Rosc. | Zingiberaceae | Herb |
| 67. | *Alstonia venenata* R.Br. | Apocynaceae | Tree |
| 68. | *Alysicarpus monilifer* (L.)DC. | Fabaceae | Herb |
| 69. | *Alysicarpus vaginalis* (L.) DC. | Fabaceae | Herb |
| 70. | *Amaranthus spinosus* L. | Amaranthaceae | Herb |
| 71. | *Amaranthus viridis* L. | Amaranthaceae | Herb |
| 72. | *Amorphophallus paeoniifolius* (Dennst.) Nicolson var. *paeoniifolius* | Araceae | Herb |
| 73. | *Ampelocissus latifolia* (Roxb.) Planch. | Vitaceae | Woody climber |
| 74. | *Anamirta cocculus* (L.) Wight & Arn. | Menispermaceae | Woody climber |
| 75. | *Andrographis paniculata* (Burm. f.) Wall. ex Nees | Acanthaceae | Herb |
| 76. | *Andrographis* sp | Acanthaceae | Herb |
| 77. | *Andropogon pumilus* Roxb. | Poaceae | Herb |
| 78. | *Anisomeles indica* (L.) Kuntze | Lamiaceae | Shrub |
| 79. | *Anodendron paniculatum* (Roxb.) A. DC. | Apocynaceae | Climbing shrub |
| 80. | *Anogeissus latifolia* (Roxb. ex DC.) Wall. ex Guill. & Perr. | Combretaceae | Tree |
| 81. | *Aphanamixis polystachya* (Wall.) Parker | Meliaceae | Tree |

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|---|---|---|---|
| 82. | *Apluda mutica* L. | Poaceae | Herb |
| 83. | *Ardisia solanacea* Roxb. | Myrsinaceae | Shrub |
| 84. | *Argemone maxicana* L. | Papavaraceae | Herb |
| 85. | *Argyreia nervosa* (Burm. f.) Boj. | Convolvulaceae | Climbing shrub |
| 86. | *Arisaema tortuosum* (Wall.) Schott | Araceae | Herb |
| 87. | *Aristida setacea* Retz. | Poaceae | Herb |
| 88. | *Artemisia japonica* Thunb. | Asteraceae | Herb |
| 89. | *Arthraxon lancifolius* (Trin.) Hochst. | Poaceae | Herb |
| 90. | *Artocarpus heterophyllus* Lam. | Moraceae | Tree |
| 91. | *Asparagus racemosus* Willd. | Liliaceae | Climbing shrub |
| 92. | *Asystasia gangetica* (L.) T. Anders. | Acanthaceae | Herb |
| 93. | *Atalantia monophylla* (L.) Correa | Rutaceae | Tree |
| 94. | *Atylosia scarabaeoides* (L.) Benth. | Fabaceae | Herb |
| 95. | *Azadirachta indica* A. Juss. | Meliaceae | Tree |
| 96. | *Baliospermum montanum* (Willd.) Muell.-Arg. | Euphorbiaceae | Shrub |
| 97. | *Bambusa vulgaris* Schrad. | Bambusaceae | shrub |
| 98. | *Barleria cristata* L. | Acanthaceae | Shrub |
| 99. | *Barleria strigosa* Willd. | Acanthaceae | Shrub |
| 100. | *Bauhinia racemosa* Lam. | Caesalpiniaceae | Tree |
| 101. | *Bauhinia semla* Wunderlin | Caesalpiniaceae | Tree |
| 102. | *Bauhinia vahlii* Wight & Arn. | Caesalpiniaceae | Woody climber |
| 103. | *Bidens pilosa* L. | Asteraceae | Herb |
| 104. | *Bischofia javanica* Blume | Bischofiaceae | Tree |
| 105. | *Bixa orellana* L. | Bixaceae | Tree |
| 106. | *Blumea mollis* (D. Don) Merr. | Asteraceae | Herb |
| 107. | *Blumea virens* Wall. ex DC. | Asteraceae | Herb |
| 108. | *Boehmeria macrophylla* Hornem. | Urticaceae | Shrub |
| 109. | *Boerhavia diffusa* L. | Nyctaginaceae | Herb |
| 110. | *Bombax ceiba* L. | Bombacaceae | Tree |
| 111. | *Bothrichloa pertusa* (L.) A. Camus | Poaceae | Herb |
| 112. | *Brachiaria ramosa* (L.) Stapf. | Poaceae | Herb |
| 113. | *Brachiaria reptans* (L.) Gard. & Hubbard | Poaceae | Herb |
| 114. | *Breynia vitis-idaea* (Burm. F.) Fischer | Euphorbiaceae | Shrub |
| 115. | *Bridelia crenulata* Roxb. | Euphorbiaceae | Tree |
| 116. | *Bridelia retusa* (L.) Spreng. | Euphorbiaceae | Tree |
| 117. | *Bridelia scandens* (Roxb.) Willd. | Euphorbiaceae | Climbing shrub |
| 118. | *Brugmansia suaveolens* (Humb. & Bonpl. Ex Willd.) Bercht.& Presl. | Solanaceae | Herb |
| 119. | *Buchanania lanzan* Spr. | Anacardiaceae | Tree |
| 120. | *Butea monosperma* (Lam.) Taub. | Fabaceae | Tree |
| 121. | *Byttneria herbacea* Roxb. | Sterculiaceae | Herb |
| 122. | *Cajanus cajan* (L.) R.Br. | Fabaceae | Shrub |
| 123. | *Calamus rotang* L. | Arecaceae | Climbing shrub |
| 124. | *Callicarpa tomentosa* (L.) Murr. | Verbenaceae | Tree |

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|---|---|---|---|
| 125. | *Calotropis □irsute□n* (L.) R. Br. | Asclepiadaceae | Shrub |
| 126. | *Calycopteris floribunda* Lam. | Combretaceae | Climbing shrub |
| 127. | *Canscora diffusa* (Vahl) R. Br. | Gentianaceae | Herb |
| 128. | *Cansjera rheedii* Gmel. | Opiliaceae | Woody climber |
| 129. | *Canthium dicoccum* (Gaertn.) Teijsm.& Binnend. | Rubiaceae | Tree |
| 130. | *Capparis divaricata* Lam. | Capparaceae | Shrub |
| 131. | *Capsicum frutescens* L. | Solanaceae | Shrub |
| 132. | *Cardiospermum halicacabum* L. | Sapindaceae | Climbing shrub |
| 133. | *Carex phacota* Spreng. | Cyperaceae | Herb |
| 134. | *Careya arborea* Roxb. | Barringtoniaceae | Tree |
| 135. | *Carissa carandas* L. | Apocynaceae | Shrub |
| 136. | *Caryota urens* L. | Arecaceae | Tree |
| 137. | *Casearia elliptica* Willd. | Flacourtiaceae | Tree |
| 138. | *Casearia esculenta* Roxb. | Flacourtiaceae | Tree |
| 139. | *Casearia graveolens* Dalz. | Flacourtiaceae | Tree |
| 140. | *Cassia fistula* L. | Caesalpiniaceae | Tree |
| 141. | *Cassia □irsute* L. | Caesalpiniaceae | Shrub |
| 142. | *Cassia mimosoides* L. | Caesalpiniaceae | Herb |
| 143. | *Cassia occidentalis* L. | Caesalpiniaceae | Herb |
| 144. | *Cassia tora* L. | Caesalpiniaceae | Herb |
| 145. | *Cassine glauca* (Roxb.) Kuntze | Celastraceae | Tree |
| 146. | *Catunaregam spinosa* (Thunb.) Tirvengadum | Rubiaceae | Tree |
| 147. | *Cayratia pedata* (Lam.) Juss. Ex Gagnep. | Vitaceae | Climbing shrub |
| 148. | *Celastrus paniculatus* Willd. | Celastraceae | Woody climber |
| 149. | *Centella asiatica* (L.) Urban | Apiaceae | Herb |
| 150. | *Chionanthus ramiflora* Roxb. | Oleaceae | Tree |
| 151. | *Chlorophytum tuberosum* (Roxb.) Baker | Liliaceae | Herb |
| 152. | *Chloroxylon swietenia* DC. | Flindersiaceae | Tree |
| 153. | *Chromolaena odorata* (L.) King & Robinson | Asteraceae | Shrub |
| 154. | *Chrysopogon aciculatus* (Retz.) Trin. | Poaceae | Herb |
| 155. | *Cipadessa baccifera* (Roth) Miq. | Meliaceae | Tree |
| 156. | *Cissampelos pareira* L. | Menispermaceae | Climbing shrub |
| 157. | *Clausena heptaphylla* (Roxb.) Wight & Arn. | Rutaceae | Shrub |
| 158. | *Cleistanthus patulus* (Roxb.) Muell.-Arg. | Euphorbiaceae | Tree |
| 159. | *Clematis gouriana* Roxb. ex DC. | Rananculaceae | Climbing Shrub |
| 160. | *Clematis smilacifolia* Wall. | Rananculaceae | Climbing shrub |
| 161. | *Clerodendrum serratum* (L.) Moon | Verbenaceae | Shrub |
| 162. | *Clerodendrum viscosum* Vent. | Verbenaceae | Shrub |
| 163. | *Cocculus hirsutus* (L.) Diels | Menispermaceae | Climbing shrub |
| 164. | *Cochlospermum religiosum* (L.) Alston | Cochlospermaceae | Tree |

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| 165. | *Coffea arabica* L. | Rubiaceae | Shrub |
| 166. | *Colebrookea oppositifolia* J. E. Smith | Lamiaceae | Shrub |
| 167. | *Colocasia esculenta* (L.) Schott | Araceae | Herb |
| 168. | *Combretum roxburghii* Spr. | Combretaceae | Tree |
| 169. | *Commelina benghalensis* L. | Commelinaceae | Herb |
| 170. | *Commelina* sp. | Commelinaceae | Herb |
| 171. | *Cordia dichotoma* Forst.f. | Boraginaceae | Tree |
| 172. | *Costus speciosus* (Koenig) Sm. | Costaceae | Herb |
| 173. | *Crotalaria albida* Heyne ex Roth | Fabaceae | Herb |
| 174. | *Crotalaria bialata* Schrank | Fabaceae | Herb |
| 175. | *Crotalaria pallida* Dryand. | Fabaceae | Herb |
| 176. | *Crotalaria prostrata* Rottl. ex Willd. | Fabaceae | Herb |
| 177. | *Cryptolepis buchananii* Roem. & Schultes | Asclepiadaceae | Climbing shrub |
| 178. | *Curculigo orchioides* Gaertn. | Hypoxidaceae | Herb |
| 179. | *Curcuma pseudomontana* Graham | Zingiberaceae | Herb |
| 180. | *Cyanotis* sp. | Commelinaceae | Herb |
| 181. | *Cyathea gigantea* (Wall. ex Hook.) Holttum | Cyathiaceae | Fern |
| 182. | *Cyathocline purpurea* (Ham. ex D.Don) Kuntze | Asteraceae | Herb |
| 183. | *Cyclea peltata* (L.am.) Hook. f & Thoms. | Menispermaceae | Climbing Shrub |
| 184. | *Cymbopogan flexuosus* (Nees ex Steud.) Wats. | Poaceae | Herb |
| 185. | *Cynodon dactylon* (L.) Pers. | Poaceae | Herb |
| 186. | *Cynoglossum zeylanicum* (Hornem.)Thunb. ex Lehm. | Boraginaceae | Herb |
| 187. | *Cyperus alopecuroides* Rottb. | Cyperaceae | Herb |
| 188. | *Cyperus kyllingia* Endl. | Cyperaceae | Herb |
| 189. | *Cyperus rotundus* L. | Cyperaceae | Herb |
| 190. | *Dalbergia paniculata* Roxb. | Fabaceae | Tree |
| 191. | *Dalbergia volubilis* Roxb. | Fabaceae | Shrub |
| 192. | *Debregeasia longifolia* (Burm. f.) Wedd. | Urticaceae | Shrub |
| 193. | *Dendrobium aphyllum* (Roxb.) Fischer | Orchidaceae | Epiphytic herb |
| 194. | *Dendrocalamus strictus* (Roxb.) Nees | Bambusaceae | Shrub |
| 195. | *Dendrophthoe falcata* (L. f.) Etting. | Loranthaceae | Parasitic shrub |
| 196. | *Derris scandens* (Roxb.) Benth. | Fabaceae | Woody climber |
| 197. | *Desmodium gangeticum* (L.) DC. | Fabaceae | Shrub |
| 198. | *Desmodium laxiflorum* DC. | Fabaceae | Herb |
| 199. | *Desmodium pulchellum* (L.) Benth. | Fabaceae | Shrub |
| 200. | *Desmodium triflorum* (L.) DC. | Fabaceae | Herb |
| 201. | *Desmodium triquetrum* (L.) DC. | Fabaceae | Shrub |
| 202. | *Desmodium velutinum* (Willd.) DC. | Fabaceae | Shrub |
| 203. | *Dicliptera foetida* (Forssk.) Blatt. | Acanthaceae | Herb |
| 204. | *Digitaria ciliaris* (Retz.) Koeler | Poaceae | Herb |
| 205. | *Digitaria longiflora* (Retz.) Per. | Poaceae | Herb |

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| 206. | *Digitaria stricta* Roth ex Roem. &Schul. | Poaceae | Herb |
| 207. | *Dillenia pentagyna* Roxb. | Dilleniaceae | Tree |
| 208. | *Dimeria ornithopoda* Trin. | Poaceae | Herb |
| 209. | *Dioscorea glabra* Roxb. | Dioscoreaceae | Climbing shrub |
| 210. | *Dioscorea opp*ositifolia L. | Dioscoreaceae | Climbing Shrub |
| 211. | *Dioscorea pentaphylla* L. | Dioscoreaceae | Climbing Shrub |
| 212. | *Dioscorea tomentosa* Koem ex Spreng. | Dioscoreaceae | Climbing shrub |
| 213. | *Diospyros melanoxylon* Roxb. | Ebenaceae | Tree |
| 214. | *Diospyros montana* Roxb. | Ebenaceae | Tree |
| 215. | *Diospyros ovalifolia* Wight | Ebenaceae | Tree |
| 216. | *Diospyros sylvatica* Roxb. | Ebenaceae | Tree |
| 217. | *Diplocyclos palmatus* (L.) Jeffrey | Cucurbitaceae | Climbing shrub |
| 218. | *Drymaria cordata* (L.) Willd. ex Roem. & Schultes | Caryophyllaceae | Herb |
| 219. | *Dumasia villosa* DC. | Fabaceae | Climbing shrub |
| 220. | *Echinochloa colona* (L.) Link | Poaceae | Herb |
| 221. | *Elaeocarpus tectorius* (Lour.) Poir. | Elaeocarpaceae | Tree |
| 222. | *Elephantopus scaber* L. | Asteraceae | Herb |
| 223. | *Eleucine indica* (L.) Gaertn. | Poaceae | Herb |
| 224. | *Embelia tsjeriam-cottam* DC. | Myrsinaceae | Shrub |
| 225. | *Emilia sonchifolia* (L.) DC. | Asteraceae | Herb |
| 226. | *Entada pusaetha* DC. | Mimosaceae | Woody climber |
| 227. | *Eragrostis ciliaris* (L.) R.Br. | Poaceae | Herb |
| 228. | *Eragrostis unioloides* (Retz.) Nees ex Steud. | Poaceae | Herb |
| 229. | *Eranthemum nervosum* (Vahl) R. Br. ex Roem. & Schultes | Acanthaceae | Shrub |
| 230. | *Eriocaulon* sp. | Eriocaulaceae | Herb |
| 231. | *Erycibe paniculata* Roxb. | Convolvulaceae | Climbing shrub |
| 232. | *Erythrina stricta* Roxb. | Fabaceae | Tree |
| 233. | *Erythrina suberosa* Roxb. | Fabaceae | Tree |
| 234. | *Eulalia trispicata* (Schult.) Henr. | Poaceae | Herb |
| 235. | *Euphorbia chamaesyce* L. | Euphorbiaceae | Herb |
| 236. | *Euphorbia heterophylla* L. | Euphorbiaceae | Herb |
| 237. | *Euphorbia hirta* L. | Euphorbiaceae | Herb |
| 238. | *Euphorbia nivulia* Buch.- Ham. | Euphorbiaceae | Tree |
| 239. | *Eusteralis stellata* (Lour.) Panig. | Lamiaceae | Shrub |
| 240. | *Evolvulus alsinoides* (L.) L. | Convolvulaceae | Herb |
| 241. | *Evolvulus nummularius* (L.) L. | Convolvulaceae | Herb |
| 242. | *Ficus arnotiana* (Miq.) Miq. | Moraceae | Tree |
| 243. | *Ficus auriculata* Lour. | Moraceae | Tree |
| 244. | *Ficus benghalensis* L. | Moraceae | Tree |
| 245. | *Ficus exasperata* Vahl | Moraceae | Tree |
| 246. | *Ficus hispida* L. f. | Moraceae | Tree |
| 247. | *Ficus microcarpa* L | Moraceae | Tree |
| 248. | *Ficus racemosa* L. | Moraceae | Tree |

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| 249. | *Ficus reliogiosa* L. | Moraceae | Tree |
| 250. | *Ficus semicordata* Buch.- Ham. ex J.E.Sm. | Moraceae | Tree |
| 251. | *Ficus tinctoria* Forst.f. | Moraceae | Shrub |
| 252. | *Firmiana colorata* (Roxb.) R.Br. | Sterculiaceae | Tree |
| 253. | *Flemingia macrophylla* (Willd.) Prain ex. Merr. | Fabaceae | Shrub |
| 254. | *Flemingia strobilifera* (L.) R.Br. | Fabaceae | Shrub |
| 255. | *Gardenia latifolia* Ait. | Rubiaceae | Tree |
| 256. | *Garuga pinnata* Roxb. | Burseraceae | Tree |
| 257. | *Globba marantina* L. | Zingiberaceae | Herb |
| 258. | *Globba racemosa* Smith. | Zingiberaceae | Herb |
| 259. | *Glochidion tomentosum* Dalz. | Euphorbiaceae | Tree |
| 260. | *Glochidion zeylanicum* (Gaertn.) Juss. | Euphorbiaceae | Tree |
| 261. | *Glycosmis mauritiana* (Lam.) Tanaka | Rutaceae | Shrub |
| 262. | *Glycosmis pentaphylla* (Retz.) DC. | Rutaceae | Shrub |
| 263. | *Gmelina arborea* Roxb. | Verbenaceae | Tree |
| 264. | *Gmelina asiatica* L. | Verbenaceae | Shrub |
| 265. | *Gnaphalium luteo-album* L. | Asteraceae | Herb |
| 266. | *Gnetum ula* Brongniart | Gnetaceae | Woody climber |
| 267. | *Gounia leptostachya* DC. | Rhamnaceae | Climbing shrub |
| 268. | *Grevillea robusta* A.Cunn. ex R.Br. | Proteaceae | Tree |
| 269. | *Grewia hirsuta* Vahl | Tiliaceae | Shrub |
| 270. | *Grewia rothii* DC. | Tiliaceae | Shrub |
| 271. | *Grewia serrulata* DC. | Tiliaceae | Tree |
| 272. | *Grewia tiliaefolia* Vahl | Tiliaceae | Tree |
| 273. | *Gymnema sylvestre* (Retz.) R.Br. ex Schultes | Asclepiadaceae | Climbing Shrub |
| 274. | *Gynura nitida* DC. | Asteraceae | Herb |
| 275. | *Hackelochloa granularis* (L.) Kuntze | Poaceae | Herb |
| 276. | *Haldina cordifolia* (Roxb.) Ridsd. | Rubiaceae | Tree |
| 277. | *Hardwickia binata* Roxb. | Caesalpiniaceae | Tree |
| 278. | *Hedyotis auricularia* L. | Rubiaceae | Herb |
| 279. | *Hedyotis herbacea* L. | Rubiaceae | Herb |
| 280. | *Helicteres isora* L. | Sterculiaceae | Shrub |
| 281. | *Hemidesmus indicus* (L.) R.Br. | Asclepiadaceae | Herb |
| 282. | *Hemigraphis latebrosa* (Heyne ex Roth) Nees | Acanthaceae | Herb |
| 283. | *Hemionitis arifolia* (Burm.f.) Moore | Hemionitidaceae | Fern |
| 284. | *Heteropogon contortus* (L.) P.Beauv. | Poaceae | Herb |
| 285. | *Hibiscus lobatus* (Murr.) Kuntze | Malvaceae | Herb |
| 286. | *Hiptage benghalensis* (L.) Kurz | Malpighiaceae | Woody climber |
| 287. | *Holarrhena pubescens* (Buch.-Ham.) Wall. Ex G. Don. | Apocynaceae | Tree |
| 288. | *Holoptelea integrifolia* (Roxb.) Planchon | Ulmaceae | Tree |
| 289. | *Homalium nepalense* Benth. | Flacourtiaceae | Tree |
| 290. | *Hydrolea zeylanica* (L.) Vahl | Hydrophyllaceae | Herb |

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| 291. | *Hypericum gaitii* Haines | Hypericaceae | Shrub |
| 292. | *Hyptis suaveolens* (L.) Poit. | Lamiaceae | Herb |
| 293. | *Ichnocarpus frutescens* (L.) R.Br. | Apocynaceae | Climbing Shrub |
| 294. | *Imperata cylindrica* (L.) Raeusch. | Poaceae | Herb |
| 295. | *Indigofera cassioides* Rottl. Ex DC. | Fabaceae | Shrub |
| 296. | *Ipomoea carnea* Jacq. | Convolvulaceae | Shrub |
| 297. | *Ipomoea muricata* (L.) Jacq. | Convolvulaceae | Climbing Shrub |
| 298. | *Ischaemum indicum* (Houtt.) Merr. | Poaceae | Herb |
| 299. | *Ischaemum* sp. | Poaceae | Herb |
| 300. | *Iseilema anthephoroides* Hack. | Poaceae | Herb |
| 301. | *Ixora undulate* Roxb | Rubiaceae | Shrub |
| 302. | *Ixora pavetta* Andr. | Rubiaceae | Small tree |
| 303. | *Jasminum roxburghianum* Wall. Ex DC. | Oleaceae | Climbing shrub |
| 304. | *Jasminum sambac* (L.) Ait. | Oleaceae | Shrub |
| 305. | *Jasminum scandens* Vahl | Oleaceae | Climbing shrub |
| 306. | *Jatropha curcas* L. | Euphorbiaceae | Shrub |
| 307. | *Justicia betonica* L. | Acanthaceae | Shrub |
| 308. | *Kalanchoe lanceolata* (Forssk.) Pers. | Crassulaceae | Shrub |
| 309. | *Knoxia sumatrensis* (Retz.) DC. | Rubiaceae | Herb |
| 310. | *Kydia calycina* Roxb. | Malvaceae | Tree |
| 311. | *Lagascea mollis* Cav. | Asteraceae | Herb |
| 312. | *Lagerstroemia parviflora* Roxb. | Rubiaceae | Tree |
| 313. | *Lannea coromandelica* (Hoult.) Merr. | Anacardiaceae | Tree |
| 314. | *Lantana camara* L. | Verbenaceae | Shrub |
| 315. | *Launaea acaulis* (Roxb.) Babe. Ex Kerr. | Asteraceae | Herb |
| 316. | *Leea asiatica* (L.) Ridsdale | Leeaceae | Shrub |
| 317. | *Leea indica* (Burm.f.) Merr. | Leeaceae | Shrub |
| 318. | *Lepidagathis cristata* Willd. | Acanthaceae | Herb |
| 319. | *Lepidagathis cuspidata* Nees | Acanthaceae | Herb |
| 320. | *Lepidagathis fasciculata*(Retz.) Nees | Acanthaceae | Herb |
| 321. | *Leptochloa chinensis* (L.) Nees | Poaceae | Herb |
| 322. | *Leucas aspera* (Willd.) Link | Lamiaceae | Herb |
| 323. | *Leucas biflora* (Vahl) R. Br. | Lamiaceae | Herb |
| 324. | *Leucas lanata* Benth. | Lamiaceae | Herb |
| 325. | *Limonia acidissima* L. | Rutaceae | Tree |
| 326. | *Lindernia crustacea* (L.) F. v. Muell. | Scrophulariaceae | Herb |
| 327. | *Litsea deccanensis* Gamble | Lauraceae | Tree |
| 328. | *Litsea glutinosa* (Lour.) C.B.Robinson | Lamiaceae | Tree |
| 329. | *Litsea monopetala* (Roxb.) Pers. | Lauraceae | Tree |
| 330. | *Lobelia alsinoides* Lam. | Lobeliaceae | Herb |
| 331. | *Loranthus* sp. | Loranthaceae | Parasitic shrub |
| 332. | *Luffa acutangula* (L.) Roxb. | Cucurbitaceae | Climbing shrub |
| 333. | *Luisia zeylanica* Lindl. | Orchidaceae | Epiphytic herb |
| 334. | *Macaranga peltata* (Roxb.) Muell.-Arg. | Euphorbiaceae | Tree |

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|---|---|---|---|
| 335. | *Macardonia procumbens* (Mill.) Small | Scrophulariaceae | Herb |
| 336. | *Madhuca longifolia* var. latifolia (Roxb.) A. Cheval. | Sapotaceae | Tree |
| 337. | *Mallotus philippensis* (Lam.)Muell.-Arg. | Euphorbiaceae | Tree |
| 338. | *Malvastrum coramandelianum* (L.) Garcke | Malvaceae | Herb |
| 339. | *Mangifera indica* L. | Anacardiaceae | Tree |
| 340. | *Marsdenia tenacissima* (Roxb.) Moon | Asclepiadaceae | Climbing shrub |
| 341. | *Maytenus emarginata* (Willd.) Ding Hou | Celastraceae | Shrub |
| 342. | *Melasma avense* (Benth.) Hand.-Mazz. | Scrophulariaceae | Herb |
| 343. | *Melastoma malabathricum* L. | Melastomataceae | Shrub |
| 344. | *Memecylon umbellatum* Burm. F. | Melastomataceae | Tree |
| 345. | *Merremia vitifolia* (Burm.f.) Hallier f. | Convolvulaceae | Climbing shrub |
| 346. | *Michelia champaca* L. | Magnoliaceae | Tree |
| 347. | *Miliusa tomentosa* (Roxb.) Sinclair | Annonaceae | Tree |
| 348. | *Milletia racemosa* (Roxb.) Benth. | Fabaceae | Woody climber |
| 349. | *Millettia extensa* (Benth.) Baker | Fabaceae | Woody climber |
| 350. | *Mimosa pudica* L. | Mimosaceae | Herb |
| 351. | *Mirabilis jalapa* L. | Nyctaginaceae | Shrub |
| 352. | *Mitracarpus villosus* (Sw.) DC. | Rubiaceae | Herb |
| 353. | *Morinda umbellata* L. | Rubiaceae | Woody climber |
| 354. | *Moringa oleifera* Lam. | Moringaceae | Tree |
| 355. | *Mucuna pruriens* (L.) DC. | Fabaceae | Climbing shrub |
| 356. | *Mukia maderaspatana* (L.) Roem. | Cucurbitaceae | Climbing shrub |
| 357. | *Murraya koenigii* (L.) Spreng. | Rutaceae | Shrub |
| 358. | *Murraya paniculata* (L.) Jack | Rutaceae | Shrub |
| *359.* | *Musa* sp | Musaceae | Herb |
| 360. | *Naravelia zeylania* (L.) DC. | Ranunculaceae | Climbing shrub |
| 361. | *Naringi crenulata* (Roxb.) Nicolson | Rutaceae | Tree |
| 362. | *Neolitsea foliosa* (Nees) Gamble | Lauraceae | Tree |
| 363. | *Nyctanthes arbortristis* L. | Nyctaginaceae | Tree |
| 364. | *Oberonia brunoniana* Wight | Orchidaceae | Epiphytic herb |
| 365. | *Olax psittacorum* (Willd.) Vahl | Olacaceae | Woody climber |
| 366. | *Oplismenus burmannii* (Retz.) P. Beauv. | Poaceae | Herb |
| 367. | *Oplismenus compositus* (L.) P.Beauv. | Poaceae | Herb |
| 368. | *Oroxylum indicum* (L.) Vent. | Bignoniaceae | Tree |
| 369. | *Osbeckia* sp. | Melastomataceae | Herb |
| 370. | *Ougeinia oojeinensis* (Roxb.) Hochr. | Fabaceae | Tree |
| 371. | *Oxalis corniculata* L. | Oxalidaceae | Herb |
| 372. | *Pancratium triflorum* Roxb. | Amarilladaceae | Herb |
| 373. | *Panicum* sp. | Poaceae | Herb |
| 374. | *Parahemionitis cordata* (Roxb. Ex Hook.f.& Grev.) Fraser-Jenk | Notholaenaceae | Fern |
| 375. | *Parthenium hysterophorus* L. | Asteraceae | Herb |
| 376. | *Paspalum scrobiculatum* L. | Poaceae | Herb |

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|---|---|---|---|
| 377. | *Passiflora foetida* L. | Passifloraceae | Climbing shrub |
| 378. | *Pavetta tomentosa* (Roxb.) J.E.Smith | Rubiaceae | Shrub |
| 379. | *Peliosanthes* sp. | Haemodoraceae | Herb |
| 380. | *Pennisetum hohenackeri* Hochst ex Steud. | Poaceae | Herb |
| 381. | *Pennisetum polystachion* (L.) Schult. | Poaceae | Herb |
| 382. | *Peperomia tetraphylla* (Forst.) Hook. & Arn. | Piperaceae | Epiphytic herb |
| 383. | *Peristrophe montana* Nees | Acanthaceae | Herb |
| 384. | *Persea macrantha* (Nees) Kosterm. | Lauraceae | Tree |
| 385. | *Phaulopsis involucra* (Forssk.) Sweet | Acanthaceae | Herb |
| 386. | *Phoenix acaulis* Roxb. Ex Buch.- Ham. | Arecaceae | Shrub |
| 387. | *Phoenix laureirii* Kunth | Arecaceae | Tree |
| 388. | *Phoenix sylvestris* (L.) Roxb. | Arecaceae | Tree |
| 389. | *Pholidota pallida* Lindl. | Orchidaceae | Epiphytic Herb |
| 390. | *Phrynium placentarium* (Lour.) Merr. | Marantaceae | Herb |
| 391. | *Phyllanthus amarus* Schum. & Thonn. | Euphorbiaceae | Herb |
| 392. | *Phyllanthus emblica* L. | Euphorbiaceae | Tree |
| 393. | *Phyllanthus maderaspatensis* L. | Euphorbiaceae | Herb |
| 394. | *Phyllanthus narayanaswami* Gamble | Euphorbiaceae | Herb |
| 395. | *Phyllanthus urinaria* L. | Euphorbiaceae | Herb |
| 396. | *Pimpinella heyneana* (Wall. Ex DC.) Kurz. | Apiaceae | Herb |
| 397. | *Piper attenuatum* Buch.-Ham. Ex Miq. | Piperaceae | Climbing shrub |
| 398. | *Pittosporum napaulense* (DC.) Rehde & Wilson | Pittosporaceae | Tree |
| 399. | *Plectranthus barbatus* Andr. | Lamiaceae | Herb |
| 400. | *Plumbago zeylanica* L. | Plumbaginaceae | Shrub |
| 401. | *Pogostemon bengalensis* (Burm.f.) O.Kuntze | Lamiaceae | Shrub |
| 402. | *Polyalthia cerasoides* (Roxb.) Bedd. | Annonaceae | Tree |
| 403. | *Polycarpaea corymbosa* (L.) Lam. | Caryophyllaceae | Herb |
| 404. | *Polygala arvensis* Willd. | Polygalaceae | Herb |
| 405. | *Polygonum chinense* L. | Polygonaceae | Shrub |
| 406. | *Pongamia pinnata* (L.) Pierre | Fabaceae | Tree |
| 407. | *Protium serratum* (Colebr.) Engler | Burseraceae | Tree |
| 408. | *Psidium guajava* L. | Myrtaceae | Tree |
| 409. | *Pteridium esculentum* (G.Forst.) Cockayne | Dennstaedtiaceae | Fern |
| 410. | *Pterocarpus marsupium* Roxb. | Fabaceae | Tree |
| 411. | *Pterospermum xylocarpum* (Gaertn.) Sant.& Wagh | Sterculiaceae | Tree |
| 412. | *Pueraria tuberosa* (Willd.) DC. | Fabaceae | Woody climber |
| 413. | *Rauvolfia serpentina* (L.) Benth. ex Kurz | Apocynaceae | Shrub |
| 414. | *Remusatia vivipara* (Roxb.) Schott. | Araceae | Herb |
| 415. | *Rhaphidophora laciniata* (Burm.f.) Merr. | Araceae | Climbing shrub |

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|---|---|---|---|
| 416. | *Rhynchostylis retusa* (L.) Bl. | Orchidaceae | Epiphytic herb |
| 417. | *Richardia brasiliensis* Gomes | Rubiaceae | Herb |
| 418. | *Ricinus communis* L. | Euphorbiaceae | Shrub |
| 419. | *Rostellularia diffusa* (Willd.) Nees | Acanathaceae | Herb |
| 420. | *Rostellularia procumbens* (L.) Nees | Acanthaceae | Herb |
| 421. | *Rostellularia prostrata* (Roxb. ex Clarke) Majumdar | Acanthaceae | Herb |
| 422. | *Rostellularia quinqueangularis* (Koenig ex Roxb.) Nees | Acanthaceae | Herb |
| 423. | *Rotala rotundifolia* (Buch.-Ham. ex Roxb.) Koehne | Lythraceae | Herb |
| 424. | *Rothia indica* (L.) Druce | Fabaceae | Herb |
| 425. | *Rubia cordifolia* L. | Rubiaceae | Herb |
| 426. | *Rubus ellipticus* Smith | Rosaceae | Shrub |
| 427. | *Rungia pectinata* (L.) Nees | Acanthaceae | Herb |
| 428. | *Sacciolepis inidca* (L.) Chase | Poaceae | Herb |
| 429. | *Salvia coccinea* Juss. ex Murr. | Lamiaceae | Herb |
| 430. | *Santalum album* L. | Santalaceae | Tree |
| 431. | *Sarcococca saligna* (D.Don) Muell.-Arg. | Buxaceae | Shrub |
| 432. | *Schefflera stellata* (Gaertn.) Harms | Araliaceae | Shrub |
| 433. | *Schleichera oleosa* (Lour.) Oken | Sapindaceae | Tree |
| 434. | *Scirpus* sp. | Cyperaceae | Herb |
| 435. | *Scleria lithosperma* (L.) Sw. | Cyperaceae | Herb |
| 436. | *Scoparia dulcis* L. | Scrophulariaceae | Herb |
| 437. | *Scurrula cordifolia* (Wall.) G.Don | Loranthaceae | Parasitic shrub |
| 438. | *Securinega leucopyrus* (Willd.) Muell.-Arg. | Euphorbiaceae | Shrub |
| 439. | *Semecarpuss anacardium* L. | Anacardiaceae | Tree |
| 440. | *Senecio nudicaulis* Buch.-Ham. ex D.Don | Asteraceae | Herb |
| 441. | *Setaria intermedia* Roem. &Schultes | Poaceae | Herb |
| 442. | *Setaria pumila* (Poir.) Roem. & Schultes | Poaceae | Herb |
| 443. | *Shuteria involucrata* (Wall.) Wight & Arn. | Fabaceae | Herb |
| 444. | *Sida acuta* Burm.f. | Malvaceae | Herb |
| 445. | *Sida cordata* (Burm.f.) Borssum | Malvaceae | Herb |
| 446. | *Sida cordifolia* L. | Malvaceae | Herb |
| 447. | *Sida rhombifolia* L. | Malvaceae | Herb |
| 448. | *Sigesbaekia orientalis* L. | Asteraceae | Herb |
| 449. | *Smilax perfoliata* Lour. | Smilacaceae | Climbing shrub |
| 450. | *Smilax zeylanica* L. | Smilacaceae | Climbing Shrub |
| 451. | *Solanum anguivi* Lam. | Solanaceae | Shrub |
| 452. | *Solanum erianthum* D.Don | Solanaceae | Shrub |
| 453. | *Solanum giganteum* Jacq. | Soalanaceae | Shrub |
| 454. | *Solanum torvum* Sw. | Solanaceae | Shrub |

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|---|---|---|---|
| 455. | *Solanum viarum* Dunal | Solanaceae | Shrub |
| 456. | *Solanum violaceum* Orteg. | Solanaceae | Shrub |
| 457. | *Solena amplexicaulis* (Lam.) Gandhi | Cucurbitaceae | Climbing shrub |
| 458. | *Sopubia delphiniifolia* (L.) G. Don | Scrophulariaceae | Herb |
| 459. | *Soymida febrifuga* (Roxb.) A.Juss. | Meliaceae | Tree |
| 460. | *Spermacoce hispida* L. | Rubiaceae | Herb |
| 461. | *Spermacoce pusilla* Wall. | Rubiaceae | Herb |
| 462. | *Spermadictyon suaveolens* Roxb. | Rubiaceae | Shrub |
| 463. | *Sphaeranthus indicus* L. | Asteraceae | Herb |
| 464. | *Spilanthes calva* DC. | Asteraceae | Herb |
| 465. | *Spilanthes radicans* Jacq. | Asteraceae | Herb |
| 466. | *Spondias pinnata* (L. f.) Kurz | Anacardiaceae | Tree |
| 467. | *Sporobolus indicus* (L.) R.Br. | Poaceae | Herb |
| 468. | *Stachytarpheta jamaicensis* (L.)Vahl | Verbenaceae | Herb |
| 469. | *Stemona tuberosa* Lour. | Stemonaceae | Climbing shrub |
| 470. | *Stephania japonica* (Thunb.) Miers | Menispemaceae | Climbing shrub |
| 471. | *Sterculia urens* Roxb. | Sterculiaceae | Tree |
| 472. | *Sterculia villosa* Roxb. ex DC. | Sterculiaceae | Tree |
| 473. | *Stereospermum chelonoides* (L.f.) DC. | Bignoniaceae | Tree |
| 474. | *Streblus asper* Lour. | Moraceae | Tree |
| 475. | *Streblus taxoides* (Heyne ex Roth) Kurz | Moraceae | Tree |
| 476. | *Striga asiatica* (L.) Kuntze | Scrophulariaceae | Parasitic herb |
| 477. | *Strobilanthes jeyporensis* Bedd. | Acanthaceae | Shrub |
| 478. | *Strobilanthus* sp. | Acanthaceae | Shrub |
| 479. | *Synadenium grantii* Hook. f. | Euphorbiaceae | Shrub |
| 480. | *Synedrella nudiflora* (L.) Gaertn. | Asteraceae | Herb |
| 481. | *Syzygium cumini* (L.) Skeels | Myrtaceae | Tree |
| 482. | *Syzygium* sp | Myrtaceae | Tree |
| 483. | *Tacca pinnatifida* Forst. | Taccaceae | Herb |
| 484. | *Tamarindus indica* L. | Caesalpiniaceae | Tree |
| 485. | *Tarenna asiatica* (L.) Kuntze ex K.Schum. | Rubiaceae | Shrub |
| 486. | *Tectona grandis* L. f. | Verbenaceae | Tree |
| 487. | *Tephrosia purpuea* (L.) Pers. | Fabaceae | Herb |
| 488. | *Tephrosia tinctoria* Pers. | Fabaceae | Herb |
| 489. | *Tephrosia villosa* (L.) Pers. | Fabaceae | Herb |
| 490. | *Terminalia alata* Heyne ex Roth | Combretaceae | Tree |
| 491. | *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn. | Combretaceae | Tree |
| 492. | *Terminalia bellirica* (Gaertn.) Roxb. | Combretaceae | Tree |
| 493. | *Terminalia chebula* Retz. | Combretaceae | Tree |
| 494. | *Themeda arundinacea* (Roxb.) Ridley | Poaceae | Herb |
| 495. | *Themeda triandra* Forssk. | Poaceae | Herb |
| 496. | *Thunbergia fragrans* Roxb. | Acanthaceae | Climbing shrub |
| 497. | *Thysanolaena maxima* (Roxb.) Kuntze | Poaceae | Herb |

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|---|---|---|---|
| 498. | *Tinospora sinensis* (Lour.) Merr. | Menispermaceae | Woody climber |
| 499. | *Toona ciliata* Roem. | Meliaceae | Tree |
| 500. | *Toxocarpus longistigma* (Roxb.) Steudel | Asclepiadaceae | Climbing shrub |
| 501. | *Trema orientalis* (L.) Blume | Ulmaceae | Tree |
| 502. | *Trichilia connaroides* (Wight & arn.) Bentve. | Meliaceae | Tree |
| 503. | *Tridax procumbens* L. | Asteraceae | Herb |
| 504. | *Triumfetta rhomboidea* Jacq. | Tiliaceae | Herb |
| 505. | *Urena lobata* L. | Malvaceae | Shrub |
| 506. | *Vallaris solanacea* (Roth) Kuntze | Apocynaceae | Woody climber |
| 507. | *Vanda tessellata* (Roxb.) Hook. ex G.Don | Orchidaceae | Epiphytic herb |
| 508. | *Vanda testacea* (Lindl.) Reichb. f. | Orchidaceae | Epiphytic herb |
| 509. | *Ventilago maderaspatana* Geartn. | Rhamnaceae | Woody climber |
| 510. | *Vernonia cinerea* (L.) Less. | Asteraceae | Herb |
| 511. | *Vicoa indica* (L.) DC. | Asteraceae | Herb |
| 512. | *Viscum articulatum* Burm. f. | Loranthaceae | Parasitic shrub |
| 513. | *Vitex peduncularis* Wall.ex Schauer | Verbenaceae | Tree |
| 514. | *Wendlandia gamblei* Cowan | Rubiaceae | Tree |
| 515. | *Woodfordia fruticosa* Kurz | Lythraceae | Shrub |
| 516. | *Wrightia arborea* (Dennst.) Mabberley | Apocynaceae | Tree |
| 517. | *Xanthium indicum* Koenig | Asteraceae | Herb |
| 518. | *Xantolis tomentosa* (Roxb.)Rafin. | Sapotaceae | Tree |
| 519. | *Xylia xylocarpa* (Roxb.) Taub. | Mimosaceae | Tree |
| 520. | *Xylosma longifolium* Clos | Flacourtiaceae | Tree |
| 521. | *Xyris pauciflora* Willd. | Xyridaceae | Herb |
| 522. | *Zanthoxylum armatum* DC. | Rutaceae | Tree |
| 523. | *Ziziphus oenoplia* (L.) Mill. | Rhamnaceae | Woody climber |
| 524. | *Ziziphus maurtiana* Lam. | Rhamnaceae | Woody climber |
| 525. | *Ziziphus rugosa* Lam. | Rhamnaceae | Tree |

## Table 4.11: Medicinal plants recorded from surrounding mine lease area of Jerrila blocks

| Sl. No | Botanical name |
|---|---|
| 1. | *Acacia sinuata* (Lour.) Merr. |
| 2. | *Acalypha indica* L. |
| 3. | *Achyranthes aspera* L. |
| 4. | *Aegle marmelos* (L.) Correa |
| 5. | *Alangium salvifolium* (L.f.) Wang. |
| 6. | *Andrographis paniculata* (Burm. f.) Wall. ex Nees |
| 7. | *Argyreia nervosa* (Burm. f.) Boj. |
| 8. | *Artemisia japonica* Thunb. |
| 9. | *Asparagus racemosus* Willd. |
| 10. | *Azadirachta indica* A. Juss. |
| 11. | *Baliospermum montanum* (Willd.) Muell.-Arg. |
| 12. | *Calotropis gigantea* (L.) R. Br. |
| 13. | *Cardiospermum halicacabum* L. |
| 14. | *Cassia fistula* L. |
| 15. | *Cassia occidentalis* L. |
| 16. | *Cassia tora* L. |
| 17. | *Centella asiatica* (L.) Urban |
| 18. | *Chlorophytum tuberosum* (Roxb.) Baker |
| 19. | *Chloroxylon swietenia* DC. |
| 20. | *Chromolaena odorata* (L.) King & Robinson |
| 21. | *Clerodendrum serratum* (L.) Moon |
| 22. | *Clerodendrum viscosum* Vent. |
| 23. | *Costus speciosus* (Koenig) Sm. |
| 24. | *Curculigo orchioides* Gaertn. |
| 25. | *Cyperus rotundus* L. |
| 26. | *Elephantopus scaber* L. |
| 27. | *Entada pusaetha* DC. |
| 28. | *Gymnema sylvestre* (Retz.) R.Br. ex Schultes |
| 29. | *Helicteres isora* L. |
| 30. | *Hemidesmus indicus* (L.) R.Br. |
| 31. | *Holarrhena pubescens* (Buch.-Ham.) Wall. Ex G. Don. |
| 32. | *Jatropha curcas* L. |
| 33. | *Limonia acidissima* L. |
| 34. | *Litsea glutinosa* (Lour.) C.B.Robinson |
| 35. | *Mallotus philippensis* (Lam.)Muell.-Arg. |
| 36. | *Mucuna pruriens* (L.) DC. |
| 37. | *Oroxylum indicum* (L.) Vent. |
| 38. | *Persea macrantha* (Nees) Kosterm. |
| 39. | *Phyllanthus amarus* Schum. & Thonn. |
| 40. | *Phyllanthus emblica* L. |
| 41. | *Plumbago zeylanica* L. |

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| 42. | *Pongamia pinnata* (L.) Pierre |
| 43. | *Pterocarpus marsupium* Roxb. |
| 44. | *Rauvolfia serpentina* (L.) Benth. ex Kurz |
| 45. | *Schleichera oleosa* (Lour.) Oken |
| 46. | *Semecarpuss anacardium* L. |
| 47. | *Sphaeranthus indicus* L. |
| 48. | *Spilanthes calva* DC. |
| 49. | *Syzygium cumini* (L.) Skeels |
| 50. | *Terminalia bellirica* (Gaertn.) Roxb. |
| 51. | *Terminalia chebula* Retz. |
| 52. | *Woodfordia fruticosa* Kurz |
| 53. | *Wrightia arborea* (Dennst.) Mabberley |
| 54. | *Zanthoxylum armatum* DC. |

**Table 4.12: Timber yielding plants recorded from surrounding mine lease areas of Jerrila blocks**

| Sl. No | Botanical name |
|---|---|
| 1 | *Acrocarpus fraxinifolius* Wight & Arn. |
| 2 | *Albizia chinensis* (Osbeck) Merr. |
| 3 | *Albizia odoratissima* (L.f.) Benth. |
| 4 | *Anogeissus latifolia* (Roxb. ex DC.) Wall. ex Guill. & Perr. |
| 5 | *Artocarpus heterophyllus* Lam. |
| 6 | *Azadirachta indica* A. Juss. |
| 7 | *Bauhinia semla* Wunderlin |
| 8 | *Bischofia javanica* Blume |
| 9 | *Bridelia retusa* (L.) Spreng. |
| 10 | *Cassia fistula* L. |
| 11 | *Chloroxylon swietenia* DC. |
| 12 | *Dalbergia paniculata* Roxb. |
| 13 | *Diospyros melanoxylon* Roxb. |
| 14 | *Diospyros ovalifolia* Wight |
| 15 | *Diospyros sylvatica* Roxb. |
| 16 | *Gardenia latifolia* Ait. |
| 17 | *Gmelina arborea* Roxb. |
| 18 | *Grewia tiliaefolia* Vahl |
| 19 | *Haldina cordifolia* (Roxb.) Ridsd. |
| 20 | *Hardwickia binata* Roxb. |
| 21 | *Holoptelea integrifolia* (Roxb.) Planchon |
| 22 | *Kydia calycina* Roxb. |
| 23 | *Lagerstroemia parviflora* Roxb. |
| 24 | *Lannea coromandelica* (Hoult.) Merr. |
| 25 | *Mangifera indica* L. |
| 26 | *Miliusa tomentosa* (Roxb.) Sinclair |
| 27 | *Ougeinia oojeinensis* (Roxb.) Hochr. |
| 28 | *Pterocarpus marsupium* Roxb. |

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|---|---|
| 29 | *Schleichera oleosa* (Lour.) Oken |
| 30 | *Semecarpuss anacardium* L. |
| 31 | *Soymida febrifuga* (Roxb.) A.Juss. |
| 32 | *Syzygium cumini* (L.) Skeels |
| 33 | *Tectona grandis* L. f. |
| 34 | *Terminalia alata* Heyne ex Roth |
| 35 | *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn. |
| 36 | *Toona ciliata* Roem. |
| 37 | *Trichilia connaroides* (Wight & arn.) Bentve. |
| 38 | *Xylia xylocarpa* (Roxb.) Taub. |

**Table 4.13: Food plants recorded from surrounding mine lease areas of Jerrila blocks**

| Sl. No | Botanical name |
|---|---|
| 1. | *Acacia sinuata* (Lour.) Merr. |
| 2. | *Aegle marmelos* (L.) Correa |
| 3. | *Alangium salvifolium* (L.f.) Wang. |
| 4. | *Amaranthus spinosus* L. |
| 5. | *Amaranthus viridis* L. |
| 6. | *Amorphophallus paeoniifolius* (Dennst.) Nicolson var. paeoniifolius |
| 7. | *Ardisia solanacea* Roxb. |
| 8. | *Artocarpus heterophyllus* Lam. |
| 9. | *Bauhinia vahlii* Wight & Arn. |
| 10. | *Buchanania lanzan* Spr. |
| 11. | *Canthium dicoccum* (Gaertn.) Teijsm.& Binnend. |
| 12. | *Carissa carandas* L. |
| 13. | *Caryota urens* L. |
| 14. | *Cayratia pedata* (Lam.) Juss. ex Gagnep. |
| 15. | *Colocasia esculenta* (L.) Schott |
| 16. | *Dendrocalamus strictus* (Roxb.) Nees |
| 17. | *Dioscorea glabra* Roxb. |
| 18. | *Dioscorea oppositifolia* L. |
| 19. | *Dioscorea pentaphylla* L. |
| 20. | *Dioscorea tomentosa* Koem ex Spreng. |
| 21. | *Diospyros melanoxylon* Roxb. |
| 22. | *Echinochloa colona* (L.) Link |
| 23. | *Ficus racemosa* L. |
| 24. | *Glycosmis mauritiana* (Lam.) Tanaka |
| 25. | *Glycosmis pentaphylla* (Retz.) DC. |
| 26. | *Gnetum ula* Brongniart |
| 27. | *Indigofera cassioides* Rottl. Ex DC. |
| 28. | *Limonia acidissima* L. |
| 29. | *Madhuca longifolia* var. *latifolia* (Roxb.) A. Cheval. |
| 30. | *Mangifera indica* L. |
| 31. | *Murraya koenigii* (L.) Spreng. |

| | |
|---|---|
| 32. | *Oxalis corniculata* L. |
| 33. | *Phoenix acaulis* Roxb. Ex Buch.- Ham. |
| 34. | *Phoenix laureirii* Kunth |
| 35. | *Phoenix sylvestris* (L.) Roxb. |
| 36. | *Phyllanthus emblica* L. |
| 37. | *Pueraria tuberosa* (Willd.) DC. |
| 38. | *Rubus ellipticus* Smith |
| 39. | *Schleichera oleosa* (Lour.) Oken |
| 40. | *Semecarpuss anacardium* L. |
| 41. | *Spondias pinnata* (L. f.) Kurz |
| 42. | *Sterculia urens* Roxb. |
| 43. | *Sterculia villosa* Roxb. ex DC. |
| 44. | *Syzygium cumini* (L.) Skeels |
| 45. | *Tamarindus indica* L. |
| 46. | *Ziziphus oenoplia* (L.) Mill. |
| 47. | *Ziziphus maurtiana* Lam. |
| 48. | *Ziziphus rugosa* Lam. |

**Table 4.14: Fodder plants recorded from surrounding mine lease areas of Jerrila blocks**

| Sl. No | Botanical name |
|---|---|
| 1. | *Albizia chinensis* (Osbeck) Merr. |
| 2. | *Andropogon pumilus* Roxb. |
| 3. | *Apluda mutica* L. |
| 4. | *Bothrichloa pertusa* (L.) A. Camus |
| 5. | *Brachiaria ramosa* (L.) Stapf. |
| 6. | *Brachiaria reptans* (L.) Gard. & Hubbard |
| 7. | *Chrysopogon aciculatus* (Retz.) Trin. |
| 8. | *Cynodon dactylon* (L.) Pers. |
| 9. | *Digitaria ciliaris* (Retz.) Koeler |
| 10. | *Digitaria longiflora* (Retz.) Per. |
| 11. | *Digitaria stricta* Roth ex Roem. &Schul. |
| 12. | *Echinochloa colona* (L.) Link |
| 13. | *Eragrostis unioloides* (Retz.) Nees ex Steud. |
| 14. | *Eulalia trispicata* (Schult.) Henr. |
| 15. | *Ficus benghalensis* L. |
| 16. | *Ficus racemosa* L. |
| 17. | *Heteropogon contortus* (L.) P.Beauv. |
| 18. | *Imperata cylindrica* (L.) Raeusch. |
| 19. | *Indigofera cassioides* Rottl. Ex DC. |
| 20. | *Ischaemum indicum* (Houtt.) Merr. |
| 21. | *Leptochloa chinensis* (L.) Nees |
| 22. | *Paspalum scrobiculatum* L. |
| 23. | *Pennisetum hohenackeri* Hochst ex Steud. |
| 24. | *Pennisetum polystachion* (L.) Schult. |

| | |
|---|---|
| 25. | *Setaria intermedia* Roem. &Schultes |
| 26. | *Setaria pumila* (Poir.) Roem. & Schultes |
| 27. | *Sporobolus indicus* (L.) R.Br. |
| 28. | *Themeda triandra* Forssk. |

**Table 4.15: Fuel plants recorded from surrounding mine lease areas of Jerrila blocks**

| Sl. No | Botanical name |
|---|---|
| 1. | *Acasia chundra* (Roxb.ex Rottl.) Willd. |
| 2. | *Acer laurianum* Hassk. |
| 3. | *Acrocarpus fraxinifolius* Wight & Arn. |
| 4. | *Alangium salvifolium* (L.f.) Wang. |
| 5. | *Albizia chinensis* (Osbeck) Merr. |
| 6. | *Albizia odoratissima* (L.f.) Benth. |
| 7. | *Anogeissus latifolia* (Roxb. ex DC.) Wall. ex Guill. & Perr. |
| 8. | *Aphanamixis polystachya* (Wall.) Parker |
| 9. | *Artocarpus heterophyllus* Lam. |
| 10. | *Atalantia monophylla* (L.) Correa |
| 11. | *Azadirachta indica* A. Juss. |
| 12. | *Bauhinia racemosa* Lam. |
| 13. | *Bauhinia semla* Wunderlin |
| 14. | *Bischofia javanica* Blume |
| 15. | *Bridelia crenulata* Roxb. |
| 16. | *Bridelia retusa* (L.) Spreng. |
| 17. | *Buchanania lanzan* Spr. |
| 18. | *Butea monosperma* (Lam.) Taub. |
| 19. | *Callicarpa tomentosa* (L.) Murr. |
| 20. | *Canthium dicoccum* (Gaertn.) Teijsm.& Binnend. |
| 21. | *Careya arborea* Roxb. |
| 22. | *Cassia fistula* L. |
| 23. | *Cassine glauca* (Roxb.) Kuntze |
| 24. | *Catunaregam spinosa* (Thunb.) Tirvengadum |
| 25. | *Chionanthus ramiflora* Roxb. |
| 26. | *Chloroxylon swietenia* DC. |
| 27. | *Cipadessa baccifera* (Roth) Miq. |
| 28. | *Cordia dichotoma* Forst.f. |
| 29. | *Dalbergia paniculata* Roxb. |
| 30. | *Dillenia pentagyna* Roxb. |
| 31. | *Diospyros melanoxylon* Roxb. |
| 32. | *Diospyros montana* Roxb. |
| 33. | *Diospyros ovalifolia* Wight |
| 34. | *Diospyros sylvatica* Roxb. |
| 35. | *Gardenia latifolia* Ait. |

| | |
|---|---|
| 36. | *Garuga pinnata* Roxb. |
| 37. | *Gmelina arborea* Roxb. |
| 38. | *Grewia tiliaefolia* Vahl |
| 39. | *Haldina cordifolia* (Roxb.) Ridsd. |
| 40. | *Hardwickia binata* Roxb. |
| 41. | *Holoptelea integrifolia* (Roxb.) Planchon |
| 42. | *Homalium nepalense* Benth. |
| 43. | *Kydia calycina* Roxb. |
| 44. | *Lagerstroemia parviflora* Roxb. |
| 45. | *Lannea coromandelica* (Hoult.) Merr. |
| 46. | *Madhuca longifolia* var. *latifolia* (Roxb.) A. Cheval. |
| 47. | *Mallotus philippensis* (Lam.)Muell.-Arg. |
| 48. | *Mangifera indica* L. |
| 49. | *Miliusa tomentosa* (Roxb.) Sinclair |
| 50. | *Ougeinia oojeinensis* (Roxb.) Hochr. |
| 51. | *Persea macrantha* (Nees) Kosterm. |
| 52. | *Pongamia pinnata* (L.) Pierre |
| 53. | *Pterocarpus marsupium* Roxb. |
| 54. | *Pterospermum xylocarpum* (Gaertn.) Sant.& Wagh |
| 55. | *Schleichera oleosa* (Lour.) Oken |
| 56. | *Syzygium cumini* (L.) Skeels |
| 57. | *Tamarindus indica* L. |
| 58. | *Terminalia alata* Heyne ex Roth |
| 59. | *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn. |
| 60. | *Terminalia chebula* Retz. |
| 61. | *Toona ciliata* Roem. |
| 62. | *Trichilia connaroides* (Wight & arn.) Bentve. |
| 63. | *Wrightia arborea* (Dennst.) Mabberley |
| 64. | *Xylia xylocarpa* (Roxb.) Taub. |
| 65. | *Xylosma longifolium* Clos |
| 66. | *Ziziphus rugosa* Lam. |

### Table 4.16: Commercially important plants recorded from surrounding mine lease areas of Jerrila blocks

| Sl. No | Botanical name |
|---|---|
| 1. | *Acacia sinuata* (Lour.) Merr. |
| 2. | *Aegle marmelos* (L.) Correa |
| 3. | *Agave americana* L. |
| 4. | *Andrographis paniculata* (Burm. f.) Wall. ex Nees |
| 5. | *Aristida setacea* Retz. |
| 6. | *Artocarpus heterophyllus* Lam. |
| 7. | *Asparagus racemosus* Willd. |
| 8. | *Bauhinia vahlii* Wight & Arn. |
| 9. | *Buchanania lanzan* Spr. |
| 10. | *Calamus rotang* L. |
| 11. | *Caryota urens* L. |
| 12. | *Cassia fistula* L. |
| 13. | *Chlorophytum tuberosum* (Roxb.) Baker |
| 14. | *Dendrocalamus strictus* (Roxb.) Nees |
| 15. | *Diospyros melanoxylon* Roxb. |
| 16. | *Hemidesmus indicus* (L.) R.Br. |
| 17. | *Jatropha curcas* L. |
| 18. | *Limonia acidissima* L. |
| 19. | *Litsea glutinosa* (Lour.) C.B.Robinson |
| 20. | *Luffa acutangula* (L.) Roxb. |
| 21. | *Madhuca longifolia* var. *latifolia* (Roxb.) A. Cheval. |
| 22. | *Mallotus philippensis* (Lam.) Muell.-Arg. |
| 23. | *Mangifera indica* L. |
| 24. | *Michelia champaca* L. |
| 25. | *Phoenix acaulis* Roxb. Ex Buch.- Ham. |
| 26. | *Phoenix laureirii* Kunth |
| 27. | *Phoenix sylvestris* (L.) Roxb. |
| 28. | *Phyllanthus emblica* L. |
| 29. | *Pongamia pinnata* (L.) Pierre |
| 30. | *Rauvolfia serpentina* (L.) Benth. ex Kurz |
| 31. | *Santalum album* L. |
| 32. | *Semecarpuss anacardium* L. |
| 33. | *Sterculia urens* Roxb. |
| 34. | *Sterculia villosa* Roxb. ex DC. |
| 35. | *Syzygium cumini* (L.) Skeels |
| 36. | *Tamarindus indica* L. |
| 37. | *Terminalia bellerica* (Gaertn.) Roxb. |
| 38. | *Terminalia chebula* Retz. |
| 39. | *Thysanolaena maxima* (Roxb.) Kuntze |
| 40. | *Ziziphus maurtiana* Lam. |

### Table 4.17: Rare, Endangered and Threatened plants recorded from surrounding mine lease areas of Jerrila blocks

| Sl. No | Botanical name |
|---|---|
| 1. | *Cyathea gigantea* (Wall. ex Hook.) Holttum |
| 2. | *Entada pusaetha* DC. |
| 3. | *Gnetum ula* Brongniart |
| 4. | *Melasma avense* (Benth.) Hand.-Mazz. |
| 5. | *Phyllanthus narayanaswami* Gamble |
| 6. | *Rauvolfia serpentina* (L.) Benth. ex Kurz |
| 7. | *Toxocarpus longistigma* (Roxb.) Steudel |

**Table 4.18: Comparative account of vegetation parameters within project affected area and surrounding mine lease area of Jerrila blocks**

| Vegetation parameters | Mine lease area | Outside |
|---|---|---|
| **Trees** | | |
| Number of species | 27 | 48 |
| Stand density (Stems /ha) | 1050 | 1360 |
| Stand basal area ($m^2$/ha) | 19.13 | 31.95 |
| Shannon Weiner index (H') | 2.750 | 3.467 |
| Simpson index (λ) | 0.101 | 0.047 |
| **Tree Saplings** | | |
| Number of species | 11 | 27 |
| Stand density (Stems /100 $m^2$) | 60 | 101 |
| Shannon Weiner index (H') | 1.829 | 3.180 |
| Simpson index (λ) | 0.253 | 0.048 |
| **Shrubs** | | |
| Number of species | 12 | 26 |
| Stand density (Stems /100 $m^2$) | 280 | 186 |
| Shannon Weiner index (H') | 1.363 | 3.134 |
| Simpson index (λ) | 0.383 | 0.049 |
| **Herbs** | | |
| Number of species | 35 | 54 |
| Stand density (Stems /100 $m^2$) | 2380 | 3000 |
| Shannon Weiner index (H') | 3.123 | 3.391 |
| Simpson index (λ) | 0.061 | 0.049 |

**Table 4.19: Vegetation parameters of trees in project affected area (Mine Lease Area) of Jerrila blocks**

No. of quadrat studied 10, Size of each quadrat $100m^2$

| Name of the species | N | D | F | RD | RF | RBA | IVI |
|---|---|---|---|---|---|---|---|
| *Albizia odoratissima* | 2 | 20 | 10 | 1.90 | 1.92 | 6.46 | 10.29 |
| *Artocarpus heterophyllus* | 1 | 10 | 10 | 0.95 | 1.92 | 3.86 | 6.74 |
| *Bauhinia vahlii* | 5 | 50 | 20 | 4.76 | 3.85 | 1.20 | 9.80 |
| *Bridelia retusa* | 2 | 20 | 20 | 1.90 | 3.85 | 1.83 | 7.58 |
| *Buchanania lanzan* | 12 | 120 | 50 | 11.43 | 9.62 | 5.69 | 26.73 |
| *Cassine glauca* | 4 | 40 | 30 | 3.81 | 5.77 | 12.97 | 22.55 |
| *Celastrus paniculatus* | 1 | 10 | 10 | 0.95 | 1.92 | 0.20 | 3.07 |
| *Dillenia pentagyna* | 1 | 10 | 10 | 0.95 | 1.92 | 0.13 | 3.01 |
| *Gardenia latifolia* | 1 | 10 | 10 | 0.95 | 1.92 | 1.11 | 3.99 |
| *Glochidion tomentosum* | 8 | 80 | 30 | 7.62 | 5.77 | 2.11 | 15.50 |
| *Grewia tiliaefolia* | 3 | 30 | 20 | 2.86 | 3.85 | 4.94 | 11.65 |
| *Homalium nepalense* | 4 | 40 | 20 | 3.81 | 3.85 | 4.17 | 11.82 |
| *Kydia calycina* | 1 | 10 | 10 | 0.95 | 1.92 | 0.76 | 3.63 |
| *Lannea coromandelica* | 4 | 40 | 20 | 3.81 | 3.85 | 5.36 | 13.02 |
| *Litsea glutinosa* | 1 | 10 | 10 | 0.95 | 1.92 | 0.45 | 3.32 |
| *Mallotus philippensis* | 6 | 60 | 20 | 5.71 | 3.85 | 1.67 | 11.23 |
| *Mangifera indica* | 2 | 20 | 10 | 1.90 | 1.92 | 13.14 | 16.96 |
| *Neolitsea foliosa* | 1 | 10 | 10 | 0.95 | 1.92 | 0.07 | 2.94 |
| *Phoenix laurerii* | 2 | 20 | 20 | 1.90 | 3.85 | 1.06 | 6.81 |
| *Phyllanthus emblica* | 26 | 260 | 70 | 24.76 | 13.46 | 15.69 | 53.91 |
| *Pterocarpus marsupium* | 1 | 10 | 10 | 0.95 | 1.92 | 1.53 | 4.40 |
| *Schleichera oleosa* | 1 | 10 | 10 | 0.95 | 1.92 | 1.38 | 4.26 |
| *Semecarpus anacardium* | 1 | 10 | 10 | 0.95 | 1.92 | 3.33 | 6.20 |
| *Sterculia villosa* | 3 | 30 | 10 | 2.86 | 1.92 | 0.33 | 5.11 |
| *Syzygium cumini* | 1 | 10 | 10 | 0.95 | 1.92 | 5.72 | 8.59 |
| *Terminalia chebula* | 9 | 90 | 50 | 8.57 | 9.62 | 2.45 | 20.64 |
| *Toona ciliata* | 2 | 20 | 10 | 1.90 | 1.92 | 2.41 | 6.24 |
| | 105 | 1050 | | | | | |

Shannon Wiener index ($H' = -\sum pi \ln pi$) = 2.75; Simpson index ($\lambda = \sum pi^2$)= 0.101

N= No. of individuals; D= Density (Stems/ ha.); F=Frequency (%);
RD= Relative Density; RF= Relative Frequency; RBA= Relative Basal Area; IVI= Importance Value Index.

**Table 4.20: Vegetation parameters of tree saplings in project affected area (Mine Lease Area) of Jerrila blocks**

No. of quadrats studied 10, Size of each quadrat 9 $m^2$

| Name of the species | N | D | F | RD | RF | IVI |
|---|---|---|---|---|---|---|
| *Albizia odoratissima* | 1 | 1.11 | 10 | 1.85 | 6.67 | 8.52 |
| *Diospyros montana* | 3 | 3.33 | 10 | 5.56 | 6.67 | 12.22 |
| *Glochidion tomentosum* | 4 | 4.44 | 20 | 7.41 | 13.3 | 20.74 |
| *Kydia calycina* | 2 | 2.22 | 20 | 3.70 | 13.3 | 17.04 |
| *Litsea glutinosa* | 6 | 6.67 | 10 | 11.11 | 6.67 | 17.78 |
| *Mallotus philippensis* | 5 | 5.56 | 10 | 9.26 | 6.67 | 15.93 |
| *Phoenix loureirii* | 25 | 27.78 | 20 | 46.30 | 13.3 | 59.63 |
| *Phyllanthus emblica* | 2 | 2.22 | 10 | 3.70 | 6.67 | 10.37 |
| *Sterculia villosa* | 1 | 1.11 | 10 | 1.85 | 6.67 | 8.52 |
| *Terminalia chebula* | 1 | 1.11 | 10 | 1.85 | 6.67 | 8.52 |
| *Ziziphus rugosa* | 4 | 4.44 | 20 | 7.41 | 13.3 | 20.74 |
| | 54 | | | | | |

Shannon Wiener index (H'= -∑pi ln pi) = 1.829   Simpson index ($\lambda = \sum pi^2$)= 0.253
N= No. of individuals; D= Density (Stems/ ha.); F=Frequency (%); RD= Relative Density; RF= Relative Frequency; IVI= Importance Value Index.

**Table 4.21: Vegetation parameters of shrubs in project affected area (Mine Lease Area) of Jerrila blocks**

No. of quadrats studied 10, Size of each quadrat 9 $m^2$

| Name of the species | N | D | F | RD | RF | *IVI* |
|---|---|---|---|---|---|---|
| *Ardisia solanacea* | 3 | 3.33 | 10 | 1.19 | 4.76 | 5.95 |
| *Celastrus paniculatus* | 1 | 1.11 | 10 | 0.40 | 4.76 | 5.16 |
| *Chromolaena odorata* | 31 | 34.44 | 30 | 12.30 | 14.3 | 26.59 |
| *Clerodendrum viscosum* | 8 | 8.89 | 10 | 3.17 | 4.76 | 7.94 |
| *Cyathea gigantea* ( Tree fern) | 1 | 1.11 | 10 | 0.40 | 4.76 | 5.16 |
| *Eusteralis stellata* | 6 | 6.67 | 20 | 2.38 | 9.52 | 11.90 |
| *Indigofera cassioides* | 2 | 2.22 | 10 | 0.79 | 4.76 | 5.56 |
| *Phoenix acaulis* | 145 | 161.11 | 60 | 57.54 | 28.6 | 86.11 |
| *Polygonum chinense* | 47 | 52.22 | 20 | 18.65 | 9.52 | 28.17 |
| *Rubus ellipticus* | 3 | 3.33 | 10 | 1.19 | 4.76 | 5.95 |
| *Spermadictyon suaveolens* | 4 | 4.44 | 10 | 1.59 | 4.76 | 6.35 |
| *Stachytarpheta jamaicensis* | 1 | 1.11 | 10 | 0.40 | 4.76 | 5.16 |
| | 252 | | | | | |

Shannon Wiener index (H'= -∑pi ln pi)= 1.363 Simpson index ($\lambda = \sum pi^2$)= 0.383
N= No. of individuals; D= Density (Stems/ ha.); F=Frequency (%);
RD= Relative Density; RF= Relative Frequency; IVI= Importance Value Index.

## Table 4.22: Vegetation parameters of herbs in project affected area (Mine Lease Area) of Jerrila blocks

No. of quadrats studied 10, Size of each quadrat 1m$^2$

| Name of the species | N | D | F | RD | RF | IVI |
|---|---|---|---|---|---|---|
| *Achyranthes aspera* | 3 | 30 | 10 | 1.26 | 1.79 | 3.05 |
| *Alocasia fornicata* | 2 | 20 | 10 | 0.84 | 1.79 | 2.63 |
| *Alpinia malaccensis* | 1 | 10 | 10 | 0.42 | 1.79 | 2.21 |
| *Alysicarpus monilifer* | 2 | 20 | 10 | 0.84 | 1.79 | 2.63 |
| *Andrographis sp.* | 3 | 30 | 10 | 1.26 | 1.79 | 3.05 |
| *Andropogon pumilus* | 8 | 80 | 10 | 3.36 | 1.79 | 5.15 |
| *Cissampelos pareira* | 1 | 10 | 10 | 0.42 | 1.79 | 2.21 |
| *Crotalaria bialata* | 2 | 20 | 10 | 0.84 | 1.79 | 2.63 |
| *Curculigo orchioides* | 3 | 30 | 30 | 1.26 | 5.36 | 6.62 |
| *Cyanotis sp.* | 15 | 150 | 20 | 6.30 | 3.57 | 9.87 |
| *Cymbopogon flexuosus* | 19 | 190 | 50 | 7.98 | 8.93 | 16.91 |
| *Cynoglossum zeylanicum* | 2 | 20 | 10 | 0.84 | 1.79 | 2.63 |
| *Dumasia villosa* | 6 | 60 | 40 | 2.52 | 7.14 | 9.66 |
| *Eulalia trispicata* | 2 | 20 | 10 | 0.84 | 1.79 | 2.63 |
| *Evolvulus alsinoides* | 2 | 20 | 10 | 0.84 | 1.79 | 2.63 |
| *Hedyotis herbacea* | 4 | 40 | 10 | 1.68 | 1.79 | 3.47 |
| *Hemigraphis latebrusa* | 1 | 10 | 10 | 0.42 | 1.79 | 2.21 |
| *Hemionitis arifolia* | 2 | 20 | 10 | 0.84 | 1.79 | 2.63 |
| *Imperata cylindrica* | 8 | 80 | 10 | 3.36 | 1.79 | 5.15 |
| *Lepidagathis cuspidata* | 8 | 80 | 10 | 3.36 | 1.79 | 5.15 |
| *Lepidagathis fasciculata* | 2 | 20 | 20 | 0.84 | 3.57 | 4.41 |
| *Leptochloa chinensis* | 27 | 270 | 30 | 11.34 | 5.36 | 16.70 |
| *Leucas biflora* | 3 | 30 | 10 | 1.26 | 1.79 | 3.05 |
| *Melasma avense* | 4 | 40 | 10 | 1.68 | 1.79 | 3.47 |
| *Mitracarpus villosus* | 12 | 120 | 20 | 5.04 | 3.57 | 8.61 |
| *Oplismenus compositus* | 11 | 110 | 10 | 4.62 | 1.79 | 6.41 |
| *Phyllanthus madraspatensis* | 4 | 40 | 10 | 1.68 | 1.79 | 3.47 |
| *Plectranthus barbatus* | 2 | 20 | 20 | 0.84 | 3.57 | 4.41 |
| *Rostellularia quinqueangularis* | 9 | 90 | 40 | 3.78 | 7.14 | 10.92 |
| *Senecio nudicaulis* | 10 | 100 | 10 | 4.20 | 1.79 | 5.99 |
| *Solanum torvum* | 2 | 20 | 10 | 0.84 | 1.79 | 2.63 |
| *Spermacoce hispida* | 4 | 40 | 10 | 1.68 | 1.79 | 3.47 |
| *Themeda triandra* | 33 | 330 | 30 | 13.87 | 5.36 | 19.22 |
| *Triumfetta rhomboidea* | 10 | 100 | 10 | 4.20 | 1.79 | 5.99 |
| *Vernonia cinerea* | 11 | 110 | 20 | 4.62 | 3.57 | 8.19 |
| | 238 | 2380 | | | | |

Shannon Wiener index ($H' = -\sum p_i \ln p_i$)= 3.123; Simpson index ($\lambda = \sum p_i^2$)= 0.061

N= No. of individuals; D= Density (Stems/ ha.); F=Frequency (%);
RD= Relative Density; RF= Relative Frequency; IVI= Importance Value Index.

## Table 4.23: Vegetation parameters of woody species in surrounding mine areas of Jerrila blocks

No. of quadrats studied =10, Size of each quadrat= 100m$^2$

| Name of the species | N | D | F | RD | RF | RBA | IVI |
|---|---|---|---|---|---|---|---|
| *Acacia torta* | 1 | 10 | 10 | 0.74 | 1.15 | 0.15 | 2.04 |
| *Acronychia pedunculata* | 1 | 10 | 10 | 0.74 | 1.15 | 0.45 | 2.34 |
| *Albizia chinensis* | 3 | 30 | 10 | 2.21 | 1.15 | 5.59 | 8.95 |
| *Albizia odoratissima* | 1 | 10 | 10 | 0.74 | 1.15 | 0.05 | 1.93 |
| *Artocarpus heterophyllus* | 1 | 10 | 10 | 0.74 | 1.15 | 3.08 | 4.97 |
| *Bauhinia vahlii* | 4 | 40 | 20 | 2.94 | 2.30 | 1.44 | 6.68 |
| *Bridelia retusa* | 4 | 40 | 30 | 2.94 | 3.45 | 5.14 | 11.53 |
| *Buchanania lanzan* | 4 | 40 | 30 | 2.94 | 3.45 | 1.56 | 7.95 |
| *Canthium dicoccum* | 1 | 10 | 10 | 0.74 | 1.15 | 0.37 | 2.26 |
| *Caryota urens* | 1 | 10 | 10 | 0.74 | 1.15 | 1.95 | 3.83 |
| *Casearia graveolens* | 2 | 20 | 20 | 1.47 | 2.30 | 0.09 | 3.85 |
| *Cassia fistula* | 1 | 10 | 10 | 0.74 | 1.15 | 0.36 | 2.24 |
| *Cassine glauca* | 6 | 60 | 40 | 4.41 | 4.60 | 1.87 | 10.88 |
| *Chionanthus ramiflora* | 3 | 30 | 30 | 2.21 | 3.45 | 1.46 | 7.11 |
| *Cipadessa baccifera* | 3 | 30 | 10 | 2.21 | 1.15 | 0.14 | 3.50 |
| *Cleistanthus patulus* | 2 | 20 | 10 | 1.47 | 1.15 | 0.33 | 2.95 |
| *Dillenia pentagyna* | 3 | 30 | 20 | 2.21 | 2.30 | 0.52 | 5.02 |
| *Diospyros montana* | 1 | 10 | 10 | 0.74 | 1.15 | 0.25 | 2.14 |
| *Diospyros sylvatica* | 1 | 10 | 10 | 0.74 | 1.15 | 0.12 | 2.00 |
| *Ficus microcarpa* | 1 | 10 | 10 | 0.74 | 1.15 | 6.37 | 8.26 |
| *Ficus semicordata* | 1 | 10 | 10 | 0.74 | 1.15 | 0.11 | 1.99 |
| *Garuga pinnata* | 1 | 10 | 10 | 0.74 | 1.15 | 0.72 | 2.60 |
| *Glochidion tomentosum* | 10 | 100 | 40 | 7.35 | 4.60 | 2.58 | 14.53 |
| *Gmelina arborea* | 1 | 10 | 10 | 0.74 | 1.15 | 0.18 | 2.06 |
| *Gnetum ula* | 1 | 10 | 10 | 0.74 | 1.15 | 0.25 | 2.14 |
| *Grewia tiliaefolia* | 4 | 40 | 30 | 2.94 | 3.45 | 1.82 | 8.21 |
| *Hiptage bengalensis* | 1 | 10 | 10 | 0.74 | 1.15 | 0.08 | 1.96 |
| *Homalium nepalense* | 4 | 40 | 30 | 2.94 | 3.45 | 0.44 | 6.83 |
| *Kydia calycina* | 1 | 10 | 10 | 0.74 | 1.15 | 0.69 | 2.58 |
| *Lannea coromandelica* | 5 | 50 | 30 | 3.68 | 3.45 | 3.06 | 10.18 |
| *Litsea glutinosa* | 1 | 10 | 10 | 0.74 | 1.15 | 0.13 | 2.01 |
| *Macaranga peltata* | 2 | 20 | 10 | 1.47 | 1.15 | 0.91 | 3.53 |
| *Madhuca longifolia* var. *latifolia* | 1 | 10 | 10 | 0.74 | 1.15 | 2.46 | 4.34 |
| *Mallotus philippensis* | 2 | 20 | 20 | 1.47 | 2.30 | 0.05 | 3.82 |
| *Mangifera indica* | 2 | 20 | 10 | 1.47 | 1.15 | 19.40 | 22.02 |
| *Neolitsea foliosa* | 2 | 20 | 20 | 1.47 | 2.30 | 0.14 | 3.91 |
| *Ougeinia oojeinensis* | 1 | 10 | 10 | 0.74 | 1.15 | 1.14 | 3.02 |
| *Phoenix laurerii* | 2 | 20 | 20 | 1.47 | 2.30 | 1.35 | 5.12 |
| *Phyllanthus emblica* | 19 | 190 | 40 | 13.97 | 4.60 | 9.05 | 27.62 |
| *Polyalthia cerasoides* | 2 | 20 | 20 | 1.47 | 2.30 | 0.91 | 4.68 |
| *Pterocarpus marsupium* | 10 | 100 | 50 | 7.35 | 5.75 | 15.63 | 28.73 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Schleichera oleosa* | 1 | 10 | 10 | 0.74 | 1.15 | 1.10 | 2.99 |
| *Syzygium cumini* | 7 | 70 | 30 | 5.15 | 3.45 | 3.37 | 11.96 |
| *Terminalia chebula* | 3 | 30 | 30 | 2.21 | 3.45 | 0.99 | 6.65 |
| *Terminalia alata* | 1 | 10 | 10 | 0.74 | 1.15 | 1.53 | 3.42 |
| *Wendlandia gamblei* | 2 | 20 | 20 | 1.47 | 2.30 | 0.18 | 3.95 |
| *Woodfordia fruticosa* | 1 | 10 | 10 | 0.74 | 1.15 | 0.06 | 1.95 |
| *Ziziphus rugosa* | 4 | 40 | 30 | 2.94 | 3.45 | 0.39 | 6.78 |
| | 136 | 1360 | | | | | |

Shannon Wiener Index (H'= -∑pi ln pi) = 3.467; Simpson Index (λ= ∑$pi^2$)= 0.047
N= No. of individuals; D= Density (Stems/ ha.); F=Frequency (%);
RD= Relative Density; RF= Relative Frequency; RBA= Relative Basal Area; IVI= Importance Value Index.

**Table 4.24: Vegetation parameters of tree Saplings in surrounding mine areas of Jerrila blocks**

No. of quadrats studied= 10, Size of each quadrat= 9 $m^2$

| Name of the species | N | D | F | RD | RF | IVI |
|---|---|---|---|---|---|---|
| *Albizia chinensis* | 9 | 10 | 10 | 9.89 | 2.78 | 12.67 |
| *Albizia odoratissima* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Casearia esculenta* | 2 | 2 | 10 | 2.20 | 2.78 | 4.98 |
| *Casearia graveolens* | 2 | 2 | 10 | 2.20 | 2.78 | 4.98 |
| *Cassia fistula* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Cassine glauca* | 2 | 2 | 10 | 2.20 | 2.78 | 4.98 |
| *Catunaregam spinosa* | 5 | 6 | 20 | 5.49 | 5.56 | 11.05 |
| *Cleistanthus patulus* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Ficus hispida* | 4 | 4 | 10 | 4.40 | 2.78 | 7.17 |
| *Gardenia latifolia* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Glochidion tomentosum* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Grewia serrulata* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Grewia tiliaefolia* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Homalium nepalense* | 3 | 3 | 20 | 3.30 | 5.56 | 8.85 |
| *Kydia calycina* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Litsea glutinosa* | 2 | 2 | 10 | 2.20 | 2.78 | 4.98 |
| *Macaranga peltata* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Mallotus philippensis* | 4 | 4 | 30 | 4.40 | 8.33 | 12.73 |
| *Nyctanthus arbortristis* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Phyllanthus emblica* | 2 | 2 | 20 | 2.20 | 5.56 | 7.75 |
| *Pterocarpus marsupium* | 1 | 1 | 10 | 1.10 | 2.78 | 3.88 |
| *Sterculia villosa* | 8 | 9 | 10 | 8.79 | 2.78 | 11.57 |
| *Syzygium cumini* | 4 | 4 | 10 | 4.40 | 2.78 | 7.17 |
| *Vendlandia gamblei* | 3 | 3 | 10 | 3.30 | 2.78 | 6.07 |
| *Ziziphus rugosa* | 7 | 8 | 40 | 7.69 | 11.11 | 18.80 |
| *Bauhinia vahlii* | 3 | 3 | 10 | 3.30 | 2.78 | 6.07 |
| *Celastrus paniculatus* | 20 | 22 | 20 | 21.98 | 5.56 | 27.53 |
| | 91 | 101 | | | | |

Shannon Wiener Index (H'= -∑pi ln pi)= 3.183; Simpson Index (λ= ∑$pi^2$)= 0.0478
N= No. of individuals; D= Density (Stems/ 100$m^2$); F=Frequency (%); RD= Relative Density; RF= Relative Frequency; IVI= Importance Value Index

**Table 4.25: Vegetation parameters of shrubs in surrounding mine areas of Jerrila blocks**

Number of quadrats studied= 10, Size of each quadrat= $9m^2$

| Name of the species | N | D | F | RD | RF | *IVI* |
|---|---|---|---|---|---|---|
| *Ardisia solanacea* | 2 | 2 | 10 | 1.20 | 2.44 | 3.64 |
| *Breynia vitis-idaea* | 6 | 7 | 40 | 3.59 | 9.76 | 13.35 |
| *Bridelia scandens* | 1 | 1 | 10 | 0.60 | 2.44 | 3.04 |
| *Chromolaena odorata* | 20 | 22 | 30 | 11.98 | 7.32 | 19.29 |
| *Cipadessa baccifera* | 7 | 8 | 20 | 4.19 | 4.88 | 9.07 |
| *Clerodendrum viscosum* | 13 | 14 | 10 | 7.78 | 2.44 | 10.22 |
| *Colebrookea oppositifolia* | 2 | 2 | 10 | 1.20 | 2.44 | 3.64 |
| *Dalbergia volubilis* | 6 | 7 | 20 | 3.59 | 4.88 | 8.47 |
| *Dendrocalamus strictus* | 1 | 1 | 10 | 0.60 | 2.44 | 3.04 |
| *Embelia tsjeriam-cottam* | 1 | 1 | 10 | 0.60 | 2.44 | 3.04 |
| *Chromolaena odorata* | 7 | 8 | 10 | 4.19 | 2.44 | 6.63 |
| *Indigofera cassioides* | 7 | 8 | 30 | 4.19 | 7.32 | 11.51 |
| *Ixora undulata* | 4 | 4 | 10 | 2.40 | 2.44 | 4.83 |
| *Jasminum sambac* | 1 | 1 | 10 | 0.60 | 2.44 | 3.04 |
| *Murraya koenigii* | 2 | 2 | 10 | 1.20 | 2.44 | 3.64 |
| *Murraya paniculata* | 1 | 1 | 10 | 0.60 | 2.44 | 3.04 |
| *Pavetta tomentosa* | 1 | 1 | 10 | 0.60 | 2.44 | 3.04 |
| *Phoenix acaulis* | 36 | 40 | 20 | 21.56 | 4.88 | 26.43 |
| *Phoenix laurerii* | 5 | 6 | 20 | 2.99 | 4.88 | 7.87 |
| *Pogostemon benghalensis* | 8 | 9 | 20 | 4.79 | 4.88 | 9.67 |
| *Polygonum chinense* | 15 | 17 | 10 | 8.98 | 2.44 | 11.42 |
| *Solanum torvum* | 1 | 1 | 10 | 0.60 | 2.44 | 3.04 |
| *Solanum erianthum* | 3 | 3 | 20 | 1.80 | 4.88 | 6.67 |
| *Spermadictyon suaveolens* | 9 | 10 | 30 | 5.39 | 7.32 | 12.71 |
| *Thysanolaena maxima* | 6 | 7 | 10 | 3.59 | 2.44 | 6.03 |
| *Triumfetta rhomboidea* | 2 | 2 | 10 | 1.20 | 2.44 | 3.64 |
| | 167 | 186 | | | | |

Shannon Wiener index ($H' = -\sum pi \ln pi$)= 3.134; Simpson index ($\lambda = \sum pi^2$)= 0.0493

N= No. of individuals; D= Density (Stems/ $100m^2$); F=Frequency (%); RD= Relative Density; RF= Relative Frequency; IVI= Importance Value Index

**Table 4.26: Vegetation parameters of herbs in surrounding mine area of Jerrila blocks**

No. of quadrats studied= 10, Size of each quadrat= $1m^2$

| Name of the species | N | D | F | RD | RF | IVI |
|---|---|---|---|---|---|---|
| *Achyranthes aspera* | 3 | 30 | 10 | 1.00 | 1.45 | 2.45 |
| *Bidens pilosa* | 27 | 270 | 20 | 9.00 | 2.90 | 11.90 |
| *Blumea mollis* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Cassia hirsuta* | 2 | 20 | 10 | 0.67 | 1.45 | 2.12 |
| *Cissampelos pareira* | 4 | 40 | 30 | 1.33 | 4.35 | 5.68 |
| *Curculigo orchioides* | 5 | 50 | 30 | 1.67 | 4.35 | 6.01 |
| *Cyanotis sp.* | 4 | 40 | 10 | 1.33 | 1.45 | 2.78 |
| *Cyclea peltata* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Cymbopogon flexuosus* | 16 | 160 | 10 | 5.33 | 1.45 | 6.78 |
| *Cyperus sp.* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Desmodium gangeticum* | 2 | 20 | 10 | 0.67 | 1.45 | 2.12 |
| *Desmodium triquetrum* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Digitaria ciliaris* | 9 | 90 | 10 | 3.00 | 1.45 | 4.45 |
| *Dumasia villosa* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Euphorbia geniculata* | 12 | 120 | 10 | 4.00 | 1.45 | 5.45 |
| *Evolvulus alsinoides* | 2 | 20 | 10 | 0.67 | 1.45 | 2.12 |
| *Gnaphalium luteo-album* | 2 | 20 | 10 | 0.67 | 1.45 | 2.12 |
| *Hedyotis herbacea* | 3 | 30 | 10 | 1.00 | 1.45 | 2.45 |
| *Hemionitis arifolia* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Imperata cylindrica* | 15 | 150 | 10 | 5.00 | 1.45 | 6.45 |
| *Justicia betonica* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Rostellularia quinqueangularis* | 5 | 50 | 20 | 1.67 | 2.90 | 4.57 |
| *Knoxia corymbosa* | 3 | 30 | 10 | 1.00 | 1.45 | 2.45 |
| *Lepidagathis cristata* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Lepidagathis fasciculata* | 16 | 160 | 30 | 5.33 | 4.35 | 9.68 |
| *Leucas biflora* | 2 | 20 | 10 | 0.67 | 1.45 | 2.12 |
| *Leucas lanata* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Macardonia procumbens* | 7 | 70 | 10 | 2.33 | 1.45 | 3.78 |
| *Malvastrum coromandelianum* | 3 | 30 | 10 | 1.00 | 1.45 | 2.45 |
| *Melasma avense* | 6 | 60 | 20 | 2.00 | 2.90 | 4.90 |
| *Phaulopsis imbrecata* | 3 | 30 | 10 | 1.00 | 1.45 | 2.45 |
| *Mitracarpus villosus* | 8 | 80 | 10 | 2.67 | 1.45 | 4.12 |
| *Mukia madaraspatana* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Oplismenus compositus* | 18 | 180 | 20 | 6.00 | 2.90 | 8.90 |
| *Oxalis corniculata* | 3 | 30 | 10 | 1.00 | 1.45 | 2.45 |
| *Phyllanthus madaraspatensis* | 2 | 20 | 10 | 0.67 | 1.45 | 2.12 |
| *Phyllanthus narayanaswami* | 2 | 20 | 10 | 0.67 | 1.45 | 2.12 |
| *Plectranthus barbatus* | 2 | 20 | 10 | 0.67 | 1.45 | 2.12 |
| *Pogostemon bengalensis* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Polygonum chinense* | 2 | 20 | 10 | 0.67 | 1.45 | 2.12 |
| *Richardia brasiliensis* | 2 | 20 | 10 | 0.67 | 1.45 | 2.12 |
| *Rungia pectinata* | 4 | 40 | 10 | 1.33 | 1.45 | 2.78 |
| *Scleria lithosperma* | 3 | 30 | 10 | 1.00 | 1.45 | 2.45 |
| *Sida acuta* | 13 | 130 | 10 | 4.33 | 1.45 | 5.78 |
| *Solanum viarum* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Sopobia delphinifolia* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Stachytarpheta jamaicensis* | 32 | 320 | 20 | 10.67 | 2.90 | 13.57 |
| *Striga asiatica* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Synedrella nudiflora* | 2 | 20 | 10 | 0.67 | 1.45 | 2.12 |
| *Themeda triandra* | 29 | 290 | 30 | 9.67 | 4.35 | 14.01 |
| *Thysanolaena maxima* | 3 | 30 | 10 | 1.00 | 1.45 | 2.45 |
| *Triumfetta rhomboidea* | 8 | 80 | 30 | 2.67 | 4.35 | 7.01 |
| *Urena lobata* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| *Xanthium strumarium* | 1 | 10 | 10 | 0.33 | 1.45 | 1.78 |
| | 300 | 3000 | 690 | | | |

Shannon Wiener index (H'= -∑pi ln pi) = 3.391; Simpson index ($\lambda = \sum pi^2$)= 0.0499
N= No. of individuals; D= Density (Stems/ 100m$^2$); F=Frequency (%); RD= Relative Density; RF= Relative Frequency; IVI= Importance Value Index

**Table 4.27: Mammalian species reported in and around the proposed mine lease area**

| S. No. | Common Name | Zoological Name | Schedule Status | Category and criteria (IUCN, 2007) |
|---|---|---|---|---|
| **1.** | Rhesus monkey | *Macaca mulatta* | Schedule II | LR |
| **2.** | Common langur | Semnopethicus entellus | *Schedule II* | *LR* |
| **3.** | Hyaena | *Hyaena hyaena* | Schedule III | LR |
| **4.** | Wild Boar | *Sus scrofa* | Schedule III | LR/LC |
| **5.** | Indian Crested Porcupine | *Hystrix indica* | Schedule IV | LR/LC |
| **6.** | Hare | *Lepus nigricollis* | Schedule IV | LR/LC |
| **7.** | Jackal | *Canis aureus* | Schedule IV | LC |
| **8.** | Fox | *Vulpus bengalensis* | Schedule IV | LC |
| **9.** | Mongoose | *Herpestes* sp. | Schedule IV | LR/LC |
| **10.** | Three striped Squirrel | *Funambulus palmarum* | - | LR/LC |

**LC- Least concern; LR- Low Risk**

## Table 4.28: Avian species as reported in Working Plan of Narsipatnam Forest Division (2003)

| S. No. | Common Name | Zoological Name | Scheduled Status | Category and criteria (IUCN, 2007) |
|---|---|---|---|---|
| 1 | Ashwren barbler/Ashy Prinia | *Prinia socialis* | Schedule IV | LC |
| 2 | Black ibis (migratory)/ Red-Naped Ibis | *Pseudibis papillosa* | Schedule IV | LC |
| 3 | Brahminy Kite | *Haliastur indus* | Schedule IV | LC |
| 4 | Black breasted quail/ Rain Quail | *Coturnix coromandelica* | Schedule IV | LC |
| 5 | Blue rock pigeon/ Rock Pigeon | *Columba livia* | Schedule IV | LC |
| 6 | Bronze winged Jacana | *Metopidius indicus* | Schedule IV | LC |
| 7 | Brown headed gull | *Larus brunnicephalus* | Schedule IV | LC |
| 8 | Black headed oriole | *Oriolus xanthornus* | Schedule IV | LC |
| 9 | Black drongo | *Dicrurus macrocercus* | Schedule IV | LC |
| 10 | Black hooded bunting | *Emberiza melanocephala* | Schedule IV | LC |
| 11 | Baya weaver bird | *Ploceus philippinus* | Schedule IV | LC |
| 12 | Little Cormorant | *Phalacrocorax niger* | Schedule IV | LC |
| 13 | Cattle egret | *Babulcus ibis* | Schedule IV | LC |
| 15 | Common sand piper | *Actitis hypoleucos* | Schedule IV | LC |
| 17 | Crimson breasted barbet/ Coppersmith barbet | *Megalaima haemacephala* | Schedule IV | LC |
| 18 | Crested lark | *Galerida cristata* | Schedule IV | LC |
| 19 | Indian Mynah | *Acridotheres tristis* | Schedule IV | LC |
| 20 | Common Iora | *Aegithina tiphia* | Schedule IV | LC |
| 21 | Common babbler | *Turdoides caudata* | Schedule IV | LC |
| 22 | Chestnut-bellied (Nuthatch) | *Sitta castanea* | - | LC |
| 23 | Common RoseFinch | *Carpodacus erythrinus* | Schedule IV | LC |
| 24 | Dabchick | *Podiceps ruficollis* | - | |
| 25 | African Darter | *Anhinga rufa* | Schedule IV | LC |
| 26 | Grey Heron | *Ardea cinarea* | Schedule IV | LC |
| 27 | Grey Partridge | *Francolinus pondicerianus* | Schedule IV | LC |
| 28 | Indian great horned owl/ Eurasian Eagle-owl | *Bubo bubo* | Schedule IV | LC |
| 29 | Grey shrike | *Lanius excubitor* | - | LC |
| 30 | Grey Tit | *Parus major* | Schedule IV | LC |
| 31 | Grey wag tail | *Motacilla cineria* | - | |
| 32 | House Swift | *Apus nipalensis* | Schedule IV | LC |
| 33 | Hoopoe/Eurasian Hoopoe | *Upupa epops* | - | LC |
| 34 | House crow | *Corvus splendens* | Schedule V | LC |
| 35 | House sparrow | *Passer domesticus* | | LC |
| 36 | Indian pea fowl | *Pavo cristatus* | Schedule I | LC |
| 37 | Indian Whiskered Tern | *Chlidonias hybrida* | - | LC |
| 38 | Indian Night Jar | *Caprimulgus asiaticus* | - | LC |
| 39 | Indian Roller/Blue Jay | *Coracialis benghalensis* | Schedule IV | LC |
| 40 | Indian Pitta | *Pitta brachyura* | Schedule IV | LC |
| 41 | Indian Robin | *Saxicoloides fulicata* | - | LC |
| 42 | Jungle bush Quail | *Perdicula asiatica* | Schedule IV | |
| 43 | Chloropsis Gold Mantled/ Blue winged leaf bird | *Chloropsis cochinchinensis* | - | LC |
| 45 | Jungle Babbler | *Turdoides striata* | Schedule IV | LC |
| 46 | Koel/Asian Koel | *Eudynamys scolopaceus* | - | LC |
| 47 | Lesser Whistling Teal | *Dendrosigna javanica* | Schedule IV | |

| | | | | |
|---|---|---|---|---|
| 48 | Little ringed Plower | *Charadrius dubius* | Schedule IV | |
| 50 | Maharatta Woodpecker | *Picoides maharattensis* | Schedule IV | |
| 51 | Open Billed Stork | *Ana stomus oscitans* | Schedule IV | - |
| 52 | Pond Heron/Paddy Bird | *Ardeola grayii* | Schedule IV | LC |
| 53 | Pariah Kite/Black kite | *Milvus migrans* | - | LC |
| 54 | Purple Moore Hen | *Porhyrio porphyirio* | - | |
| 55 | Pied Kingfisher | *Ceryle rudis* | Schedule IV | LC |
| 56 | Pied Hornbill | *Anthracoceros malabaricus* | Schedule I | |
| 57 | Pied Mynah/Asian pied contra | *Sturnus contra* | Schedule IV | LC |
| 58 | Pied bushchat | *Saxicola caprata* | - | LC |
| 59 | Purple throated sunbird | *Nectarinia sperata* | Schedule IV | LC |
| 60 | Red headed Merlin | *Falco chicqera* | Schedule I | |
| 61 | Red Junglefowl | *Gallus gallus* | - | LC |
| 62 | Red -Wattled Lapwing | *Vanellus indicus* | - | LC |
| 63 | Rose ringed parakeet | *Psittacula krameri* | Schedule IV | LC |
| 64 | Red-rumped swallow | *Hirundo daurica* | - | LC |
| 65 | Red whiskered bulbul | *Pictonotus jacosus* | Schedule IV | LC |
| 66 | Red vented bulbul | *Picnonotus cafer* | Schedule IV | LC |
| 67 | Red head Bunting | *Emberiza bruniceps* | Schedule IV | LC |
| 69 | Red turtle Dove/Red collared dove | *Streptopelia tranquebarica* | Schedule IV | LC |
| 70 | Little Egret | *Egretta garzetta* | Schedule IV | LC |
| 71 | Spot-Billed Duck | *Anas poecilorhyncha* | Schedule IV | LC |
| 72 | Shikra | *Accipiter badius* | - | LC |
| 73 | Shaheen Falcon/Barbary Falcon | *Falco pelegrinoidesr* | **-** | LC |
| 74 | Stone curlew | *Burhinus oedicnamus* | Schedule IV | |
| 75 | Spotted Dove | *Stimatopelia chinensis (Streptopelia chinenesis)* | Schedule IV | LC |
| 76 | Spotted owlet | *Ethene brama* | - | LC |
| 77 | Small green bee eater | *Merops orientalis* | - | LC |
| 78 | Scarlet minivet | *Pericrocotus flammeus* | Schedule IV | LC |
| 79 | Spotted munia/ Scaly breasted munia | *Lonchura punctulata* | Schedule IV | LC |
| 80 | Tree pipet/Olive backed pipit | *Anthus hodgsoni* | Schedule IV | LC |
| 81 | White backed/Bengal Vulture/white rumped vulture | *Gyps benghalensis* | Schedule IV | CR A2ce+3ce |
| 82 | White-throated fantail | *Rhipidura albicollis* | - | LC |

CR- Critically Endangered; LC- Least concern

### Table 4.29: Reptiles reported in and around the proposed mine lease area

| S. No. | Common Name | Zoological Name | Schedule status |
|---|---|---|---|
| **1** | Indian spectacled cobra | *Naja naja* | Schedule IV |
| **2** | Russels Viper | *Vipera russeli* | Schedule IV |
| **3** | Krait | *Bangarus caeruleus* | Schedule IV |
| **4** | Saw scaled viper | *Echis carinatus* | Schedule IV |
| **5** | Green tree snake | *Dryophis* sp. | Schedule IV |
| **6** | Rat snake | *Ptyas mucosus* | - |
| **7** | Monitor lizard | *Varanus monitor* | - |
| **8** | Common wall lizard | *Gecko sp.* | - |
| **9** | Wall lizard | *Memicactylus sp.* | - |
| **10** | Garden lizard | *Calotes versicolor* | Schedule IV |
| **11** | Chameleon | *Chameleo calacratus* | - |

### Table 4.30: Insect species recorded in and around the proposed mine lease area

| S. No. | Common Name | Zoological Name | Schedule Status (IUCN, 2007) |
|---|---|---|---|
| **Orthoptera** | | | |
| 1 | Grass hoppers | Species to be identified | **-** |
| **Homoptera** | | | |
| 2 | Aonla aphid | *Cerciahpis emblica* | **-** |
| 3 | Soft scale | Un identified | **-** |
| 4 | Armoured scale | Un identified | - |
| **Lepidoptera** | | | |
| 5 | Common Crow | Euploa core core | *Schedule IV* |
| 6 | Lemon butterfly | Papilio demoleus | |
| 7 | Common sergent | Athyma perius | |
| 8 | Indian Fritillary | Argynnis hyperbius | |
| 10 | Common sailor | Neptis hylas | |
| 11 | Tawny coster | *Acraea terpsicore* | |
| 12 | Indian Cupid | Evere lacturnus syntala | |
| 13 | Common Pierot | Castalius rosimon | |
| 14 | Common Jazebel | Delias eucharis | |
| 15 | Common Castor | Ergolis merione | |
| 16 | Common Grass yellow | *Eurema hecabe simulate* | Schedule IV |
| 17 | Plain Tiger | *Danaus chryssipus chryssipus* | - |
| 18 | Bark eating caterpiller | *Indarbela sp.* | - |
| **Coleoptera** | | | |
| 19 | Red palm weevil | *Rynchophorus ferrugenius* | **-** |
| **Diptera** | | | |
| 20 | Aonla gall insect | Betuosa stylophora | **-** |
| **Hymenoptera** | | | |
| 21 | Rock bee | Apis dorsata | **-** |
| 22 | Red ant | Un identified | **-** |
| 23 | Black ant | Un identified. | **-** |
| **Odonata** | | | |
| 24 | Dragon fly | Un identified | |

**Table 4.31: Aquatic biota in various sampling sites around Jerrila blocks**

| Sl. No. | Stream Site | Organisms | | | |
|---|---|---|---|---|---|
| | | Phytoplankton | Zooplankton | Other invertebrates | Vertebrates |
| 1 | Near R.V. Nagar | *Spirogyra* | *Cyclops*<br>*Cladocera*<br>Rotifer<br>Ostracod | *Chironomus* larvae<br>*Gerris*<br>Mayfly nymph | |
| 2 | Near Kothapalli village | | *Cladocera*<br>Rotifer | Mayfly nymph | |
| 3 | Near Ebulam village | *Spirogyra* | *Cyclops*<br>Ostracod | *Chironomus* larvae<br>*Hydracarina*<br>Nematode<br>Unidentified larvae<br>Mayfly nymph | |
| 4 | Near Rinthada | | *Cyclops*<br>*Cladocera*<br>Rotifer<br>Ostracod | *Chironomu*s larvae<br>*Gerris*<br>Mayfly nymph<br>Anisope<br>Unidentified insect | Fish larvae |
| 5 | Near Lothugedda | *Spirogyra* | *Cyclops*<br>Ostracod<br>Rotifer | Mayfly nymph<br>Unidentified beetle<br>Unidentified insect | Fish larvae |
| 6 | Ganjengi gedda | -- | *Cyclops*<br>Ostracod<br>Rotifer | *Chironomus* larvae<br>Mayfly nymph | -- |
| 7 | Near Lothugedda Check post | -- | -- | *Gerris* | -- |

**Table 4.32: Details of aquatic sampling sites around Jerrila blocks**

| Sl. No. | Latitude | Longitude | Site | Water flow | Temp. (°C) | pH |
|---|---|---|---|---|---|---|
| 1 | 17°52' 102''N | 82°15' 206''E | Near R.V. Nagar | Low | 20.9 | 7.83 |
| 2 | 17°53' 314''N | 82°10' 353''E | Near Kothapalli village | High | 18.9 | 7.4 |
| 3 | 17°51' 21''N | 82°17' 195''E | Near Ebulam Village | Moderate | 26.2 | 7.2 |
| 4 | 17°51' 29''N | 82°19' 185''E | Near Rinthada | Modera te | 26.0 | 7.8 |
| 5 | 17°52' 17''N | 82°25' 102''E | Near Lothugedda | Mode rate | 26.8 | 7.7 |
| 6 | | | Ganjengi gedda | High | -- | 8.52 |
| 7 | | | Near Lothugedda Check post | Very low | -- | -- |

**Table 4.33: Percentage occurrence of aquatic biota in sampling sites around Jerrila blocks**

| Sl. No. | Stream site | Organisms | %Occurrence/ Presence |
|---|---|---|---|
| 1 | Near R.V. Nagar village | *Gerris* | 28.07 |
| | | Rotifer | 28.07 |
| | | *Cladocera* | 14.04 |
| | | Mayfly nymph | 10.53 |
| | | Ostracod | 8.77 |
| | | *Cyclops* | 7.02 |
| | | *Chironomus* larva | 3.51 |
| | | *Spirogyra* | √ |
| 2 | Near Kothapalli village | Rotifer | 75.00 |
| | | *Cladocera* | 21.43 |
| | | Mayfly nymph | 3.57 |
| 3 | Near Ebulam village | Mayfly nymph | 31.25 |
| | | *Cyclops* | 18.75 |
| | | Ostracod | 12.50 |
| | | *Hydracarina* | 12.50 |
| | | *Chironomus* larva | 12.50 |
| | | Unidentified nymph | 6.25 |
| | | Nematode | 6.25 |
| | | *Spirogyra* | √ |
| 4 | Near Rinthada village | Anisope | 38.14 |
| | | *Cladocera* | 17.80 |
| | | Fish larva | 15.25 |
| | | *Gerris* | 9.32 |
| | | *Cyclops* | 5.93 |
| | | Mayfly nymph | 5.93 |
| | | Rotifer | 5.08 |
| | | Ostracod | 0.85 |
| | | *Chironomus* larva | 0.85 |
| | | Unidentified insect | 0.85 |
| 5 | Near Lothugedda village | Mayfly nymph | 61.11 |
| | | *Cyclops* | 14.81 |
| | | Rotifer | 7.41 |
| | | *Chironomus* larva | 5.56 |
| | | Fish larva | 3.70 |
| | | Ostracod | 3.70 |
| | | Unidentified beetle | 1.85 |
| | | Unidentified insect | 1.85 |
| | | *Spirogyra* | √ |
| 6 | Ganjengi gedda | Rotifer | 40.91 |
| | | *Chironomus* larva | 27.27 |
| | | *Cyclops* | 13.64 |
| | | Mayfly nymph | 9.09 |
| | | *Cladocera* | 9.09 |
| 7 | Near Lothugedda Check post | *Gerris* | 100.00 |

**Table 4.34: Distribution of Arbuscular Mycorrhizal Fungi (AMF) in the roots and soil samples collected from different sample plots of project affected area (Mine Lease Area) and surrounding mine lease area**

| S. No. | Sample plots (Block - I) | AMF colonization | | | % AMF colonization* | AMF spore population/ 100 gm of soil* |
|---|---|---|---|---|---|---|
| | | A | V | H | | |
| 1. | Sample plot – 1 (Surrounding Mine Lease Area) | **+** | **+** | **+** | 88 | 272 |
| 2. | Sample plot – 2 (Mine Lease Area) | **-** | **+** | **+** | 12 | 76 |

A – Arbuscular structures
V – Vesicular structures
H – Hyphal structures
* Mean of 3 replications; (+) = Present; (-) = Absent

| | |
|---|---|
| 1-25% | Low |
| 26-50% | Moderate |
| 51-75% | High |
| 76-100% | Very High |

**Table 4.35: Frequency distribution of Arbuscular Mycorrhizal Fungi (AMF) recorded from the rhizosphere soil samples collected from different sample plots of project affected area (Mine Lease Area) and surrounding mine lease area**

| S. No. | AM Fungi | Sample plots | | (%) Frequency |
|---|---|---|---|---|
| | | 1 (Outside Mine Lease Area) | 2 (Mine Lease Area) | |
| 1 | *Glomus* sp. | + | - | 50 |
| 2 | Section 1.08 Glom us albidum | + | + | 100 |
| 3 | *Glomus clarum* | + | - | 50 |
| 4 | *Glomus claroideum* | - | + | 50 |
| 5 | *Glomus fulvus* | + | - | 50 |
| 6 | *Glomus geosporum* | + | + | 100 |
| 7 | Section 1.09 Glom us microcarpum | + | - | 50 |
| 8 | *Glomus occultum* | + | - | 50 |
| 9 | *Glomus pubescens* | + | - | 50 |
| 10. | *Gigaspora* sp. | + | - | 50 |

(+) Present; (-) Absent

**Table 4.36: Status of fungal flora in the soil samples collected from different sample plots in project affected area (Mine Lease Area) and surrounding mine lease area**

| S. No. | Sample plots (Block - I) | Fungal Types | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | Total Population* ($10^{-3}$ cfu $g^{-l)}$ |
| 1. | Sample plot 1 (Outside Mine Lease Area) | 6 | 17 | 89 | 4 | 5 | 8 | - | 9 | 138 |
| 2. | Sample plot 2 (Mine Lease Area) | - | - | 17 | - | 6 | 5 | 28 | - | 56 |

* Mean of 3 Replications
cfu - Colony forming units

| | |
|---|---|
| (a) *Alternaria* sp. | *(e) Mucor sp.* |
| *(b) Aspergillus* sp. | *(f) Penicillium sp.* |
| *(c) Aspergillus niger* | *(g) Rhizopus* sp. |
| *(d) Curvularia* sp. | (h) Sterile mycelial form |

**Table 4.37: Fungal population in soil samples collected from different sample plots**

| S.No. | Name of fungi | Total population ($10^{-3}$ cfu $g^{-l)}$ |
|---|---|---|
| 1. | *Alternaria* sp. | 6 |
| 2. | *Aspergillus* sp. | 17 |
| 3. | *Aspergillus niger* | 106 |
| 4. | *Curvularia* sp. | 4 |
| 5. | *Mucor* sp. | 11 |
| 6. | *Penicillium* sp. | 13 |
| 7. | *Rhizopus sp.* | 28 |
| 8. | Sterile mycelium | 9 |

cfu = Colony forming units

**Table 4.38: Status of Bacterial and Actinomycetes population in the soil samples collected from different sample plots (x $10^2$ cfu.$g^{-1}$) in project affected area (Mine Lease Area) and surrounding mine lease area**

| S. No. | Sample plots (Block - I) | Bacterial colonies* | | | Actinomycete colonies* | |
|---|---|---|---|---|---|---|
| | | ***Bacillus*** | ***Pseudomonas*** | **Unidentified** | ***Streptomyces*** | **Unidentified** |
| 1. | Sample plot 1 (Surrounding Mine Lease Area) | 6.5 | 20.5 | 6.0 | --- | 2.0 |
| 2. | Sample plot 2 (Mine Lease Area) | 42.0 | 9.5 | 2.0 | --- | 1.5 |
| Total | | 48.5 | 30.0 | 8.0 | --- | 3.5 |

* Mean of 3 replications

**TABLE 4.39:IN-PUT INDICATING COMPLIANCE ON MODEL TERM OF REFERENCE FOR EIA AND EMP STUDIES OF BAUXITE MINING PROJECT IN JERRILA BLOCK I, VISHAKHAPATNAM**

| Chapter | | Description | Compliance on page no. |
|---|---|---|---|
| 1. | Introduction | Profile of project proponent and background, nature, size, location of the project and scope of EIA | 1-10 |
| 2. | Project Attributes | Project details, proposed mining activities, and features project setting | 11-38 |
| 3. | Physical Environment | Describes about the present status of the various components of the environment viz. Air, Noise, Water, Soil and Land. | 39-70 |
| 4. | Biological Environment | Study of species diversity and status of flora, terrestrial fauna, aquatic fauna and soil micro-flora | 71-103 |
| 5. | Socio-economic environment | Demography and economic status based on household survey | 104-129 |
| 6. | Impact identification, prediction and assessment | Impact of mining activity on the physical environment (air, noise, water, land and soil) and biological environment (flora and fauna) and its mitigation measures | 130-155 |
| 7. | Environmental Management Plan | It includes preventive measures for controlling pollution and long term monitoring plans of environment | 156-174 |
| **Additional studies** | | | |
| 8. | Greenbelt Development Plan | Proposal for 30 m wide Greenbelt all around the mine lease area | 175-177 |
| 9. | Landscape and Site Restoration Plan | Mainly dealt with pre mining, post mining and during operation land restoration and stabilization plans | 178-182 |
| 10. | Afforestation Plan | Plan for plantation and financial assistance | 183-185 |
| 11. | Ecorestoration Plan | Mine overburden & its eco rehabilitation | 186-190 |
| 12. | Biodiversity Conservation and Management Plan | Consists plan for plant wealth & wildlife | 191-200 |
| 13. | Solid Waste Management Plan | Dealt with waste type, their disposal and minimization including funds for monitoring | 201-211 |
| 14 | Social Management Plan | Various possible schemes for upliftment of project affected families | 212-231 |
| 15. | Human Health Management Plan | Occupational health and preventive measures | 232-238 |
| 16. | Risk Assessment and Disaster Management Plan | Effective management for emergencies that can arise during mining operations. | 239-244 |

**TABLE 4.40:ADDITIONAL COMPLIANCE ON TERMS OF REFERENCE FOR EIA AND EMP STUDIES OF BAUXITE MINING PROJECT IN JERRILA BLOCK I VISHAKHAPATNAM AS PER LETTER DT. 31.10.2007**

| Sl. No | Description | Chapter | page no. |
|---|---|---|---|
| 1. | Brief Description on the State-of-art Technology used | Project Attributes<br>Chapter 2.2 | 14-20 |
| 2. | Location of proposed township of the project | Not Applicable | |
| 3. | Cumulative impact on ambient air quality due to Jerala Block –I and Block –II which are adjacent to each other and other sources. | Physical Environment<br>Chapter 3.3 | 49-56 |
| 4. | An inventory of floral species likely to be affected shall be got prepared and duly vetted | Ecological Environment<br>Chapter 4.4 | 73-86 |
| 5. | Impact of the local people due to diversion of forest land for mining and proposed measures for socio economic development of the affected villages in the project zone. | Socio-economic Environment<br>Chapter 5.1 – 5.6 | 104-123 |
| 6. | House hold survey about the source of livelihood of the tribal house holds and other weaker sections | Socio-economic Environment<br>Chapter 5.7 | 124-128 |
| 7. | A scientific conservation plan for fauna | Ecological Environment<br>Chapter 4.5 | 87-96 |
| 8. | Conceptual Mining Plan for every 5 years for the life of the mine | Project Attributes<br>Chapter 2.3 | 20-28 |
| 9. | Measures of control of soil erosion and management of silt. | Solid Waste Management Plan<br>Chapter 13.3 & 13.4 | 201-207 |
| 10. | Geotechnical study | Physical Environment<br>Chapter 3.5 | 59-67 |
| 11. | Plan for abatement and compensation for damage to nearby agricultural land / common property | Not Applicable | |
| 12. | Health and Safety measures for the workers including training on eradication and health effect on exposure to dust etc. | Human Health and Disaster Management Plan<br>Chapter 15 & 16.5 | 232-238<br>&<br>243 |
| 13. | Measures for soil erosion and silt management | Solid & waste management Plan<br>Chapter 13 | 201-211 |
| 14. | Green Belt development and selection of plant species | Green belt development plan<br>Chapter 8 | 175-177 |
| 15. | Details of budget allocation and break-up for implementation of above activities | Social Management Plan<br>Chapter 14.7 | 225 |