ESIA STUDY

MOHER & MOHER AMLOHRI EXTENSION COAL BLOCKS, M.P. (INDIA)

CHAPTER 6.

ANTICIPATED ENVIRONMENT & SOCIAL IMPACT

6. ANTICIPATED ENVIRONMENT & SOCIAL IMPACT

6.1 INTRODUCTION

Prediction of impacts is the most important step of environmental impact assessment. Superimposition of predicted impacts over baseline environmental scenario gives the ultimate environmental scenario. The environmental components that are likely to be influenced and modified by the project activities are (i) land or topography and soil, (ii) water and drainage, (iii) air, (iv) flora and fauna (biological or ecological components) and (v) socio-economic components.

Table 6-1: Types and Cause of Environmental Impact

Types of Impacts	Cause of impact
Impacts on Air quality	Generation of SPM & RSPM from various sources during mining operation
Impacts on Land and soil	By overburden dumping, mining, top soil generation and solid waste generation
Impacts on hydrology and hydrogeology (surface water and ground water)	Wash off from OB dump by surface runoff; wash off of eroded material of soil, leaching of oil /grease, waste water generated due to sanitation purpose and other purposes.
Impact on noise and vibration	Operation of Heavy Earth Moving Machines (HEMM), drilling and blasting
Impact on ecology (Forest, species of flora and fauna)	Loss of forest land, Loss of surface vegetation
Impact on socio-economic environment (population and settlement)	Resettlement & Rehabilitation, Land use pattern change, Economic growth, Environment quality degradation, lowering of water table causing shortage of drinking water.

A. ENVIRONMENTAL IMPACT

6.2 IMPACT ON AIR QUALITY

The different process of handling, transportation, and storage of coal in the mining activities are prone to generation of high levels of fugitive dust that may increase the levels of SPM to high extent. Dusts are generated due to the following mining processes:

- Generation of dust due to drilling and blasting for removal of overburden and coal;
- Generation of dust due to transportation of overburden to dumpsites and transportation to Coal Handling Plant;
- Generation of dust from coal handling;
- Generation of dust due to movement of heavy vehicles.

In this section impact on air environment due to emissions generated from various activities of the project have been assessed.

Air quality modelling is an important tool for prediction, planning and evaluation of air pollution control activities besides identifying the requirements for emission control to meet the regulatory standards. The efficient management of air quality requires the use of modelling techniques to analyze the patterns of pollutant concentrations.

6.2.1 Model Used

In the present case, Industrial Source Complex [ISC3] 1993 Dispersion Model based on steady state Gaussian Plume Dispersion, designed for area sources for short term and developed by United States Environmental Protection Agency [USEPA] has been used for simulations from area sources.

6.2.1.1 *Air Quality Prediction*

The dust emissions from mining activity have been estimated for coal production of 12 MTPA and 20 MTPA.

Table 6-2: Coal Production Details and Transportation Details

S. No.	Parameters	Capacity 12 MTPA	Capacity 20 MTPA
1.	Coal Production (Mt/Yr)	12	20
2.	Waste Generation (Mm^3/yr)	48	76
3.	Road lead length to Coal Stock yard (km)	2.5	4.0
4.	Road lead length to Dumpsite within the quarry area (km)	2.5	3.0

Resultant Ground level Concentrations for SPM based on meteorological data collected during the study period is estimated.

Control Factors

The various control factors for dust suppression have been summarized below and have been used to estimate emissions.

Table 6-3: Dust Control Factor for various Process

Operation / Activities	Control Methods and emission reduction
Transporting	50% for WBM road
Dust generation due to loading of OB and coal	50% with water spraying

6.2.1.2 *Source Strength Estimation*

The proposed mining activity, include various activities like ground preparation, excavation, drilling and blasting, handling and transport of coal and over burden.

These activities have been analysed systematically basing on published literature and USEPA-Emission Estimation Technique Manual, for Mining AP-42. Estimated emissions are given in **Table 6.4.**

Table 6-4: Emission Strength

Parameters	Mine Capacity		
	Unit	12 MTPA	20 MTPA
MINE PARAMETERS			
Coal Production	MTPA	12	20
Daily Coal Production	t/day	33803	56338
OB Removal(Peak)	M.CuM/Year	45.97	76.52
Daily OB removal	m^3 /day	129493	215549
By Dragline	m^3 /day	44423	63437
By Shovel + Dumpers	m^3 /day	85070	152113
Stripping ratio	m^3/t	3.83	3.83
Total Working day in a year	Number	355	355
(i) Top Soil Removal			
Total volume of top soil removed per day	% of OBR	10	10
The Quantity of Top Soil generated per day	m^3 /day	12949	21555
Density	t/m^3	1.6	1.6
Dust Emission Factor	Kg/t	0.029	0.029
The dust generated in this operation	kg/day	600.85	1000.15
Control Factor	%	50	50
Dust generation after applying control factor	kg/day	300.42	500.07
(ii) OB Removal			
Drilling			
Nos. of RBH Drills			
- 250 mm RBH Drills	Nos.	6	10
- 311 mm RBH Drills	Nos.	2	4
Yield			
- 250 mm RBH Drills	m^3/m	88.59	88.59
- 311 mm RBH Drills	m^3/m	89.5	89.5
Total meterage required	m/day	1457	2426
For Dragline Benches	m/day	496	709
For Shovel Benches	m/day	960	1717
Total No. of holes (day)	Nos.	66	113
Emission Factor		0.59	0.59
Dust Generated	kg/day	39	67
Blasting			

Parameters	Mine Capacity		
	Unit	12 MTPA	20 MTPA
Total area of OB benches being blasted in a day	m^2	2528	4121
Emission Factor		0.00022	0.00022
Dust Generation due to blasting	kg/day	0.56	0.91
Dust generation due to OB removal	kg/day	39.35	67.64
(iii) Coal Extraction			
Drilling			
Total No. of holes (day)	No.	15	20
Emission Factor	kg/day	0.1	0.1
Dust Generated	kg/day	1.5	2
Blasting			
Total area of coal benches being blasted in a day	m^2	623	1038
Emission Factor		0.00022	0.00022
Dust Generation due to blasting	kg/day	0.14	0.23
Loading of Coal			
Emission Factor		0.02	0.02
Dust generation due to loading of coal	kg/day	676.06	1126.76
Dust due to extraction of coal	kg/day	677.69	1128.99
(iv) Transportation of overburden OB dump site			
Capacity of each dumper	Tonnes	70	221
Total number of trips per day	number	1215	688
Average distance traveelled by each dump trucks	km	2.5	3
Total Vehicle km travelled per day	VKT/day	6076	4130
Emission Factor	Kg/km.	2.25	2.25
Dust generation due to OB transportation	kg/day	13672	9292
Control Factor	%	50	50
Dust generation after applying control factor	kg/day	6836.02	4645.98
(v) Unloading of OB			
Emission Factor	kg/t	0.001	0.001
Dust generated	kg/day	85.07	152.11
Coal Transportation			
Transportation of Coal to CHP			
Capacity of each dumper	Tonnes	70	221
Total number of trips per day	number	483	255
Average distance travelled by each dump trucks	km	2.5	3
Total Vehicle km travelled per day	VKT/day	2414	1530
Emission Factor	Kg/km.	2.25	2.25
Dust generation due to Coal transportation	kg/day	5433	3441

Parameters	Mine Capacity		
	Unit	12 MTPA	20 MTPA
Control Factor	%	50	50
Dust generation after applying control factor	kg/day	2716.30	1720.73
Coal Handling Plant			
Emission Rate	kg/t	0.02	0.02
Emission due to unloading of coal at CHP	kg/day	676.06	1126.76
Emission rate	kg/T	0.02	0.02
Emission due crushing of the coal	kg/day	676.06	1126.76
Emission rate	kg/t	0.0003175	0.0003175
Emission at the conveyor point	kg/day	10.73	17.89
Emission rate	kg/T	0.0003175	0.0003175
Emission at the unloading point of conveyor belt	kg/day	10.73	17.89
Emissions from CHP	kg/day	1373.58	2289.30
Emission from the Mine	gm/sec	139.22	121.58
Emissions from the Mine	gm/sec/Sq.m.	0.00000683	0.00000597

6.2.1.3 *Model Options Used For Computations*

Modeling Procedure

Prediction of ground level concentrations (GLCs) due to proposed mine has been estimated by Industrial Source Complex, Short Term (ISCST3) as per CPCB guidelines. ISCST3 is US-EPA approved model to predict the air quality. The model uses rural dispersion and regulatory defaults options as per guidelines on air quality models (PROBES/70/1997-1998).

Model Options Used for Computations

The options used for short-term computations are:

- Calms processing routine is used by default;
- Wind profile exponents is used by default, 'Irwin';
- Flat terrain is used for computations;
- It is assumed that the pollutants do not undergo any physico-chemical transformation and that there is no pollutant removal by dry deposition;
- Washout by rain is not considered

6.2.1.4 *Meteorological Data*

Mixing Height: As site specific mixing heights were not available, mixing heights based on CPCB publication, "*SPATIAL DISTRIBUTION OF HOURLY MIXING DEPTH OVER INDIAN REGION", PROBES/88/2002-03* has been considered for Industrial Source Complex model to establish the worst case scenario.

Table 6-5: Mixing Height

Hour of The day	Mixing Height (in meter)
7	50.0
8	100.0
9	200.0
10	500.0
11	800.0
12	800.0
13	1000.0
14	1000.0
15	1200.0
16	1000.0
17	800.0
18	500.0
19	50.0

Hourly Meteorological Data

Micrometeorological and microclimatic data recorded at the continuous weather monitoring stations on wind speed, direction, temperature and rainfall at one hour interval for the monitoring period from 'Dec 2007 to Feb 2008' was used as meteorological input.

Stability Class

The distribution of stability classes during this period is given in **Table 6.6.**

Table 6-6: Stability Frequency Occurrence in (%)

Stability Class	Frequency of Occurrence
A	8.35
B	25.06
C	20.88
D	8.35
E	16.66
F	20.70

6.2.2 Presentation of Results

In the present case model stimulations have been carried for mine capacities of 12 MTPA and 20 MTPA using the hourly Triple Joint Frequency data. Short-term simulations were carried to estimate concentrations at the receptors to obtain an optimum description of variations in concentrations over the site in 20km radius covering 16 directions. The incremental concentrations are estimated for the monitoring period. For each time scale, i.e. for 24 hr (short term) the model computes the highest concentrations observed during the period over all the measurement points.

Impact Due to Coal Mining Activity

The maximum incremental GLCs due to mining are superimposed on the maximum baseline SPM concentrations recorded during monitoring period to arrive at the likely resultant concentrations after implementation of the proposed mining. The cumulative concentrations (baseline + incremental) after implementation of the project for 12MTPA and 20 MTPA capacities are tabulated in **Table 6.7 and 6.8** respectively. Isopleths were drawn for the SPM distribution in the area is shown in **Figure 6.1 and 6.2 respectively**

Table 6-7: Resultant Concentrations of SPM after Implementation of Coal Mining on 24 Hourly Basis in µg/m³ (For Production of 12 MTPA)

AAQ Location	Location Direction/ Distance	Max Baseline GLC (µg/m^3)	Incremental GLC (µg/m^3)	Resultant GLC (µg/m^3)
Pokhra tola	E/0.7	146	10.02	156.02
Nigahi Tola	NNE/1.8	160	11.78	171.78
Amlohri	S/2.5	150	5.75	155.75
Dasuati	SSE/3.8	170	8.15	178.15
Nigahi	E/4.0	172	10.79	182.79
Gorbi	NNE/3.8	192	5.23	197.23
Jayant colony	SE/7.0	176	3.69	179.69
Nawanagar	SE/5.0	172	6.48	178.48
Parari	NW/3.4	146	4.94	150.94
Teldah	W/4.7	146	5.80	151.80
Chanpathar	SE/2.7	176	10.96	186.96

It may be noted that since this being area source and no barriers considered for computation during operation the actual ground level concentration are likely to be lower than predicted

Table 6-8: Resultant Concentrations of SPM after Implementation of Coal Mining on 24 Hourly Basis in µg/m³ (For Production of 20 MTPA)

AAQ Location	Location Direction/ Distance	Max Baseline GLC (µg/m^3)	Incremental Baseline Concentration (µg/m^3)	Resultant GLC (µg/m^3)
Pokhra tola	E/0.7	146.0	13.82	159.82
Nigahi Tola	NNE/1.8	160.0	18.98	178.98
Amlohri	S/2.5	150.0	8.40	158.40
Dasuati	SSE/3.8	170.0	13.38	183.38
Nigahi	E/4.0	172.0	23.45	195.45
Gorbi	NNE/3.8	192.0	13.29	205.29
Jayant colony	SE/7.0	176.0	12.75	188.75
Nawanagar	SE/5.0	172.0	13.50	185.50

AAQ Location	Location Direction/ Distance	Max Baseline GLC ($\mu g/m^3$)	Incremental Baseline Concentration ($\mu g/m^3$)	Resultant GLC ($\mu g/m^3$)
Parari	NW/3.4	146.0	11.70	157.70
Teldah	W/4.7	146.0	9.36	155.36
Chanpathar	SE/2.7	176.0	18.24	194.24

It may be noted that since this being area source and no barriers considered for computation during operation the actual ground level concentration are likely to be lower than predicted.

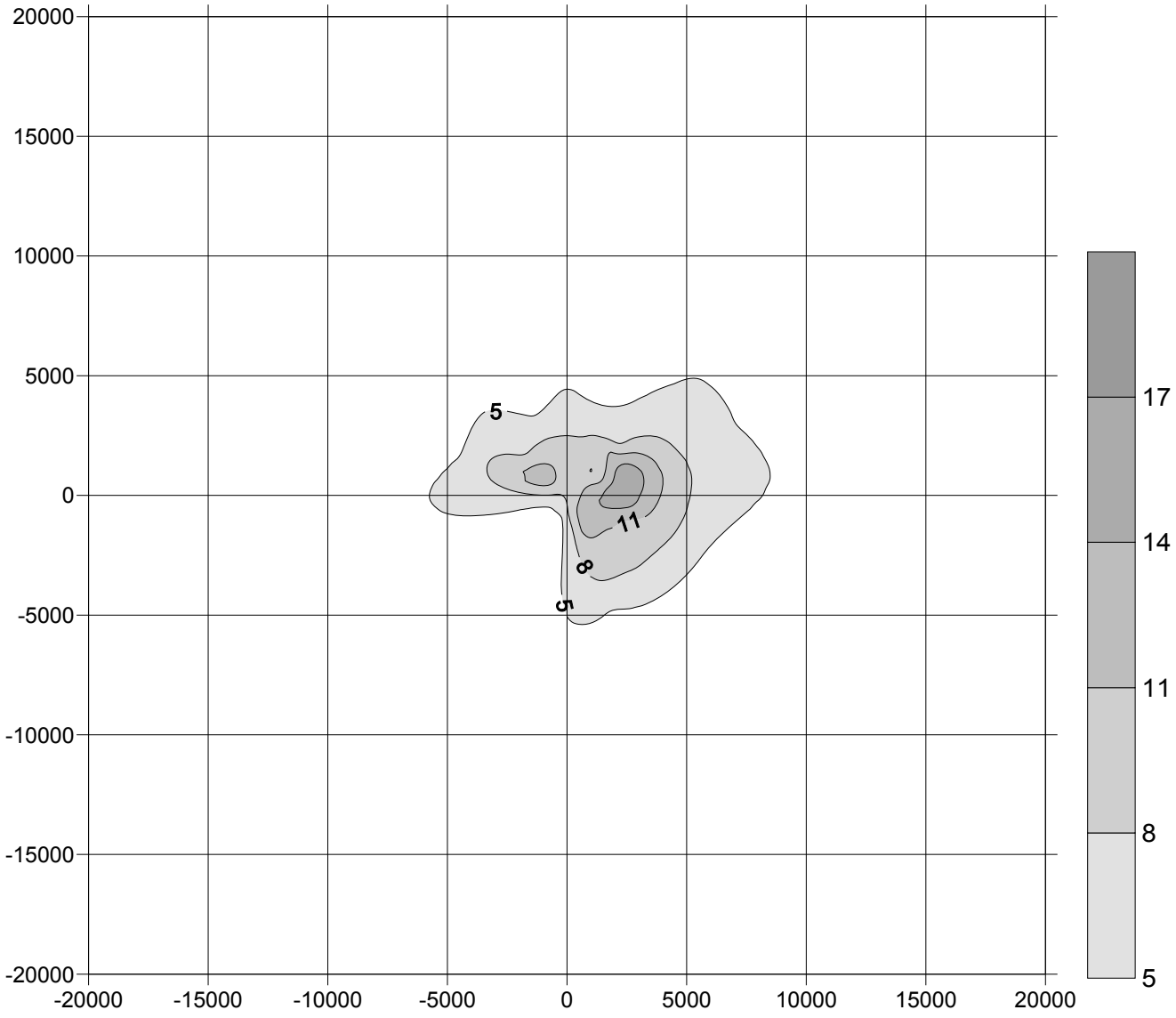

Fig 6.1- 24 hourly Impact Isopleths for SPM (12 MTPA)

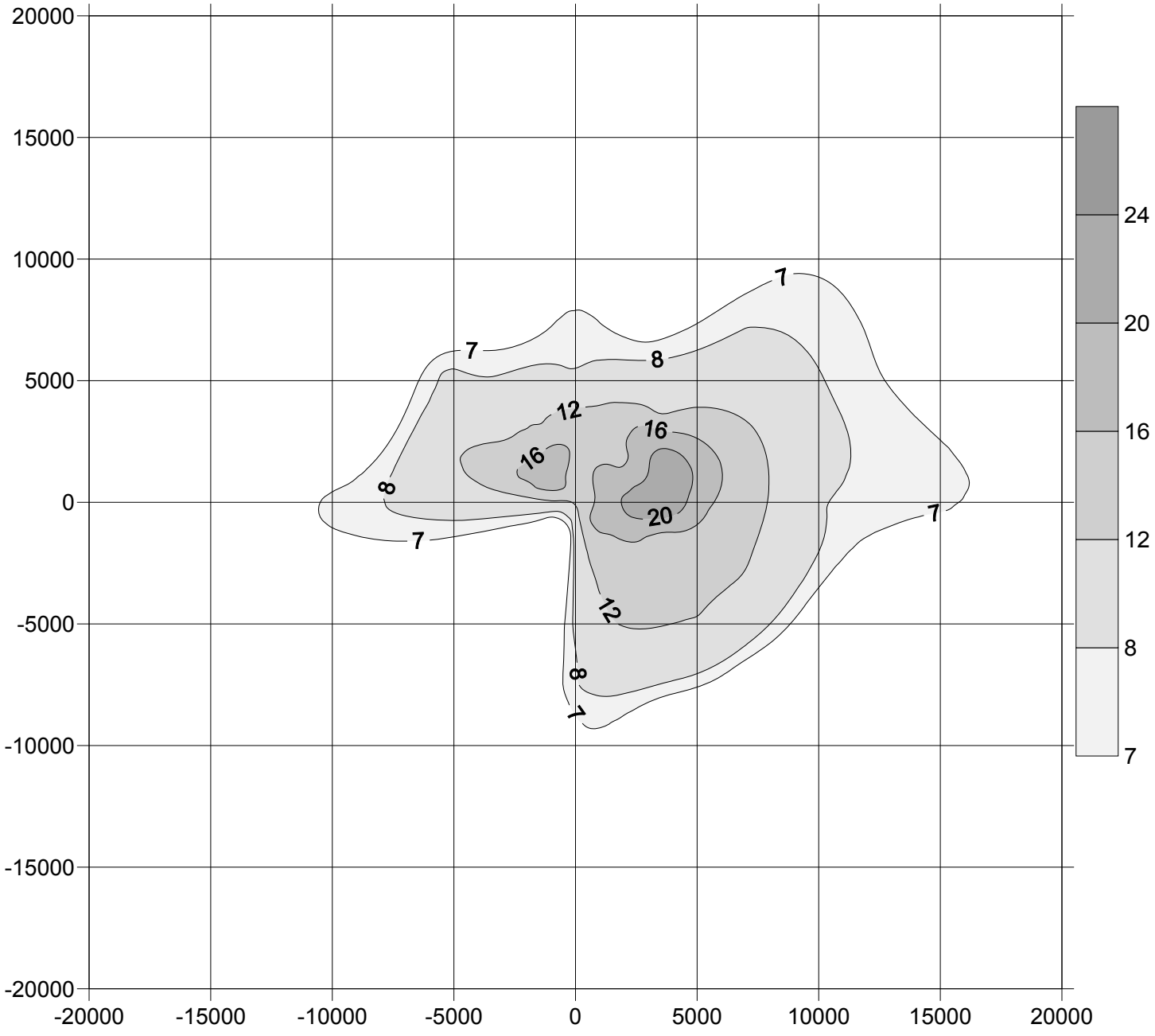

Fig 6.2- 24 hourly Impact Isopleths for SPM (20 MTPA)

6.3 IMPACT ON LAND AND SOIL

The impact on land can be assessed in two ways:

- Impact on land due to excavation.
- Impact on Land-use /Land-cover and Landscape due to the whole mining Project

6.3.1 Impact on Land

Environmental impact of the mining activity on land environment are based on the nature of activities, extent of area covered and associated aspects of environmental concern. Change in land use is the main environmental descriptor affected by OC mining.

Land use pattern

The total Project area is 2037ha. Out of which, 1440ha i.e. 71% of the land will be excavated. The OB dump will occupy 320ha of land and the green belt will be planted over 62Ha of land within the project area .Infrastructure and other facilities will occupy in 247 ha and safety zone will be 15ha. The disturbed area within project area will comprise excavated land, area occupied by infrastructure, roads etc.

Year wise land requirement for excavation and dumping for achieving 12 MTPA upto 4th year and for the rated capacity of 20 MTPA upto 6th year of mine operation is given in Table 6.9.

Table 6-9: Year wise Land Requirement for Excavation and Dumping

Year	Land in ha for excavation		Land in ha for External Dumping		Total in ha	
	12MTPA	20MTPA	12MTPA	20MTPA	12MTPA	20MTPA
1	47	123	51	21	98	144
2	36	117	53	89	89	206
3	51	125	116	180	167	305
4	41	116	204	30	245	146
5		114				114
6		112				112

Table 6.10 provides the landuse pattern at the end of mining operations.

Table 6-10: Anticipated Land Use at the end of Mining Operations

Particulars	Capacity 12 MTPA		Capacity 20 MTPA	
	Requirement (Ha.)	% Utilisation	Requirement (Ha.)	% Utilisation
Mine Area	1440	70.69	1440	70.69
External Dump Area	320	15.71	320	15.71
Infrastructure	190	9.33	200	9.82
Green belt/Safety zone	87	4.27	77	3.78
Total	2037	100	2037	100.00

Land Degradation and Aesthetic Environment

The block stands as high plateau over the plains in the South and West. The plateau is characterized by steep escarpment extending roughly along the Southern and Western block boundaries. The Southern escarpment facing towards South is more pronounced and

steeper than the Western scarp face. The general height of the escarpment varies from 100 to 175 m from the base of escarpment.

Visual intrusion

Due care has to be taken (from the conception stage of the project) for reducing the visual intrusion to a minimum. However, the movement of vehicles for transportation of coal from the mine to the power plant may cause some intrusion. The other visual intrusion will be the backfill dump with 90m height, which will be visible from a distance. Appropriate measures such as green belt cover will be needed to reduce visual intrusion from dumps, roads and facilities. However, the dumps will be afforested by the end of life of mine. Also the mine void will be partially backfilled and afforested and the rest will be converted into water reservoir

As far as topography of the core zone is concerned, it will undergo changes. During the first nine years an external OB dump will be made in the southern part of the mines over 320 hectares of non coal bearing area. The internal dump will also start from the 2nd year onwards. This waste generation will cause two major impacts viz.

- Soil erosion and loss of soil fertility
- Land degradation

The waste generated can be divided into two viz. topsoil generation and other overburden consisting of hard rocks and sandstones and sandy soils consisting of weathered rocks.

6.3.1.1 *Top Soil and Sub-soil Generation*

The quality of soil (mainly the top soil) will suffer disturbance in an opencast mines. There is a possibility of soil nutrients loss in the open dump area. This can be solved to some extent by storing the soil in specially earmarked top-soil bank. The topsoil is proposed to be kept separately in temporary top soil dump for reclamation purpose. It will also be used for growing plants along the roads. The topsoil stockpiles will have height of approximately 6 metre and grassed to retain fertility if it is to be preserved over years. Top soil details are presented below

1	Quantity	:	3.0 Mcum
2	Height of Top soil dump	:	6m
3	Year of reclamation	:	After 6th and 4th year of mine operation for 12 and 20 MTPA respectively

As per the Geological Report prepared by CMPDIL, it has been found that there has been severe erosion of top soil in the Moher Block due to high elevation leading to exposure of weathered mantel. The generation of top soil will be from the Moher-Amlohri Extension Coal Block and Overburden Area of 600 ha to the depth of maximum 0.5m. This will result in total top soil generation of about 3.0Mm^3.

The sub soil thickness in the Moher and Moher Amlohri extension coal block was found to be to the maximum extent of 6.1m.

6.3.1.2 *Overburden Generation*

The overburden mined from the initial cut and also the initial years of operation will be dumped externally. The permanent internal dump will start from the 2nd year onwards. Individual tiers of OB dumps would have maximum height of 30 m at an angle of 38° Overall slope angle of OB dump would be about 27°. Maximum top level of Internal Dump will be 500m.

- The waste-dumping programme is planned to reduce the land locking to the minimum as well as to maximise backfilling.
- The total volume of OB to be handled is about 1893.73 Mm^3, out of which about 90% will be internally dumped and balance 10% will be dumped in the external dump located on the southern side of South Pit on the non-coal bearing area.

The progressive and cumulative waste generated during mining operation after each year is mentioned in **Table 6.11 and 6.12.**

Table 6-11: Year wise Coal and Overburden Production Details for 12 MTPA

Years	External Dump (Mm^3)	Internal Dump (Mm^3)			Grand Total (Mm^3)
		By D/L	By Shovel + Dumper Comb.	Total	
Yr.-1	9.20	-	-	-	9.20
Yr.-2	21.00	0.57	-	0.57	21.57
Yr.-3	18.20	12.25	12.00	24.25	42.45
Yr.-4	30.20	15.27	-	15.27	45.47
Yr.-5	30.20	15.72	-	15.72	45.92
Yr.-6	30.20	15.77	-	15.77	45.97
Yr.-7	25.00	13.56	5.20	18.76	43.76
Yr.-8	20.00	13.13	7.60	20.73	40.73
Yr.-9	16.00	13.17	11.60	24.77	40.77
Yr.-10	-	12.85	27.60	40.45	40.45
Yr.-11 to15	-	55.18	138.00	193.18	193.18
Yr.-16 to 20	-	55.59	174.40	229.99	229.99
Yr.-21 to 25	-	61.25	230.00	291.25	291.25
Yr.-26 to 30	-	62.44	230.00	292.44	292.44
Yr.-31 to 35	-	57.96	230.00	287.96	287.96
Yr.-36 to 40	-	38.32	184.30	222.62	222.62
Total	200.00	443.03	1250.70	1693.73	1893.73

Table 6-12: Year wise Coal and Overburden Production Details for 20 MTPA

Years	External Dump (Mm^3)	Internal Dump (Mm^3)			Grand Total (Mm^3)
		By D/L	By Shovel + Dumper Comb.	Total	
Yr.-1	5.47	-	-	-	5.47
Yr.-2	23.20	-	-	-	23.20
Yr.-3	46.75	-	-	-	46.75
Yr.-4	54.00	8.05	-	8.05	62.05
Yr.-5	44.00	18.86	10.00	28.86	72.86

Years	External Dump (Mm^3)	Internal Dump (Mm^3)			Grand Total (Mm^3)
		By D/L	By Shovel + Dumper Comb.	Total	
Yr.-6	30.93	18.71	23.07	41.78	72.71
Yr.-7 to 10	-	88.46	216.00	304.46	304.46
Yr.-11 to15	-	111.55	270.00	381.55	381.55
Yr.-16 to 20	-	88.08	270.00	358.08	358.08
Yr.-21 to 25	-	90.00	270.00	360.00	360.00
Yr.-26 to 31	-	60.00	146.60	206.60	206.60
Total	204.35	483.71	1205.65	1689.38	1893.73

6.4 IMPACT ON WATER QUALITY

6.4.1 Impact on Drainage

The mines area is drained by many small seasonal streams which remain dry for most part of the year. The characteristics are as follows:

- Streams : Mostly seasonal streams
- Order of stream : - 1st , 2nd and 3rd
- Pattern of drains : - Radial and Dendritic types
- Main streams : Kachan River, Bakura River, Harrawaha Nala, Chingitola Nala and Chamarkhah Nala

Following watersheds will be under core zone as shown in fig 6.3

- Chingitola Nala- Flowing S-W, meets to Kachan River
- Forest Nala- Flowing Southward, meets to Kachan River
- Hadhadawa Nala- Flowing Southward, meets to Kachan River
- Kachan River meets to GBPS

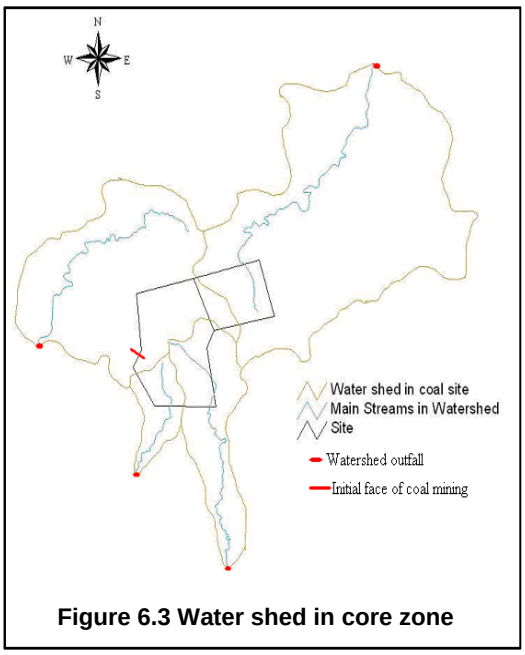

Figure 6.3 Water shed in core zone

Table 6-13: Impact on Watershed

Watershed in the Core Zone	Catchment Area (Sq.km)	Affected Catchment Area (sq.km)	Remark
Watershed 1: Forest nala	10.278	4.17	South external dumping site come across the stream
Watershed 2 : Harrwaha nala	19.81	8.12	Mining Operation take place after 20 year at this stream side
Watershed 6: Chamarkhah nala	38.31	11.20	Mining Operation take place after 20 year at this stream side
Watershed 9: Chingitola nala	34.22	7.4	Mining Operation take place in initial years

Source: Area Drainage Study Report, Department of Civil Engineering, IIT Delhi, August 2008

As these are not perennial nalas / streams, situations of water-logging or blockage of major streams will not occur. No major impact on perennial streams which are developed near the base of escarpment of Moher block is envisaged.

6.4.2 Impact due to Discharge on Surface Water

The surface water quality is likely to be affected with higher load of suspended solids by the following:

- Wash off from dumps
- Pumping out mine water to surface water channels
- Effluent from workshop, etc

Wash off from Dumps: Wash off from OB dumps containing suspended solids is likely to cause contamination/ siltation of surface water-bodies. It is proposed to provide garland drainage at the foot of the dump which will collect the wash off from the OB dump. This foot drain would carry water to a sedimentation tank from where the overflow would be directed into a natural drain through controlled discharge outlets.

Pumping out mine water to surface water channels: The pumped out water during dewatering may carry higher concentration of suspended solids. The mined out water is planned to be used for green-belt development, equipment washing, sprinkling, etc. Any run-off will be passed through catch pits to arrest any loose material being carried with water. Unutilized water shall be treated before discharging.

Other sources: Other sources of pollution are by oil and grease contamination of surface water from oil/grease handling area and workshop for which treatment plan has been envisaged. Sewage waste generated from domestic waste such as septic tank, hand washing and canteen can also cause damage to water quality for which treatment measures has been envisaged.

6.4.3 Impact on Ground water

6.4.3.1 *Impact on Ground water Quality*

Ground water pollution can take place only if dumps and stock piles contain harmful chemical substances, which may get leached by precipitation of water and percolate to the groundwater table, thus causing water pollution. However in this project neither the coal nor the OB contains any harmful ingredients which could leach down to the water table and pollute it. Thus, no adverse impact on ground water quality is anticipated.

Meager amount of sanitary waste, generated from various facilities will be treated properly through septic tanks and soak pits and is not anticipated to cause any water pollution. Other domestic waste water from mines and colony will be used for dust suppression.

The ground water table of the region will be marginally affected during operation of mine as the water will be drawn from the ground for mining purpose. The ground water level around 237 m periphery of the quarry may experience the change in terms of availability. However in present case as outcome of the hydro-geological study it was found that that the ground water condition is in the safe category.

Impact due to Pumping from the Mine

The water will accumulate through precipitation as well as mine seepage in the mine sump. Ground water is proposed to be used for drinking and domestic purposes mainly through ground water. The peak annual requirement of potable water for drinking and domestic purpose including peripheral village is 0.28 Million Cubic meter and for industrial use 1.18Million cubic meter at the peak capacity. The water requirement for potable use will be met from underground source through bore well and for industrial use from underground as well as from other source. Impact area arrived based on Sichardt Formula is starting from quarry edge upto 237m radially on all sides in worst scenario.

Effects on Ground Water Table: Based on ground water estimation committee report 1997 ground water level fluctuation has been estimated. During the mine operation the fluctuation is 5.08Mm^3 based on calculation of water level fluctuation (WLF) method and by rainfall Infiltration (RIF) method it is 3.95 Mm^3. It is observed that recharge calculated by water level fluctuation method is consistent, higher than the value calculated by rainfall infiltration method. As the difference if more than 20%, the RIF method can be adopted as recommended by GEC, 1997 report.

6.5 IMPACT ON NOISE AND VIBRATION

6.5.1 Impact on noise levels

Noise is unwanted and unpleasant sound which causes distraction, disturbance and annoyance. Continuous exposure to high level of noise can impair human hearing power. The construction activities generate noise mainly on account of:

- Transportation machinery
- Site preparation

The impact of this airborne noise will be limited to the construction area and will be temporary. The noise of activities also disturbs animals/birds living in the surroundings area.

The main noise generating sources during coal mining are coal drills, dozer operation, ripper operation, blasting, shovels operation, dumper movement, conveyer movement, service vans, crushing, and truck movement. Intermittent noise is generated due to operation of diesel generator.

Impact on Noise Level

In order to predict ambient noise levels due to the coal mining the noise modeling has been done. For computing the noise levels at various distances with respect to the coal mining site, noise levels are predicted by a user friendly model the details of which are elaborated below.

Model for sound wave propagation during mining

For an approximate estimation of dispersion of noise in the ambient air from the point source, a standard mathematical model for sound wave propagation is used. The noise generated by equipment decrease with increase distance from the source due to wave divergence. An additional decrease in sound pressure level with distance from the source is expected due to atmospheric effect or its interaction with objects in the transmission path.

For hemispherical sound wave propagation through homogenous loss free medium, one can estimate noise levels at various locations, due to different sources using model based on first principles, as per the following equation:

$$L_{p2} = L_{p1} - 20\text{Log}\,(r_2 / r_1) - A_E \qquad (1)$$

Where, Sound L_{p2} and L_{p1} are the Sound Pressure Levels (SPL) at points located at a distances of r_2 and r_1 from the source. A_E is attenuations due to Environmental conditions (E). The combined effect of all the sources can be determined at various locations by the following equation.

$$L_{p(total)} = 10\text{Log}\,(10^{(Lpa)/10} + 10^{(Lpa)/10} + 10^{(Lpa)/10} + . . \ldots\ldots\ldots\ldots) \qquad (2)$$

Where L_{pa}, L_{pb}, L_{pc} are noise pressure levels at a point due to different sources.

Environmental Correction (A_E):

The equivalent sound pressure level can be calculated from the measured sound pressure level ($L_{eq\ measured}$) averaged over the measurement surface area 'S' and from corrections K_1 and K_2 and is given by ;

$$(L_{eq\ measured}) = (L_{eq\ measured}) - K_1 - K_2 \qquad (3)$$

Where,

K_1 = Factor for the background noise correction. The correction was not applied in this modeling exercise, as it was not possible to measure the background noise levels by putting off machines. Hence it was considered as zero.

K_2 = Environmental correction

Model Details:

Based on the above equation user friendly model has been developed. The details of the model are as follows:

- Maximum number of sources is limited to 200;
- Predicted Noise levels at any distance specified from the source;
- Model is designed to take topography or flat terrain;
- Co-ordinates of the sources in meters;
- Maximum and Minimum levels are calculated by the model;
- Output of the model in the form of isopleths; and
- Environmental attenuation factors and machine corrections have not been incorporated in the model but corrections are made for the measured L_{eq} levels.

Input for the model

The sources where noise level monitored in mining site are core drill, dozer operation, ripper operation, blast hole drillers, blasting, shovels operation, trippers movement, conveyers movement, service vans, crushing, truck movement. Intermittent noise is generated due to operation of diesel generators are given in Table 6.14 the values mentioned are at 1m distance from the source.

Table 6-14: Likely Noise Levels

Sl. No.	Source Name	Noise level in dB(A)
1	Core drill	95
2	Dozer Operation	95
3	Diesel Generator	75
4	Blast hole driller	95
5	Blasting	90
6	Shovels Operation	95
7	Dumper Movement	95
8	Conveyers Movement	85
9	Crushing	90
10.	Truck Movement	75-95

Model outputs

The ambient noise levels have been predicted for proposed coal mining. The predicted noise levels at the boundary of the coal mine in different directions are given in Table 6.15. There will be slight impact on the village during blasting for a short time period and due to masking effect it will not have any significant impact for rest of the time.

Table 6-15: Predicted Noise Levels

Sl. No.	Distance from ML boundary (m)	Noise level dB (A)
1	100	61.0
2	200	53.4
3	300	49.3
4	400	46.1
5	500	41.2
6	750	36.6
7	1000	31.8
8	1500	24.9

Sl. No.	Distance from ML boundary (m)	Noise level dB (A)
9	2000	21.0

The operations of these equipment will generate noise ranging between 75 – 95 dB (A). The predicted noise level due to operation of such equipment at a distance of 0.5 km from the ML boundary is 41.2 dB (A).

As the ambient noise levels are higher than the predicted noise levels, due to masking effect, only marginal increase in the ambient noise levels is envisaged in the vicinity of mine.

Impacts due to ground vibration (due to blasting)

In accordance with DGMS regulations, the lease area shall maintain a safety distance of 500 m distance from blasting area. However, keeping in view the presence of villages beyond the statutory safety zone adequate measures shall be followed during blasting. The empirical equations (USBM) which can be used for assessment of peak particle velocity (ppv) values at nearby locations are as follows:

The derived empirical equation for main ore body is:

$V = K_1 \{D/ (Q^{0.5})\}^{K2}$

Where

V = Peak Particle Velocity in mm/s

D = Distance between location of blast and gauge point

Q = Quantity of explosive per round

Detailed study shall be carried out during mining operation and recommendations will be complied to meet the DGMS, Dhanbad (Circular No. 7 dated 29 -08-1997) which are given in Table 6.16.

Table 6-16: Permissible Peak Particle Velocity (ppv) in mm/sec.

Type of structure	Dominant excitation frequency		
	<8 Hz	8-25 Hz	>25 Hz
A. Buildings/structures not belonging to owner			
Domestic houses /structures (Kuchha brick and cement)	5	10	15
Industrial buildings (RCC and framed structures)	10	20	25
Objects of historical Importance and sensitive structures.	2	5	10
B. Building belonging to owner with limited span of life			
Domestic houses/structures (Kuchha brick and cement)	10	15	25
Industrial buildings (RCC and framed structures)	15	25	50

6.6 IMPACT ON ECOLOGY

Ecological impacts from open cast mining result from loss of forest cover and from generation of pollutants both in air and water. Further, excavation of soil causes damage to its structure and composition.

The impacts on ecology of the area are expected to be minimal as no sanctuary, national park and tiger or elephant reserve is affected by the project. Also no prominent grassland ecosystem has been found in the Core and Buffer zone areas.

However, Schedule-1 fauna were found in core and buffer zone in the project site. The study areas do not represent any migratory paths or corridors to the birds and mammalian fauna. The impact of proposed mining on ecology as a whole is described below.

6.6.1 Loss of forest

Out of 2037ha of project land, 1198ha of forest land will be diverted for the project. The forest to be removed during the mining operation contains mixed type of forest with 20 to 40% tree cover as per the Forest Working Plan. The loss of vegetation in the area will have following impacts:

- Loss of vegetation by excavation and dumping thereby affecting the species for which such vegetation was the host.
- Migration of biotic species to neighboring ecosystems

6.6.1.1 *Loss of Forest Produce*

The losses of forest produce due to the felling of trees are detailed in **Table 6.17**.

Table 6-17: Loss of Forest Produce

Parameter	Unit	Forest Land	Revenue Forest Land
Area	Hectare	1094.49	103.51
Site Quality	Quality	VB & IVB	VB
Forest Density		0.2 - 0.4	0.2
Estimated Number of Trees	No.	934857	4122
Estimated Volume	Cubic meter	119612	2101
Timber	Cubic meter	25402	1222
Fuel	Cubic meter	94209	880
Estimate Quantity of grass (fodder) in metric tones	Metric tones/year	3284	311

Source: Forest Enumeration Survey

6.6.1.2 *Impact on local species*

- Loss of forest will result into migration of species of fauna to another ecosystem;
- Migration of faunal species due to noise, vibrations and lights;
- No recorded medicinal plants are established;
- Lowering of water table due to continuous abstraction of ground water affecting the vegetation growth near the quarry edge up to the radius of influence

- There will be negligible impact on the forest and ecology of the buffer zone due to air borne emission from the project as these are meeting the national ambient air quality standards;

6.7 IMPACT ON SOCIO-ECONOMIC CONDITIONS

6.7.1 Rehabilitation and Resettlement

As already discussed, there is going to be displacement due to the project. The estimated Project Affected Families (PAFs) is shown in **Table 6.18.**

Table 6-18: No. of Affected Families

S. No.	Village	No of affected families
1	Moher	317
2	Bengabasti	22
3	Amroli	204
4	Nuagarh	74
Total		617

6.7.2 Impact of Influx

The sparse population of the project area and geographical location of the project do not pose any major impact on the local population due to influx of outside labour. However, there might be isolated cases that may impact the local community. The situations that may have a bearing on the Project activities and impact the local community include

- Social Impacts emanating from interaction of the project influx population with host community potentially resulting in conflicts due to cultural differences and social beliefs and traditions.
- Economic Impacts would depend upon the business activities pursued by the local community in terms of sale of commodities, vegetables and other daily use items required by the people residing in the construction workers colony and the staff coming to work site. The locals might set up roadside eateries, petty shops and garages to cater to the workers population and the transport vehicles coming to the project area. This would have a positive impact on the local economy and may very well augment the incomes of the local community who establish and run such businesses.
- There would be temporary environmental impacts due to establishment of the construction workers colony and the waste disposal. Adequate waste treatment and disposal mechanisms would be implemented to ensure scientific waste management and disposal.
- The construction workers colony and the township would be self sufficient in terms of services and requirement of commodities and fuel sources. There would be no dependency of the project personnel on the village infrastructure and common property resources for amenities and cooking fuel.

- Influx management measures have been proposed in the subsequent sections to address the above mentioned impacts.

6.7.3 Socio-economic Condition

The proposed project will provide employment to the local population, as mostly locals will be recruited for the purpose. Even indirect job opportunities will be created in the area business outside the project boundary. Many will find employment in service sector and marketing of day-to-day needs viz. poultry and other agricultural products. The project will improve the basic infrastructure and the people of nearby villages can also use these amenities.

6.7.4 Impact of Forest Diversion on the Community

The Scheduled tribes (ST) population residing in the area have minimum dependence on the Minor Forest Produce for their sustenance. They depend on either agriculture or mining/industrial activities. Therefore, proposed coal mining projects is expected to bring economic development for local population.

The Moher Coal mining project will make a significant positive impact on community life by way of provide direct and indirect employment, service and support opportunities. The envisaged coal mining project will bring about economic prosperity in the area. The projects in this region will be required to undertake special development programs to take care of health, education, communication and suitable livelihood of the tribal population living around coal bearing area. Such a scheme will reduce biotic pressure and help forest conservation.

6.7.5 Impact on Cultural Resources

There are no specific cultural heritage sites in and around the project area. Also there are no tangible properties or natural features that would be considered cultural heritage site.

6.7.6 Impact on labour

Most of the labours will be on contractual basis. Separate labour camps have been made within the infrastructure premises of the project for labours. Primarily host community will be given preference based on skills. Therefore, conflict of the migrating labour with local, is not likely to take place. Regular check will be done through supervisors so that labours do not interfere with the local inhabitants for their cultural values.

6.8 CUMMULATIVE IMPACT

The active mines located in the North and Eastern side of the mine are Gorbi and NCL respectively. The impacts of these mines are already reflecting in the baseline condition of the study area.

6.8.1 Impact from Coal Transportation

Coal from mines will be transported to receiving pits located near the mine entries through dump trucks. The crushed coal will be transported through belt conveyors upto the loading point over Over land Conveyor (OLC) and subsequently to power plant.

Fugitive emission will not take place due to closed conveyor system. Also no congestion on the local transportation is envisaged due to proposed conveying system. Approx. 73 acres of land required additionally for the coal conveyor system will affect about 280 families. The route of the coal conveyor system has been finalized on the basis of minimum disturbance especially agriculture and habitats.

For transportation of the coal from mines to the power plant, a single flight overland coal conveyor is proposed. Since it is a single flight conveyor from mines to the power plant, there are no transfer points along the route of conveyor. The impact of the coal corridor is envisaged to be minimal as the preventive measures are inbuilt in the design of conveyor systems and all safety measures are adopted.

6.9 ASSESSING SIGNIFICANCE OF ENVIRONMENTAL IMPACTS

Impacts are typically classified as either positive or negative, reversible or irreversible, short term or long term. In this project impacts are classified as to their potential significance. The classification system is based on degrees of significance of impact, for example:

- **High–** Highly adverse and Irreversible in Nature
- **Moderate-** Much adverse compare to Low significance and Irreversible in Nature
- **Minimal / Low-** Low Impact and Reversible in nature
- **None-** No impact

Potential impacts were identified for the following environmental attributes:

- Air quality impacts;
- Hydrology, hydrogeology and water quality impacts;
- Land and soil impacts;
- Socio-economic and cultural impacts;
- Noise impacts;
- Ecological impacts (flora and fauna);

A summary table was compiled for each of these areas of potential impact, identifying logically distinct impacts which were comprehensive in their scope.

Table 6-19: Significance of Potential Environmental Impacts

Environment Parameter	Potential Significance	Reasons	Mitigation Measures
Air	High	• Generation of dust due	• Implementation of dust arrester,

Environment Parameter	Potential Significance	Reasons	Mitigation Measures
		to drilling and blasting for removal of overburden and production of coal; • Generation of dust due to transportation of overburden to dumpsites and transportation of coal to Coal Handling Plant; • Generation of dust from coal handling; • Generation of dust due to movement of heavy vehicles and mining machineries;	sharp drill bits. • Dust musk would be provided to the workers • Engines and other equipment shall be maintained to limit NO_X and SO_2 • Water sprinkling on haul road, dump and coal stack would be continuous phenomena • Green belt development
Water	High	• Impacts on the surface water drainage system of the area are mentioned below: • Wash off from Dumps • Soil erosion from mine and road • Pumping out mine water to the surface water channels • Oil and grease contamination of surface water from oil / grease handling area. • Impact on Ground Water: Ground water pollution can take place if dumps and stock piles contain harmful chemicals.	• Garland / guided drain around the mines with settling pond will be provided to prevent surface runoff water from outside the quarry area entering inside the mine. • Surface run-off within the mine shall be treated before discharging and utilizing for other purposes. Maximum of surface run-off shall be utilized within the mine. Mine water to be pumped to distribution network for sprinkling, plantation and other uses. • Surface run-off will be diverted away from the dump by garland drains at higher contour. The surface run-off from the overburden dump is to be collected in a garland drain provided at the foot of the dump. This foot drain would carry water to a sedimentation tank from where the overflow would be directed into natural drain through controlled discharge outlets. The overflow would be monitored regularly.

Environment Parameter	Potential Significance	Reasons	Mitigation Measures
			• Peripheral bunds will be erected on the outer edge of the abandoned benches before reclamation so that the solid is not carried away by storm water. Formation of gullies is to be prevented which may cause serious erosion. Chutes will be constructed by using stone or masonry to guide the water in areas with loose soil to prevent erosion. The mine water will be passed through specially constructed catch pits to arrest any loose material being carried with water. • To prevent surface and ground water contamination by oil / grease and sewage waste, following control measures are proposed to be implemented. • Leak proof containers will be used for storage and transportation of oil/grease. • The floors of the areas wherever oil/grease is handled will be kept effectively impervious. • Work shop effluent containing high suspended solids and oil & grease will be discharged into oil and grease trap where oil will be collected separately in the oil pit. • Used oil will be stored separately in drums for sale or disposal. • The sewage waste generated from domestic waste such as septic tank, hand washing and canteen will be let into a collection tank after passing through bar screen and oil trap, to remove floating matters and vegetable oils. • The surface and ground water in and around the mine, coal handling plant and infrastructure will be

Environment Parameter	Potential Significance	Reasons	Mitigation Measures
			regularly tested and appropriate control measures shall be adopted in case of any pollutant is detected above the prescribed limit. • All stacking and loading areas will be provided with proper garland drains equipped with baffles to prevent wash off from reaching the downstream natural channels. • During operations and particularly after cessation of mining, the mine would behave as ground water reservoir to improve recharge system. • During post mining the mine can be used for rain water harvesting and commercial fishing etc. by the local people.
Land Degradation	Moderate	Impact on land due to Waste Generation in Initial stage. Impact on Land-use / Land-cover and Landscape due to the whole mining Project	• Stage-wise reclamation plan which consist two parts namely • Technical Reclamation • Biological Reclamation
Soil Quality Degradation	Low	Soil erosion and loss of soil fertility Land degradation	• Top-soil will be conserve in scientific manner to manage the fertility of the soil • Continuous monitoring of soil quality • Green belt development
Noise	Low	As no sensitive locations in the vicinity of the project site.	• Proper green cover will be provided to neutralize the noise
Ecosystem	Moderate	Ecological impacts from open cast mining result from loss of forest land for mining and from generation of pollutants both in air and water. Further excavation of soil causes damage to its structure and composition.	• Compensatory afforestation in double of the forest land diverted • Green belt development conserve local biota • Efforts for ecological restoration
Socio-economic	High	Involuntary Resettlement Influx of Labours	• The PAPs will be rehabilitated in a planned manner.

Environment Parameter	Potential Significance	Reasons	Mitigation Measures
			• Compensation will be provided as per R&R Policy specially devised for SPL and approved by GoMP. • CSR activities of SPL will also help to improve the living style as well as education status of the local villagers. • Construction labours will be housed on temporary construction camp. • A separate housing colony with adequate provision of water, electricity and waste management facilities will be set-up for the operational workers.

6.10 SIGNIFICANCE OF THE IMPACTS

Project impacts need to be summarised in one table for easy comparison and interpretation. The 'Modified Matrix' method has been adopted to identify the potential of Impacts. This method involves the establishment of cause-effect relationship and also **'The Parameter Important Value (PIV)'** against each environmental Impact parameter.

The identification of environmental impact is based on the baseline condition as described in chapter 4 and nature of proposed activities as detailed in chapter 3 and other indirect resultant activities.

The PIV values are determined by subjective judgment considering the relative importance and significance of individual parameter. After deciding PIV, these values have to be distributed among all the cause-effect relationship, which are established between those particular affected Environmental and Social parameters and the concerned project activities by means of indices called **"Relative Parameter Importance Indices (RPII)"** such that the sum of all indices is equal to unity. The RPII values are decided based on the relative importance of cause-effect relationship and highest important one is given highest RPII value and the lowest important one is given lowest RPII value.

Another index, which is to be determined for each cause effect relationship is called **"Environmental Impact Index (EII)".** The scale for EII varies from zero to one. The value one is assigned to an impact of highest order and zero to assign to an impact of negligible magnitude. The adverse impacts, EII carries a negative sign and for beneficial impacts one,

it carries positive sign. **Weighted Environmental Impact Index (WEII)** is arrived by multiplying score of RPII and EII.

For determining the value of EII, the environmental impact parameters are divided into two categories.

6.10.1 Category 'A' Parameter

This category incorporates environmental and social impact parameters, whose quality varies linearly with the magnitude of impact area as related to the proposed project activities and includes:

- Surface and ground water resources
- Socio-economic aspects
- Land-use
- Human settlement

6.10.2 Category 'B' Parameter

This category incorporates environmental and social impact parameters, whose quality varies logarithmically with the magnitude of impact area as related to the proposed project activities and includes:

- Surface and Ground water quality
- Air quality
- Noise level
- Ground Vibration
- Health
- Flora
- Wildlife

The bases for determination of EII value are given in **Table 6.20** and **6.21** respectively. After determining EII for each cause-effect relationship the same will be multiplied with RPII to get a 'Weighted Environmental Impact Index (WEII)". These values are once again multiplied with PIV and addition of all these values gives the impact score of that particular environmental parameter. The impact score, obtained for all environmental and social impact parameters is added together to get total impact score. This total impact score is used for interpretation and decision-making.

Table 6-20: Determination of EII for Category 'A' Parameters

S. No.	Impact Magnitude (in %)	EII
1	No Change	0.00
2	0 – 4.9% Change	0.05
3	5 – 14.9% Change	0.10
4	15 – 24.9% Change	0.20
5	25 – 34.9% Change	0.30

S. No.	Impact Magnitude (in %)	EII
6	35 – 44.9% Change	0.40
7	45 – 54.9% Change	0.50
8	55 – 64.9% Change	0.60
9	65 – 74.9% Change	0.70
10	75 – 84.9% Change	0.80
11	85 – 94.9% Change	0.90
12	> 95% Change	1.00

Table 6-21: Determination of EII for Category 'B' Parameters

S. No.	Impact Magnitude (in %)	EII
1	No Change	0.00
2	0 – 4.9% Change	0.02
3	5 – 14.9% Change	0.05
4	15 – 24.9% Change	0.10
5	25 – 34.9% Change	0.15
6	35 – 44.9% Change	0.25
7	45 – 54.9% Change	0.50
8	55 – 64.9% Change	0.75
9	> 65% Change	1.00

6.10.3 Project activities and environmental parameters

The mining operation and allied activities, which are likely to cause potential impacts on environment, are listed below:

- Land and soil degradation due to mining activity
- Involuntary Resettlement
- Air emission from coal exploration activities
- Noise generation
- Water consumption
- Wastewater generation / disposal
- Provision of civic amenities
- Tree plantation programmes

The likely impacts of these activities and benefits are already discussed under present chapter.

6.10.4 Parameters importance value for environmental components

The environmental components listed in the earlier section are assigned with PIV so as to convert the environmental impacts into commensurate units, which could be aggregated easily to get the total score of environmental impacts. The parameter importance values are assigned by marking and pair-wise comparison procedure. This procedure involves preparation of a table containing number of columns corresponding to the range of value, which can be assigned a 'Score of importance' against each impact area. The score of importance is any integer ranging from one to six. The most affected parameters carries a score of six and the least affected parameters carries a score of one.

6.10.5 Importance Ranking

This score is made considering the intensity and nature of impact over the identified impact area. The impact areas considered along with their ranking are tabulated in **Table 6.22**.

Table 6-22: Determination of Parameters Importance Value (PIV)

S. No.	Impact Area	Ranking					
		1	2	3	4	5	6
1.	Surface Water Resources	No impact on Surface water / Drainage System	Minor impact on the temporary water chainage	Impact on first order stream	Diversion or realignment of the local nala	Diversion of the stream feeding the main water body of the region	Diversion of the major water body of the region
2.	Ground Water Resources	No impact on the ground water table	Minor impact on the ground water resources	Impact of aquifers but area is falling in safe zone and radius of influence within	Radius of influence is more than 250 m but less than 500 m	Radius of influence is more than 500 m but less than 250 m	Impact of aquifers but area is falling in critically drought prone zone
3.	Air Quality	Very minor impact on the Ambient Air Quality off the region	Impact is limited for the quantified time schedule	Impact is limited to 1 kms from the project site	High impact (but within stipulated standards) on one component of the Air	High impact (but within stipulated standards) on all components of air quality	Predicted Air Quality will exceed the stipulated standard

S. No.	Impact Area	Ranking					
		1	2	3	4	5	6
					Quality		
4.	Water Quality	No change in water quality with negligible change	Minimum change in physic-chemical properties of the receiving water body	Moderate Change in physical properties of the water of receiving body	Moderate Change in physical & chemical both properties of the water of receiving body	Change in Surface as ground water quality	Significant change in Surface water quality
5.	Noise levels	No change beyond noise generating equipment premises	Minimum change beyond noise generating equipment premises	Moderate change beyond noise generating premises	Moderate change in ambient level	Moderately high change in ambient level	Significant change in ambient level
6.	Ground Vibration	No impact on ground vibration	Impact on ground vibration is limited to safety zone only	Low impact of ground vibration on nearby community	Moderate impact of ground vibration on nearby community	High impact of ground vibration on nearby community	Impact of ground vibration on nearby community may cause to hearing loss or other physical problems
7.	Health	Minimum Risk due to State of Art Technology with health care facilities for workers and host population	Minimum Risk due to State of Art Technology with PPE and first aid facility for workers	Low Risk due to Available Technology with PPE and first aid facility for workers	Moderate Risk due to PPE with first aid facility for workers	High Risk working environment with first aid facility for workers	High Risk working environment which requires frequent monitoring of workers health
8.	Public	No change	Use of	Acquisition	Acquisitio	Acquisition	Acquisition

S. No.	Impact Area	Ranking					
		1	2	3	4	5	6
	Utilities	in utilities due to project activity except for strengthening of utilities for host community	existing roads and acquisition of Govt. & Pvt. Land and strengthening facilities for host community	of agriculture land, diversion of road, etc and no strengthening of the facilities	n of agriculture land, community areas, facility places, diversion of road, etc	of agriculture land, water body, community areas, facility places, diversion of road, etc	of agriculture land, residential areas, water body, community areas, facility places, diversion of road or nala, etc
9.	Economic aspects						
		Located in highly industrialized urban area with opportunity of secondary as well as tertiary sources of income	Located in highly industrialized mining areas with opportunity of secondary sources of income	Located in agriculturally developed area with opportunity of primary as well as tertiary sources of income	Located in agriculturally developed but dense population required more employment opportunity	Positive impact since project located in backward region	Located in agriculturally poor
10.	Land-use & Soil Characteristics	Poor Soil fertility and without any sensitive land use degradation or diversion for project purpose	Poor Soil fertility and with only diversion of forest area	Poor Soil Fertility but diversion of forest area and settlements for project purpose	Moderate Soil Fertility with forest area diversion and settlements for project purpose	Fertile Soil with sensitive zones within project site	Fertile Soil and peoples earn their livelihood from the area being diverted for the project

S. No.	Impact Area	Ranking					
		1	2	3	4	5	6
11.	Flora	No change and impact on flora at site or in impact zone	Insignificant change and impact on flora at the site and in impact zone	Due to ground clearance open vegetation shrubs will be removed	Site have flora with economic value and is part of reserved or protected forest	Site fall in specially protected area for their floral value	Project Site fall in National Park or wildlife sanctuary
12.	Wildlife	The site and immediate adjacent area is devoid of wild animals	Entire Impact zone does not have any schedule I & II species	Impact zone is having some endangered species. However, impact zone doesn't fall in the migratory routes	Impact zone have endanger ed fauna and fall n migratory paths	The site have endangere d fauna and migratory routes	The site fall in the migratory route or having the endangere d fauna
13.	Human Settlement	Host community is capable to provide skilled and unskilled labour, no cultural change and no impact on natural resources	Host community is capable to provide unskilled labour, insignificant cultural change	Major influx of labours and chances of conflict of culture & communica ble diseases	In-migration will effect natural resources and amenities already available	In-migration of skilled and moderate change in socio-cultural profile of host community	In-migration of skilled and unskilled labor and significant change in socio-cultural profile
14.	Culture	No change in culture of host community	Minimum impact in culture due to influx of migrants labor and introduction of their culture	Moderate impact in culture due to change in economic activity and social status	Moderate impact in culture due to change in economic activity and impact on	Change in culture due to involuntary resettleme nt and livelihood pattern associated	Significant impact in culture due to involuntary resettleme nt of indigenous people

S. No.	Impact Area	Ranking					
		1	2	3	4	5	6
			within host community		their cultural or religious precincts	with income generation of host community	
15.	Human Resettlement	No R&R issues only immigration of labours and minimum chances of conflict with host community	Involve Involuntary resettlement with only land oustees consist	Involve Involuntary resettlement with only land oustees	Involve Involuntary resettlement with only land oustees consist of indigenous population but include R&R Colony facilities	Involve Involuntary resettlement with only land oustees consist of indigenous population but no R&R Colony facilities is being provided	Involve Involuntary resettlement of densely populated area

Table 6-23: Parameters Importance Value (PIV)

S. No.	Impact Area	Ranking						Total	Weightage	PIV
		1	2	3	4	5	6			
1.	Surface Water Resources				-			4	4/49	81.6
2.	Ground Water Resources			-				3	3/49	61.2
3.	Air Quality				-			4	4/49	81.6
4.	Water Quality			-				3	3/49	61.2
5.	Noise levels				-			4	4/49	81.6
6.	Ground Vibration		-					2	2/49	40.8
7.	Health		-					2	2/49	40.8
8.	Public Utilities		-					2	2/49	40.8
9.	Economic aspects					-		5	5/49	102.0
10.	Land-use & Soil Characteristics			-				3	3/49	61.2
11.	Flora				-			4	4/49	81.6
12.	Wildlife			-				3	3/49	61.2

S. No.	Impact Area	Ranking						Total	Weightage	PIV
		1	2	3	4	5	6			
13.	Human Settlement			-				3	3/49	61.2
14.	Culture		-					2	2/49	40.8
15.	Human Resettlement					-		5	5/49	102.0
Total								**49**		**999.6**

6.10.6 Weighted Environmental Impact Index (WEII)

It is necessary to establish Relative Parameter Importance Index (RPII) and Environmental Impact Index (EII) in order to arrive at the Weighted Environmental Impact Index (WEII).

6.10.6.1 *Relative Parameter Importance index (RPII)*

The RPII indicates the importance of interaction between the action the action and environmental components. It is assigned any value between 0 and 1 and the sum of all the values of RPII under each environmental component is equal to 1. The importance of an interaction is related to the significance or assessment of the consequences, of the anticipated interaction. Assignment of RPII to an interaction is based on the subjective judgement. While deciding RPII, first the RPII values are distributed among adverse and beneficial impacts depending upon their significance. The RPII values, distributed are once again distributed among the respective interactions depending upon their individual significance. The most important interactions under a particular impact area are given the maximum RPII, whereas the lowest important one is given minimum RPII. As the significance increases the RPII also increases.

The RPII values for all the interactions, along with the criteria for deciding the same is presented in **Table 6.24**.

6.10.6.2 *Environmental Impact Index (EII) Matrix*

The index represents the magnitude of an impact due to the interaction established between an environmental component and a project activity. This impact magnitude is represented by a numerical value, which is determined from **Tables 6.20** and **6.21** The environmental components are grouped into two categories viz. 'A' and 'B' discussed in earlier paragraph. The EII for category 'A ' environmental component is determined from **Table 6.20** and the same for category 'B' is determined from **Table 6.21**. The PIV are determined for each impact area project activity interaction and are given in **Table 6.22** along with remarks. The Parameter Importance Value (PIV) is given in **Table 6.23.**

Table 6-24: Impact Matrix without Mitigation Measures

Impact Area	WEII (RPII X EII)	PIV	Total (WEII X PIV)
Surface Water Resources	-0.36	81.6	-29.376
Ground Water Resources	-0.2	61.2	-12.24
Air Quality	-0.4325	81.6	-35.292
Water Quality	-0.63	61.2	-38.556
Noise levels	-0.53	81.6	-43.248
Ground Vibration	-1	40.8	-40.8
Health	-0.615	40.8	-25.092
Public Utilities	0.35	40.8	14.28
Economic aspects	0.32	102	32.64
Land-use & Soil Characteristics	-0.22	61.2	-13.464
Flora	-0.515	81.6	-42.024
Wildlife	-0.465	61.2	-28.458
Human Settlement	-0.3	61.2	-18.36
Culture	-0.1	40.8	-4.08
Human Resettlement	-0.6	102	-61.2
Total		999.6	-345.27

Calculation has been done upto 3rd place of decimals

The total score is '–345.27' which indicates "Appreciable but reversible impact and appropriate control measure are important" as observe from **Table 6.24.**

6.10.6.3 *Potential Impact Identification using Environmental Impact Matrix without Mitigation Measures*

The total impact score is assessed by the use of following relative scales.

Upto -200	:	No appreciable impact on environment
-200 to -400	:	Appreciable but reversible impact and appropriate control measure are important
-400 to -600	:	Significant Impact mostly reversible after a short period and mitigation measure are crucial
-600 to -800	:	Major Impact, which is mostly irreversible
-800 to -1000	:	Permanent irreversible impact

Table 6-25: Potential impact identification impact matrix without mitigation measures

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
Social and Environmental Assessment and Management System										
1.	Air Quality	Blasting & Drilling	1	Dust & gases (NO_X) are produced during blasting & drilling. High SPM level is expected during these operations.	Adverse	0.50	Huge quantity of dust due to drilling and blasting	-0.75	60.0	Uncontrolled blasting and drilling activities
2.	Air Quality	Transportation of overburden and coal	2	Causes dust nuisance and gaseous pollution due to transportation	Adverse	0.20	Insignificant increased in traffic density envisaged	-0.25	40.0	Insignificant impact on air quality as road transportation not envisaged
3.	Air Quality	Transportation through conveyor system	3	Increase in dust level	Adverse	0.05	Covered conveyor system	-0.10	20.0	Covered conveyor system
4.	Air Quality	DG Set Operation	4	Gaseous emission	Adverse	0.05	Standby Operation	-0.05	10.0	Standby Operation
5.	Air Quality	Green belt development all along the	5	It serves as a natural screen in attenuation of air	Beneficial	0.20	Green belt will help to attenuate the dust particles inside	0.00	0.0	No Green belt in primitigative stage

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
		periphery of the coal mine		pollution			the block boundary			
6.	Water Quality	Provision of civic amenities	1	Deterioration in water quality due to disposal of domestic waste water	Adverse	0.20	Release of domestic wastewater is relatively low	-0.15	30.0	Un-treated domestic waste water contains high BOD, Coliform and suspended matter
7.	Water Quality	Mining Operation	2	Impact due to run-off from OB dump area and pump-out water	Adverse	0.80	Significant quantity of pump-out water generated	-0.75	60.0	Un-treated water contains high suspended matter
8.	Noise Levels	Blasting, drilling and loading during mining operation	1	Significant Impact	Adverse	0.50	Significant as high noise will produce due to mining operation	-1.0	65.0	High noise generation from the un-controlled blasting
9.	Noise Levels	Transportation	2	Increase in noise level due to vehicular traffic	Adverse	0.30	Less significant as road transportation of raw / material product not envisaged	-0.10	20.0	Insignificant increase in noise level due to movement of few trucks and vehicles used for raw material transportation
10.	Noise Levels	Vegetative	3	It serves as	Beneficial	0.20	Less significant as	0.00	0.0	No plantation is

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
		Plantation		barrier for noise propagation, thereby reducing noise levels			compared to the noise sources			proposed in pri-mitigative stage
11.	Ground Vibration	Blasting Operations	1	Impulsive ground vibration	Adverse	1.00	Only Interaction	-1.00	65.0	Uncontrolled blasting will create high ground vibration in the area
Labor and Working Condition										
12.	Health	Mining Operation	1	Impact on health due to air & noise pollution and accidents & injuries	Adverse	0.50	Potential for exposure to noise, air pollution, accidents and injuries is high	-1.0	65.0	High potential for air pollution and noise level, accident in pre-mitigative case
13.	Health	Vegetative Plantation	4	Improves the health of inhabitants by acting as a barrier to air and noise pollution	Beneficial	0.20	More significant as compared to effects due to transportation and civic amenities	0.00	0.0	No plantation in pri-mitigative stage
Pollution Prevention and Abatement										
14.	Land use and Soil	Exploration of coal	1	Impact due to opencast	Adverse	0.30	Removal of the top-soil will create major	-0.20	15.0	Excavation will confined to the

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
	Characteristics			excavation			impact on soil fertility of the area			mining lease area only
15.	Land use and Soil Characteristics	Overburden dumping	2	Soil and land degradation due to dumping of the overburden	Adverse	0.30	Dumping of solid waste (over burden) may have an impact on the landuse of the area	-0.40	40.0	Unplanned dumping of the overburden may have an impact on soil fertility and aesthetics of the area
16.	Land use and Soil Characteristics	Provision of civic amenities	3	Domestic Waste Disposal	Adverse	0.10	Domestic waste will be generate through labor camp	-0.40	40.0	Potential for adverse impact under pri-mitigative stage
17.	Land use and Soil Characteristics	Vegetation Plantation	4	Beneficial effect on land as it improves aesthetics and provides shelter for wildlife	Beneficial	0.20	Moderate importance due to potential for soil erosion prevention	0.00	0.0	No impact in pre-mitigative stage
Community health, safety and security										
18.	Health	Transportation	2	Deteriorates health due to Air & Noise Pollution	Adverse	0.10	Insignificant increase in transportation activities	-0.15	30.0	Lower impact envisaged

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
19.	Health	Provision of civic amenities	3	Affects health through disposal of sewage on open land causing mosquito breeding & water borne diseases	Adverse	0.10	Less significant in comparison to mining operation	-1.00	70.0	Potential for water borne diseases and mosquito nuisance is high during pre-mitigative stage
20.	Health	Improvement in the medical facility	5	Ambulance and Other facility will improve the regional medical facility	Beneficial	0.10	Less significant as compared to the effects due vegetative plantation	0.00	0.0	Pre-mitigative Stage
Land Acquisition and Involuntary Resettlement										
21.	Human Resettlement	Land Acquisition for mining purpose	1	4 village is getting affected due to the project	Adverse	0.60	Significant	-1.00	>95.0	Unplanned R&R activities will have a major impact on the community residing at the project site
22.	Human Resettlement	Compensation and R&R Colony	2	Compensation and R&R colony facility will be provided as Govt. directives	Beneficial	0.40	Compensation at the time of rehabilitation and housing facility will lessen the impact of R&R	0.00	0.00	Pre-mitigative Stage

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
Bio-diversity Conservation and Sustainable Natural Resource Management										
23.	Flora	Diversion of forest land	1	Impact due to diversion of forest area for industrial purpose	Adverse	0.50	Diversion of forest land for industrial purpose	-1.00	70.0	Highly significance
24.	Flora	Mining and transportation purpose	2	Adverse impact of dust due to Air and Noise Pollution	Adverse	0.10	Dust ad gaseous pollution due to mining activity	-0.15	30.0	Low potential for negative impact on flora
25.	Flora	Compensatory afforestation & Vegetative Plantation	4	Creation of vegetative habitat	Beneficial	0.40	This interaction has high significance	0.00	0.0	No plantation in pre-mitigative stage
26.	Wildlife	Diversion of forest land	1	Diversion of forest land will have an impact on habitat of the wildlife of the core zone	Adverse	0.30	Will make an impact on wildlife of the area	-1.00	70.0	Diversion of forest land
27.	Wild Life	Mining operations	2	Adverse through Air & Noise Pollution	Adverse	0.30	Interaction has high significance	-0.50	50.0	Effect due to noise and air pollution is high by which migration of biotic species may be there

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
28.	Wild Life	Transportation	3	Adverse effect due to air and noise pollution	Adverse	0.15	Not Significant	-0.10	20.0	Not significant
29.	Wild Life	Compensatory afforestation & Vegetative Plantation	4	Will improve the habitat	Beneficial	0.25	Compensatory afforestation in double of the forest land being diverted will restore the habitats for wildlife	0.0	0.0	No Plantation in the pre-mitigative stage
30.	Surface Water Resources	Mining operation	1	Diversion / Realignment of the drainage system	Adverse	0.4	No major nala is present, only first and second order streams are there.	-0.40	40.0	Streams are seasonal in nature
31.	Surface Water Resources	Disposal of Wash off dumps and mined out water	2	Water containing high amount of suspended solids	Adverse	0.40	Significant as this water contain high concentration of suspended solids	-0.50	50.0	Wash-off will be disposed of into the streams
32.	Surface Water Resources	Construction of water body in post mining stage	3	This will improve the water resource status of the area	Beneficial	0.20	As this will take place in the post mining stage	0.00	0.0	No water body will be constructed in pre-mitigative stage
33.	Ground Water Resources	Pumping of water from Mine area	1	This can affect the water table in nearby areas	Adverse	0.50	High Significance	-0.40	40.0	Mining activity can affect the water table of the area

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
Indigenous Peoples										
34.	Public Utilities	Mining operations	1	Improved Public Utility Services and amenities in the area, e.g. Power Supply, Road Network, Water Supply, Sanitation, Medical Facilities & Communication	Beneficial	0.50	Significant as it covers the surrounding villages	0.40	40.0	SPL will facilitate improvement of amenities
35.	Public Utilities	Transportation	2	Provides better transportation System, Road Network and vehicular movement	Beneficial	0.50	Only two interactions	0.30	25.0	Access roads will be made to the project area, which will also be available to surrounding area
36.	Economic Aspects	Mining Activities	1	Increased employment opportunities, both direct and indirect, thereby increasing economic status	Beneficial	0.60	Significant potential of Direct as well as Indirect Employment	0.40	40.0	Indirect and Direct employment, plus availability of power will enhance economic activities
37.	Economic	Transportation	2	Increased indirect	Beneficial	0.30	Comparatively less	0.20	20.0	The proposed

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
	Aspects			employment opportunities and thereby increase in the economic status			influential interaction			mining activity will increase a number of Indirect Employment
38.	Economic Aspects	Provision of civic amenities	3	Increased employment both by direct and indirect ways. Employment in commercial services improved economic status of people	Beneficial	0.10	Employment is restricted to limited persons in commercial services	0.20	20.0	Marginal job opportunities are envisaged
39.	Human Settlement	Mining operations	1	Environmental degradation due to increase in population, impacting natural resources	Adverse	0.50	Significant Importance	-0.30	30.0	Influx of People in the project influence area
40.	Human Settlement	Provision of civic amenities	2	Increased population puts the strain on existing transport facilities	Adverse	0.50	Only two interactions	-0.30	25.0	Low significance as marginal increase will take place

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
Cultural Heritage										
41.	Culture	Mining operations	1	Influx of people of various culture will have substantial effect on local culture	Adverse	1.00	Only one interaction	-0.10	10.0	Low impact due to limited employees from outside the study area

ESIA STUDY

MOHER & MOHER AMLOHRI EXTENSION COAL BLOCKS, M.P. (INDIA)

CHAPTER 7.

ENVIRONMENT & SOCIAL MANGEMENT PLAN

7. ENVIRONMENT & SOCIAL MANAGEMENT PLAN

7.1 OBJECTIVES

The mining process management should implement sound Environment Management Plan (EMP) which will make environment protection an essential requirement, equal in status with production and profit. Prediction of the potential environmental and social impact arising due to development activities are incorporated as the heart of EIA process. An equally essential element of this process is to develop measure to eliminate, offset, or reduce adverse impacts to acceptable levels and enhance the beneficial ones during implementation and operation of the projects. The integration of the project planning is done by clearly defining the environment requirements within an Environment & Social Management Plan (ESMP).

The Environment Management Plan for Moher and Moher Amlohri Extension Coal Block has been developed with a view to bring down the levels of impacts within limits. In each of the areas of impact as assessed in Chapter 6, measures have to be taken to mitigate adverse impacts and where these are beneficial in nature such impacts are to be enhanced/augmented so that the overall adverse impacts are reduced to a low level as possible.

The formulation of ESMP of this coal mining project is based on the following consideration:

- Proposed project activities
- Studies on Environmental Impact Assessment as derived from different base line data / information
- Surface blasting and safety
- Air and water pollution control
- Work zone Environment improvement
- Solid waste management
- Biological reclamation and landscaping
- Occupational Hazards and Safety
- Environmental monitoring facilities
- Environment management
- Rehabilitation and Resettlement
- Mine Closure / Reclamation Plan

Careful planning and strategy adopted for the operation of a project is the route to achieve economic growth as well as environmental protection.

7.2 LAND DEGRADATION AND CONTROL MEASURE

Conservation of land resources can promote sound land use to match with the land capabilities or suitability and to initiate correct land resources, development / suitability in the country. Land Degradation is one of the major adverse impacts of the open cast mining in the form of excavated voids and also in the form of waste dumps.

As stated in above chapters out of 2037 ha area, 1440 ha land will be degraded by open pit mining. A total of 1695ha would be reclaimed after mining and covered by plantations, while 25 ha of water body and 16 ha of road would be left out for future uses. Balance area includes infrastructure, slopes, periphery and batter, where plantation will be done during final mine closure. For 20 MTPA, 1808 ha is reclaimed during mine closure. The following mitigation measure would also be adopted for minimize the adverse impact of land degradation due to proposed coal block project.

7.2.1 Stage-Wise Reclamation Plan

It is planned that the external OB Dump will reach its maximum height by the 9th year in case of 12 MTPA, whereas the same reaches maximum height by 4th year. However the reclamation work for the dump will start from the 5th year onwards. Similarly the sides will also be ready for reclamation. The stages of reclamation plan are discussed in detail at Chapter-9 of this report. The post-mining land-use of the block area is shown in **Table 7.1** (12 MTPA) and **Table 7.2** (20 MTPA).

Table 7-1: Comparative Land-Use of Core Zone (12 MTPA)

Pre-Mining	Proposed	Post-mining
Forest Land: 1198 ha	Quarry Area:1440 ha	Reclaimed Area: 1608 ha
Settlements: 148 ha	Infrastructure Facilities (Project Office, Workshop, CHP, coal transport and handling corridor): 190 ha	Road: 16 ha
Agricultural land: 374 ha	External Dump and Top soil stock yard Area: 320 ha	Water Body: 25 ha
Wasteland: 317 ha	Diversion and Approach Road: 20 ha	
	Safety Zone for Quarry and OB Dump: 15 ha	Infrastructure: 95 ha
	Green Belt: 72 ha	Undisturbed Land: 293 ha
Total 2037 ha	Total 2037 ha	Total 2037 ha

Table 7-2: Comparative Land-Use of Core Zone (20 MTPA)

Pre-Mining	Proposed	Post-mining
Forest Land: 1198 ha	Quarry Area:1440 ha	Reclaimed Area: 1808 ha
Settlements: 148 ha	Infrastructure Facilities (Project Office, Workshop, CHP, coal transport and handling corridor): 200 ha	Road: 16 ha
Agricultural land: 374 ha	External Dump and Top soil stock yard Area: 320 ha	Water Body: 25 ha
Wasteland: 317 ha	Diversion and Approach Road: 20 ha	
	Safety Zone for Quarry and OB Dump:	Infrastructure: 105 ha

Pre-Mining	Proposed	Post-mining
	15 ha	
	Green Belt : 62 ha	Undisturbed Land: 83 ha
Total 2037 ha	Total 2037 ha	Total 2037 ha

7.2.2 Mitigation Measures

The total volume of OB to be removed will be 1893.73 Mm^3. The average stripping ratio is 4 cum/t and the maximum depth of excavation will be around 290 m in the north-east corner of the site. Reclamation of mined out land will be given due importance as a step for sound land resource management.

Any effort to control adverse impact would be incomplete without an appropriate land reclamation strategy. The first step in a successful reclamation programme is to decide reclamation land use. In the proposed environment management plan, it is envisaged to bring back the land to its original form. So in the sense of the above, reclamation will consist of two parts namely:

- Technical reclamation; followed by
- Biological reclamation.

7.2.2.1 *Technical Reclamation*

For technical reclamation, required number of dozers and graders has been provided. It will consist of the following steps:

- o Leveling and terracing,
- o Gully plugging,
- o Top Surface drainage,
- o Filling of cracks and fissures and
- o Coil matting where ever necessary

7.2.2.2 *Biological Reclamation*

After the Technical Reclamation, the area will be further biologically reclaimed by adopting the following procedures:

Broadcasting of grass seeds and Plantation

Plantation is one of the best known mitigation measures to arrest air pollution, land erosion and degradation and noise pollution. Sasan Power Limited will ascertain that plantation, other than the mandatory green belt development is done with cooperation from State Forest Departments and other experts in this field.

The greenbelts and plantations on reclaimed lands will be done using local species. The trees will be of native species and will provide habitat for birds and also provide food for wild animals. The green belt will also control dust pollution and mitigate noise in addition to increasing vegetative cover.

The list of species suitable for developing the green belt and plantations for reclamation is given in **Table 7.3**.

Table 7-3: List of Trees (native species) for Plantation

S. No.	Species	S. No.	Species
1.	Acacia Nilotica (Babul)	9.	Shorea Robusta (Sal)
2.	Azadirachta India (Neem)	10.	Mangifera Indica (Mango)
3.	Bauhinia Variegata (Kachnar)	11.	Modhuca Indica (Mohul)
4.	Butea Frondasa (Palas)	12.	Syzigium Cumini (Jamun)
5.	Bombax Malabaricum (semal)	13.	Gmelia Arborea (Gambhari)
6.	Boswellia Serraata (Salai)	14.	T. Arguna (Asan)
7.	Cassia Fistula (Ammatus)	15.	Pterovarpus (Baja)
8.	Croton Oblongifolius (Putri)	16.	Bambusa Arundinacae (Kantabans)
Trees specially for Slopes			
1.	Cassia fistula	4.	Accasia Mearnsii
2.	Accassia Tortilis	5.	Ficus Glomerata
3.	C. Siamea		

7.2.3 Top Soil Management

The total area to be excavated is 1440 ha. The only contribution of top soil will be from Moher Amlohri Extension and from the OB Dump Area of 600 ha. It is proposed to remove the topsoil with an average thickness of 0.5 m. Thus approximately 3.0 Mm^3 topsoil will be generated during the whole life of mine. Initially 1.6 Mm^3 of top soil generated from OB Dump area of 320 ha will be stored. This valuable top soil which is part of overburden would be removed with care before mining in the area. It would be preserved separately in a manner so as to protect its productivity for future plantations and land reclamation purpose. In the preserving phase following steps would be adopted to keep the top soil in good condition.

- The surface should be thoroughly ripped with suitable sub-soiling machinery for the purpose of
- Aeration of soil, and
- Encouragement of deep-rooting plants by introduced vegetation.
- Following ripping, the heap should be cultivated with suitable low-maintenance species, like dwarf grasses, immediately to prevent erosion and gully formation.
- The surface vegetation should be actively maintained with seeding and weed control operations.
- Garland drains will be provided around the mine wherever required to arrest any soil from the mine area being carried away by the rain water

- Bench levels will be provided with water gradient against the general pit slope, to decrease the speed of storm water and prevent its uncontrolled descent.
- Loose material slope will be strengthened by plantation and by making contour trenches at 2 m interval to check soil erosion both due to wind and rain.

7.2.4 Management of Road

The road constructed during mining operation for the movement of the transport shall be kept in good condition and will be continuously sprinkled with water. During the reclamation / afforestation period till the mine is fully reclaimed and afforested materials required for planting and growing of plants and trees, manures etc. would be transported to the site by truck.

7.2.5 Solid Waste Management

It is proposed to backfill overburden in maximum possible de-coaled area. Initially for 9 years the over burden will be transported by dumpers from the mine to the outside dump in case of 12 MTPA, whereas the same will continue upto 6^{th} year in case of 20 MTPA and subsequently for reclamation and restoration of degraded land i.e. de-coaled voids.

7.3 AIR ENVIRONMENT: MITIGATION MEASURES

Mitigation measures applied for air pollution control will be based on the baseline ambient air quality monitoring data. As per the results of ambient air quality monitoring data, the background concentrations of SPM, SO_2 and NO_X are well within the stipulated CPCB standards for most of the samples. The proposed mining operations and related activities are expected to add mainly air borne particulates. However, the addition of gaseous pollutants due to the proposed activities is expected to be relatively low.

7.3.1 Control of Particulate Matter

Dust would be generated mainly during drilling and blasting, mining and handling as well as transportation of coal. It would be effectively controlled as discussed below:

Drilling and Blasting

- Dust arrester would be provided with drills.
- Sharp drill bits would be used for drilling the holes.
- Blasting will be done in fixed time in the afternoon and optimum explosives will be used.

Loading, Handling and Transportation

- Water sprinkling on haul road, dump and coal stack would be continuous phenomena. The width of haul road will be 35 m and that for coal will be 25 m at 12 MTPA stage, where as road width will be 35 m in case of 20 MTPA.

- Regular maintenance of pay-loaders and truck engines (in the initial year) to limit emission of harmful exhaust fumes.
- Plantation around quarry, office, services areas and dumps would be carried out.

Haul roads and stock-piles

- Dust suppression system (like water spraying) would be adopted at roads, which are used for transportation of coal/OB.
- Installation of water sprinklers (Whirling) has been proposed along the roads to suppress the dust.
- Static as well as mobile water sprinkling system will be provided at the haul road of proposed mine to suppress the fugitive dust emission. At some part of haul road efficient static water sprinkling system will be provided at the side of the road which will be operated on regular interval to maintain the road wet.
- For the balance part of the haul road, water will be sprayed by efficient mobile sprinklers. Roads will be maintained wet to minimize the fugitive dust level and to maintain the ambient air quality within norms.
- Transport vehicles shall be maintained leak proof.
- Transfer points of coal will be provided with appropriate hoods/chutes to prevent fugitive dust emission.
- The top soil and OB dump will be stabilized with plantation part by part as soon as the dumping on those parts is completed.

7.3.1.1 *Control of Noxious Emission*

To ensure that NOx levels do not increase during the proposed mining operations, the following control measures will be adopted:

- Good quality explosives will be used for which the oxygen balance will be checked from time to time.
- Primer to Column ratio will be rationalized. The ratio thus established, for producing minimum NOx, will be adhered to.
- Engines shall be maintained to limit NO_X & SO_2.

7.3.1.2 *Other Control Measures*

In addition to the control measures proposed during mining and transportation operations, following steps will be taken to prevent air pollution due to airborne dust:

- To control CO levels, all heavy and light vehicles shall be tested for pollutants concentration in their exhausts regularly and well maintained. Strict vigil will be kept in and around the operational area for any fire, which shall be immediately controlled.
- Dense tree belts will be planted around the mine and crushing and loading sites. Development of greenbelt to restrict dust moving towards habitations.

- Plantation over already mined out area will be done after backfilling as per schedule (with minimum gap between excavation and afforestation)
- Dumps to be maintained with designed slope, benching, drainage control etc. to avoid wash-outs and gully formations to reduce loose materials.
- Regular collection of slimes and accumulated dust for disposal into dumps
- Dust mask would be provided persons working in dust prone areas.

7.4 WATER ENVIRONMENT: MITIGATION MEASURES

Storm water

Control measures to be adopted are briefly discussed below:

- Check dams will be provided with screens to prevent solids if any from wash off due to mine related activities.
- Peripheral bunds will be erected on the outer edge of the abandoned benches before reclamation so that the soil is not carried away by storm water.
- Chutes will be constructed by using local stone or masonry to guide the water in areas with loose soil to prevent suspended solid load in run-off and uncontrolled descent of water wherever necessary.
- Construction of garland drains around freshly excavated and dumped areas so that flow of water with loose material is prevented.
- The mine water will be passed through specially constructed catch pits to arrest any loose material being carried away with water.
- Any areas with loose debris within the leasehold will be planted.
- Garland drains will be constructed surrounding the OB dumps and will be connected to the surface water reservoir to avoid the run-off mixing directly to natural water channels before settling.

Measure to minimize adverse effects on water regime

For minimizing the impact on ground water resources, it is proposed to install some rainwater harvesting structures in the ML area. The mine pit during active mining will also serve as the rainwater harvesting structure allowing water to percolate into the ground. The proposed rainwater structures will be constructed near the mine office, workshop, near the OB dump and other locations.

7.4.1 Groundwater Management

In order to avoid ground water contamination by oil/grease and sewage waste, following control measures are proposed to be implemented.

- Leak proof containers will be used for storage and transportation of oil/grease.
- The floors of the areas wherever oil/grease is handled will be kept effectively impervious.
- Any wash off from the oil/grease handling area and workshop will be drained through impervious drains. Work shop effluent containing high suspended solids and oil & grease

will be discharged into oil and grease trap where oil will be collected separately in the oil pit. Flash mixture shall be provided for adding of lime and alum. Clear water will be stored in a clear water tank which can be used for different purpose.

- Used oil will be stored separately in drums for sale or disposal.
- The sewage waste generated from domestic waste such as septic tank, hand washing and canteen will be let into a collection tank after passing through bar screen and oil trap, to remove floating matters and vegetable oils. The over flow from oil trap will be pumped into an aeration tank of 50 cum./hr capacity. Aerated water shall be stored in a settling tank for different uses.
- The surface and ground water in and around the mine, coal handling plant and infrastructure will be regularly tested and appropriate control measures shall be adopted in case of any pollutant is detected above the prescribed limit.
- All stacking and loading areas will be provided with proper garland drains equipped with baffles to prevent wash off from reaching the downstream natural channels. It is also proposed that quarry pump out water shall be utilized after settling;

7.4.1.1 *Management of Groundwater Resources*

The hydro-geological studies carried out for the coal block, including its core and 10 km radius buffer zone have revealed that at present the ground water development factor in the area comes about 75.11% [(Annual groundwater draft/Net Annual groundwater availability) x 100]. The stage of ground water development in the project area and its buffer zone is classified as “Safe” category.

In the core zone ground water recharge will be disturbed during active mine life only and this short term impact will not have any major impact on other users as core zone is not having activity in terms of agricultural or industrial in nature. The 10 km buffer zone where habitation is present will remain in safe zone even during mine operation, since balance ground water availability is 25.99 Mm^3. Also other intervention like planned garland drainage, retention pond, percolation tanks and phase wise plantation scheme will be adopted.

The ground water inflow in the mines and its withdrawal will not affect the overall ground water table of the influence zone since the water will be channelized through garland drains into sedimentation tanks. The treated water will be discharged into natural drains.

7.4.2 Domestic Wastewater

It is planned to have no housing facility within Mining Lease Area and most of the operational worker will be accommodated in a common colony within the power plant colony situated at a distance of about 20 km. Wastewater will be only generated from restrooms and offices. As the domestic waste water will be negligible, site specific facilities like septic tanks will be provided, so it will not be released into any water body.

7.4.3 Mine Wastewater- Effluent

To prevent surface and ground water contamination, following control measures are proposed to be implemented:

- Mine water should be pumped to settling tank for settling and then the clean water will be pumped out and discharged.
- Leak proof containers will be used for storage and transportation of oil/grease.
- To avoid oil/grease spillage in the store, the container containing oil/grease will be kept in empty open containers of higher volume than these containers.
- The area over which oil/grease is handled will be kept effectively impervious.
- Any wash off from the oil/grease handling area or workshop will be drained through impervious drains, collected in specially constructed pit and treated appropriately.
- The sewage waste will lead to appropriately designed septic tanks and soak pits to prevent any pollution of surface or ground water.
- All the effluent tested regularly before discharging to the natural drains to meet the applicable standards.

The surface and ground water in and around the mine, loading plant and infrastructure will be tested as per the monitoring schedule proposed and appropriate control measures will be adopted, if required.

All stacking and loading areas will be provided with proper garland drains equipped with baffles to prevent wash offs from reaching the downstream natural channels. The quality of effluent standards will follow the MoEF discharge guidelines as tabulated in Table 7.4. This would finally be led to Kachan Nadi situated at distance of about 3km.

Table 7-4: Effluent Characteristics

Parameters	Unit	Standard for Effluent
Total Suspended Solids	mg/L	50
pH	S.U.	6 – 9
COD	mg/L	150
BOD5	mg/L	50
Oil and Grease	mg/L	10
Arsenic	mg/L	0.1
Cadmium	mg/L	0.05
Chromium (VI)	mg/L	0.1
Copper	mg/L	0.3
Cyanide	mg/L	1
Cyanide Free	mg/L	0.1
Cyanide WAD	mg/L	0.5
Iron (total)	mg/L	2.0
Lead	mg/L	0.2

Parameters	Unit	Standard for Effluent
Mercury	mg/L	0.002
Nickel	mg/L	0.5
Phenols	mg/l	0.5
Zinc	mg/L	0.5

7.4.4 Waste Management

The waste management plan will cover wastes including overburden waste likely to be generated during project construction and operational phases along with the quantity, storage and disposal plan.

Overburden (Topsoil and waste)

Total OB generation throughout the mine life will be 1893.73 Mm^3 out of which only 200 Mm^3 will be accommodated in the external OB dump in the initial years. Partial backfilling will be started in the de-coaled area from 4^{th} year and complete backfilling will be practiced after 6^{th} year of mining. The dump will be stabilised and afforested. The top soil will be used for spreading over backfilled area and over OB dump for plantation. The area of top soil stack will be afforested.

Sludge from oil/water separator

Effluent from workshops, vehicle washing etc will be passed through impermeable drains and will be treated in the oil/water separator. The oil & grease thus collected will be sold to the recycling vendors. The treated effluent will be re-circulated in the workshop.

Sludge created by mine water in settling pond

Sludge from the mine water settling pond will be removed periodically.

Sludge from domestic waste

Sludge from the domestic waste will be utilized as manure for the plantation in the mine lease area and on dump.

Hazardous Waste

- Hazardous waste, including waste oils and chemicals, spent packaging materials and containers, will be managed as described in the General EHS Guidelines;
- All the used oil will be collected in separate drum and will be sold to the MoEF or CPCB approved recycler.
- Debris generated during construction phase will be used as a landfill during infrastructure construction like office and roads.

7.5 NOISE ENVIRONMENT: MITIGATION MEASURES

The ambient noise level monitoring carried out in and around the proposed mine shows that the ambient noise levels are well within the stipulated limits of CPCB.

Within an operational mine, major noise sources are operation of mine machineries and equipment and belt conveyor. To keep the ambient noise levels within the permissible limits of 75 dB(A), the following measures shall be adopted:

- Innovative approaches of using improvised plant and machinery designs, with in-built mechanism to reduce sound emissions like improved silencers, mufflers and closed noise generating parts.
- Provision and maintenance of thick tree belt to screen noise.
- Proper maintenance of noise generating machinery including transportation vehicle as trucks, conveyor belts etc. will be ensured.
- Provision of air silencers to modulate the noise generated by the machines
- Enclosed cabins in Heavy Earth Moving Machinery for operators.
- Provision of the air silencer to modulate the noise generated by the machines, wherever required.
- Provision of earplugs, earmuffs etc. to operators and other persons exposed to high noise levels
- Reducing the exposure time of workers to the higher noise levels by rotation.
- Provision would be made for noise absorbing pads at foundations of vibrating equipment to reduce noise emissions.

7.5.1 Blasting Vibration: Mitigation Measures

- Periodical Study on vibrations due to blasting will be done and the recommendations/suggestions given as per the result of the said study will be strictly adhered to.
- The peak particle velocity (PPV) of ground vibration will be kept below 50 mm/s by controlled blasting techniques, which is substantially below the permissible limit of 70 mm/s.
- Drilling and charging pattern will be modified, if required, based on the vibration study to be carried out periodically.
- Non electrical detonators will be used. To contain fly rocks, stemming column will not be less than burden of the hole.
- Maximum total period of blast should preferably be less than 600 milliseconds to minimize cut-offs
- Each blast will be carefully planned, checked, executed and observed. Blasting data will be recorded. During blasting a responsible officer will be supervising the whole operation to meet the standards and practices.
- Blasting will be carried out at mid day.
- To contain fly rocks, stemming column will not be less than burden of the hole.
- Blasting will not be carried out when strong winds are blowing towards the inhabited areas.

Apart from the above in order to ensure slope stabilisation, controlled blasting will be adopted to avoid tension cracks and back breaks.

7.6 ECOLOGICAL ENVIRONMENT: MITIGATION MEASURES

Floral environment could be affected by mining activities due to

- Air Pollution i.e. both dust & gaseous pollution
- Water pollution
- Land Pollution

In the present study area, there is no likelihood of any pollution to flora beyond the boundary of mining lease area in the 10 km. radius buffer zone. This is because

- Sources of pollution i.e. dust, gaseous emission, solid and liquid effluents is minimized at the generation point itself and adequate measures are taken to prevent their impact on environment. So, there is no pollution due to distant carriers like air and water.
- Strict control measures to prevent air and water pollution would lead to no adverse impact on the floral environment of the adjacent area.
- The greenery to be developed under green belt development programme will improve the floral environment of the adjoining area and will bring back the animals, birds, insects, reptiles and other small animals, which might have gone away for the time being.

In compliance to TOR/EC stipulation, Wildlife Conservation Plan has been prepared and submitted for approval to State Forest Department, GoMP. The same has been presented to Expert Appraisal Committee (EAC), MoEF and clearance has been accorded. The measures suggested in the **Wildlife Conservation Plan** are as below:-

- To improve the forest cover and animal food value in the surrounding forest area (outside the active mining area i.e. the impact zone) and create favorable conditions for wildlife, compensatory afforestation has also been proposed over an approximate area of 2430 ha. This will fulfill the requirement of forest cover and value for augmenting necessary food and shelter for the animals in the adjoining area.
- The greenery to be developed under green belt development programme will also improve the floral environment of the adjoining area and will bring back the animals, birds, insects, reptiles and other small animals, which might have gone away for the time being. Also biological reclamation will be done by plantation of local species. The trees will be of native species and will provide habitat restoration for birds and also provide food for wild animals. The green belt will also control dust pollution and mitigate noise in addition to increasing vegetative cover.
- To create a sense of belonging and love for nature and wildlife in the adjoining villages by creating awareness.

- To increase the status of wildlife by creating consciousness among the local people and thereby preventing poaching.
- To prevent forest fire by deploying un-employed youth of the villages and ex-military jawans as firewatchers especially during fire season.
- To improve water holes by construction of check dam, artificial water hole and camouflaging such area to allow the wildlife to quench their thirst peacefully.
- To convince the villagers not to cultivate crops those attract wild animals.
- To eliminate man-bear conflict by creating anti-depredation team manned by the village youth, ex-military jawans and to provide first aid facility in the villages to meet exigencies particularly in case of bear attack.
- To improve the socio economic condition of the villagers by providing them with skill and finance for diary, poultry, vegetable cultivation, horticulture, farm forestry, tailoring, small business etc. Besides, they should be imparted with training to upgrade their skill.
- Vaccination of cattle to prevent spread of communicable diseases to the wildlife especially to ungulates.
- To improve protection against illicit felling, poaching, forest fire by deploying 2 ex-army jawans with mobility to help existing forest staff and to provide help to the forest department for protection in whichever way possible.
- Regulating daily blasting at a fixed time using muffled blasting techniques.
- Educating the village youth regarding the need for conservation of wildlife and measures taken for the same through visits to exemplary site like Sanctuaries and National Parks may be within the division or outside.
- Provide fencing along pit mouth to prevent fall of animals.
- Planting on O.B. dump reclaimed mine area with indigenous species of grass, shrubs and tree species with mixture of edible species. The topsoil layer would be removed before mining to keep separately for use on the top of reclaimed area adding borrowed soil.
- All the machinery that would be used would be state-of-the-at and the very best available technology. This would reduce frequency of machinery movement.
- Proper maintenance of mining machinery and vehicles to reduce noise.
- Plan and open very few extraction roads to prevent opening of the entire area to minimize vehicular movement and thereby reduce sound and air pollution.
- Spray of water to reduce dust pollution.
- Compensatory afforestation: In addition to above measures as per conditions of In-Principle Forest Clearance compensatory afforestation will be provided in line with the prevailing rules of forest department for the forest/reserve forest falling within the ML area.
- **Plantation during mining:** A plantation program over life of the mine has been planned in a phased manner. The plantation will be started from first year of mining.
- **Green belt:** A 7.5m width of green belt development around the ML area will be completed within 3 years over an area of 15 ha.

- A thick plantation is proposed to be provided and maintained around the mining area and along the roads.

The yearly requirement of plants during the various years and stages of the mining project is as shown in the Table 7.5 and 7.6.

Table 7-5: Requirement of Plants (Year/Stage Wise and Location Wise) (12MTPA)

Year	Requirement of plants for mine reclamation/afforestation & green belt					
	Area (Ha.)					No. of trees @ 2500/Ha
	Green belt	Surface dump	Backfill	undisturbed	Total	
1st	10				10	25000
2nd	20				20	50000
3rd	20				20	50000
4th	20	10		50	80	200000
5th	17	150	159	50	376	940000
10th		160	152	50	362	905000
15th			157	50	207	517500
20th			64	6	70	175000
Conceptual (25th)			756		756	1890000
Total	87	320	1288	206	1901	4752500

Table 7-6: Requirement of Plants (Year/Stage Wise and Location Wise) (20MTPA)

Year	Requirement of plants for mine reclamation/afforestation & green belt					
	Area (Ha.)					No. of trees @ 2500/Ha
	Green belt	Surface dump	Backfill	undisturbed	Total	
1st	10				10	25000
2nd	20				20	50000
3rd	20				20	50000
4th	20	10		50	80	200000
5th	7	150	122	33	312	780000
10th		160	143		303	757500
15th			463		463	1157500
20th			181		181	452500
Conceptual (25th)			506		506	1265000
Total	77	320	1411	83	1891	4727500

To fulfill the requirements of nursery plants, a common nursery will be established at the site. The fauna in this part of forest consists mostly of common small species, which will be initially scared away by mining and allied activities but at least some of them will be attracted back to the green belt, which will be planned in a manner so that it matches the forests in the area. Once the mine is abandoned the artificial forests are expected to be recolonised by animals coming from nearby forest areas.

7.7 ENVIRONMENT MONITORING

Environment monitoring has to be executed by a multidisciplinary team headed by a senior executive reporting to head of the mines. The team should be responsible for planning, execution and monitoring of all aspects of the environment, starting from startup of project to closure of mines. The organization chart is prepared with a core group only for environment management and a supporting group from allied disciplines and area of activities. This supporting group would consist of civil, mechanical (HEMM), electrical, commercial / finance, while core group should have experts from mining, geology, horticulture / forestry and laboratory. The said team will be responsible for:

- Collecting water and air samples, to monitor air and water
- Analyzing the water and air samples
- Implementing the control and protective measures
- Coordinating the environmental environment related activities within the project as well as with outside agencies
- Collecting statistics of health of workers
- Green belt development and inventory of flora
- Monitoring the progress of implementation of environmental management programme
- Ambient noise level monitoring
- Management of drainage system, dumps, reclamation & restoration etc.

The laboratory will be suitably equipped for sampling/testing of various environmental pollutants.

The Organisational set up for Environmental monitoring cell is given in Figure 7.1

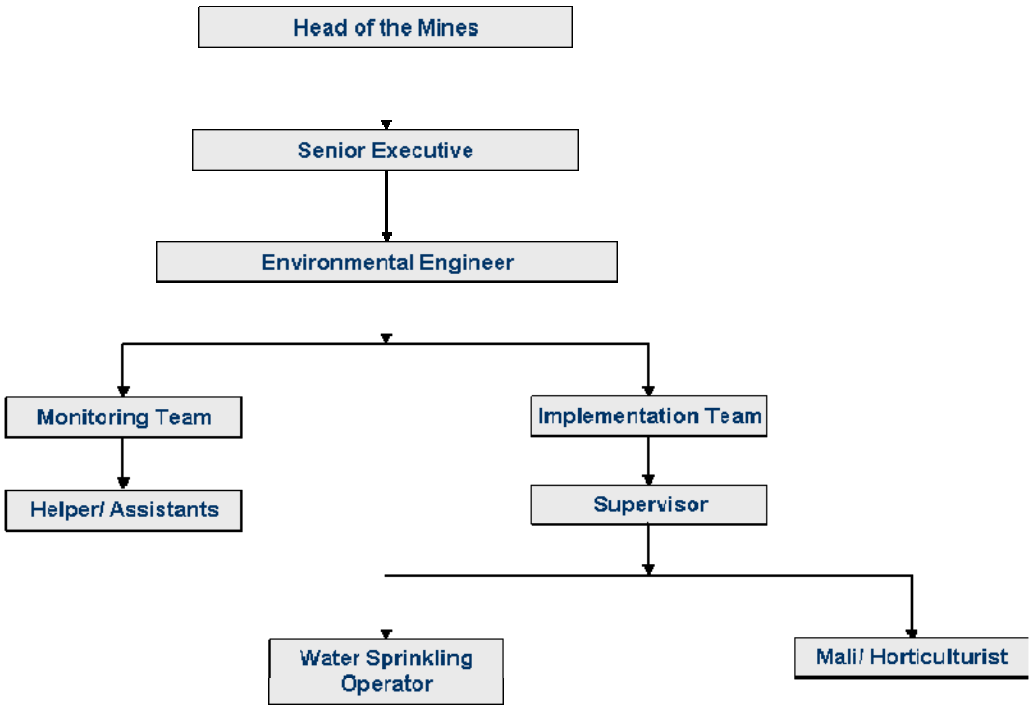

Figure 7.1: Organizational Set-up for Environment Monitoring Cells

7.7.1 Monitoring Schedule and Parameters

To evaluate the effectiveness of Environment Management Programme, regular monitoring of the important environmental parameters will be taken up. The schedule, duration, and parameters to be monitored are shown in Table 7.7.

Table 7-7: Monitoring Schedule and Parameters

Sl. No.	Description of Parameters	Schedule and Duration of Monitoring
1	Air Quality (SPM, RSPM, SO_2, NO_X) monitoring in five locations ➢ In the pit office/workshop ➢ Two monitoring station in up wind ➢ Two in downwind in consultation with SPCB	24 hourly sample with schedule to be decided in consultation with SPCB
2	Continuous micro-meteorological monitoring in one location	Continuous
3	Water Quality of surface and ground water around the site will be collected from 4 locations in consultation with SPCB ➢ One of the locations will be in near the OB Dump ➢ One near the active working area ➢ One near the natural discharge points in Kachan Nadi	Once in a season for 4 seasons in a year
4	Ambient Noise Level in consultation with SPCB	Once in a month
5	Inventory of flora to judge the comparative status will be done in the nearest forest	Once in 2 years

Sl. No.	Description of Parameters	Schedule and Duration of Monitoring
6	Soil ➢ One of the locations will be in near the OB Dump ➢ One near the active working area	Once in 2 years in reclaimed land

7.8 SOCIO-ECONOMIC ENVIRONMENT MITIGATION MEASURES

7.8.1 Resettlement and Rehabilitation

Six hamlets of Moher village and part of Amlohri and Naugarh villages are coming within the project area and the residential areas of this village have to be acquired. This would involve displacement and rehabilitation.

Resettlement and Rehabilitation of the affected villages in a satisfactory manner is necessary for smooth progress of mining operation. Sasan Power Limited on its part will take special care to provide generous package of compensation to project affected persons based on the guidelines of the Madhya Pradesh State R&R Policy.

SPL should provide land purchase assistance to those affected families who want to purchase replacement land. This can be through working with the local tehsildars, providing legal assistance and well as support during land negotiations. Wherever preferred, SPL should include land based livelihood restoration programmes for rehabilitation of the land owners.

7.8.2 Compensation / Benefits to displaced families / persons

As per Govt. of Madhya Pradesh Model R & R Policy, displaced families will be provided the compensation (apart from the compensation legally due under Land Acquisition Act depending on category of the family / person.

7.8.2.1 *Development of Infrastructure*

As required under Govt. of Madhya Pradesh Model R & R Policy, proposed R & R plan envisages creating infrastructure at the new site which is in line with the lifestyle of affected people. In the R & R colony following infrastructure facilities will be provided:

Roads

Road connectivity will be provided for connecting the R&R colony to the main roads. Main roads within the R & R colony would be metalled.

Water and sanitation

Water supply is through community hand pumps. Drainage will be open type with drains on either side of the road to ensure proper hygiene.

Primary and Middle School

A primary and middle school with initial capacity of more than 1000 students (including 100 students in balwadi) would be built. It will also have a balwadi, library and sufficient playgrounds. The school would be built on modular concept with provision for future expansion.

Community/Panchayat Hall

A community cum Panchayat building will be constructed. The building will also include a store room, an office and a library

Cooperative store / Daily market

A daily market with both covered and open shops will be constructed at the new settlement. This would be centrally located in the R & R colony and would also have platforms with shade on top for vendors to display their products / vegetables

Religious Places

3 temples are currently planned to be constructed at the new site for the local people

Health Centre

Health centre will comprise of an OPD, dispensary, pathological laboratory, emergency room and a labor room. Though the health centre will primarily serve the R & R colony it would also be accessible to adjoining villages

Herd Land and Animal Shed

There is an identified herd land next to the R&R colony that will be used for animal grazing. The proposed resettlement site would also have adequate land for animal shed for keeping animals and fodder

Cremation and Burial ground

A cremation ground and a burial ground (provisional/optional) will be built

Sewage system

Sewage system will consist of septic tanks

7.8.3 Rehabilitation Monitoring Plan

7.8.3.1 *Monitoring & Evaluation of the Community Development Plan implementation*

To assess the impacts of CDP implementation and to ensure that it is moving in the right direction, it is important that an effective monitoring and evaluation mechanism is put in place. As the onus of CDP implementation would largely be on the Gram Panchayat / community, internal monitoring is essential to monitor that the activities are being implemented within the prescribed time frame and are likely to produce desirable results. An internal monthly monitoring by the community is recommended so that they are able to identify the gaps and make an effort to bring it back on the right track.

7.8.3.2 *Rehabilitation Action Plan Monitoring*

The internal monitoring process will share its findings through monthly monitoring reports in the first year of the project, which it will share with the Rehabilitation Manager. This report will be shared with the corporate office on a quarterly basis. SPL will report to IFC on a half-yearly basis.

The external monitoring for Resettlement Action Plan will be held every quarter during the implementation process. Evaluations will be conducted once in mid-term and once at the end of the rehabilitation process.

7.8.4 R&R Implementation Plan

Implementation of R&R Plan is one of the major tasks that need to be carried out during the project implementation. The PAPs would receive adequate notice, counseling and assistance before handing over their assets. The implementations of R&R Plan begins with land acquisition, payment of compensation, identifying the relocation sites in consultation with the affected people and assisting them at each stage of relocation and rehabilitate them keeping the interests of the host communities. The R&R activities are a part of the R&R Plan presented in Chapter 5.

7.8.5 Labour Management

Following facilities are recommended for the labour camps:

- Labour camp site shall have electricity and ventilation system, water supply and community latrines with semi-permanent structures for their workers
- Water to be disinfected before consumption
- Commissioning of community latrines and septic tanks are proposed to be constructed.
- Adequate facilities for collection, conveyance and disposal of solid waste shall be developed for solid waste collection conveyance and disposal

7.8.6 Influx Management

The ultimate responsibility for the opportunistic influx management control rests with the Government. It is always the government's responsibility to provide support to areas

experiencing a rise in population. It may stipulate local infrastructure development and hiring requirements, environmental and social impact restrictions and other responsibilities that SPL takes on to be able to launch the project.

7.8.6.1 *Compliance to Employment Security and Safety Norms*

SPL would ensure that necessary safeguards in terms of employment security, minimum wages and amenities are provided by the EPC contractors and subcontractors.

The company code of conduct would be followed to ensure harmonious personnel relation at site with focus on safe working conditions and access to basic amenities for the workforce deployed at site and the construction workers colony.

7.8.6.2 *Legal Framework*

All the workmen of the company will be governed by the relevant Indian Labour laws presented in detail in Chapter 2.

7.8.6.3 *Influx Management Measures*

Majority of the staff appointed by SPL and its contractors reside in the towns of Waidhan and Singrauli that offer good connectivity, markets, better educational facilities, medical facilities and housing options including recreational facilities.

The workers engaged by the contractors and sub-contractors involved in manual labour and unskilled trades would reside in the construction workers camp established in the project site. The construction workers camp to be set up by SPL and its contactors would ensure adequate living conditions with basic amenities. The facilities to be provided in the camp would include:

- Canteen / mess facilities for food,
- Electricity
- Potable water supply in construction workers dwelling units,
- Provision of cooking fuel (LPG or kerosene),
- Provision of separate toilets and bathrooms for men and women,
- Waste management in the camp,
- Medical facilities

7.8.6.4 *Vector Disease Management*

Water storage dams can potentially create and change the existing pattern of vector breeding sites. The WSD may also create a new breeding site for the snail host of schistosomiasis, an important parasitic disease that is common in many tropical climates.

- Residual indoor spraying (IRS) is proposed for the project with a clear understanding of the local mosquito vectors and their pre-existing resistance to available insecticides;

- Development of an effective short and long- term monitoring and evaluation program for both workers and potentially affected communities.

7.8.6.5 *Responsibilities and Opportunities*

The **Table 7.8** list out the activities and interventions that would ensure efficient influx management and identifies the agencies responsible for their implementation and coordination

Table 7-8: Responsibility Matrix (Influx & Labour Management)

Activities	Contractor	SPL	State / Panchayat
1. Economic Interventions			
Local labour	●	❍	
Low cost shopping / facilities at camp	❍	●	
Supply chain development	❍	●	
2. Site Infrastructure Upgradation			
Camp location	❍	●	
Influx settlements design	❍	●	
Traffic safety	❍	●	
3. Social Awareness			
Worker education about alcohol and drugs	❍	●	❍
Random worker drug and alcohol tests	❍	●	
Community education	❍	●	❍
4. Health Education			
Worker health program and education	❍	●	
5. Social Sensitization			
Social education program for workers	❍	●	
Worker interaction with the community	●	❍	
Site security	●	❍	
Public information campaign		●	
Influx integration into the community	●	❍	
Law and order			●

● Primary Responsibility ❍ Secondary Responsibility

In addition to this SPL will make regular interaction with the local community to maintain social harmony of the area.

7.9 TRAFFIC MANAGEMENT

Traffic Management details from the proposed Coal Mine are as under

- All work activities will be scheduled and managed such that access on public roads is maintained at all times.
- Where a full or partial road closure is required, access will be provided either through the provision of localized detours around work sites, or through the use of traffic control (signs or traffic controllers) to permit only one-way traffic movement past work site;
- Heavy vehicle transports will be planned after or before peak traffic periods;
- Heavy vehicle routes will use the designated heavy vehicle routes and will avoid the local roads in residential areas;
- Transport of dangerous goods will follow the existing heavy vehicle /dangerous goods routes and will avoid the local roads on the residential areas;
- Vehicles transporting dangerous goods will not 'park-up' in residential areas;

7.10 COMMUNITY DEVELOPMENT PLAN

Any industry has a role to play in development of an area in which it works. In most cases, it is difficult to operate and do business without the co-operation of the local communities and other stakeholders. To build a good rapport with the local communities, it is essential to engage the local community along with village level institutions in an ongoing process of consultations and discussions involving the kind of joint initiatives the project can initiate for the sustainable development in the village.

While the entitlement framework and rehabilitation action plan specifically focus on the project affected families, the project proponents see this project as an opportunity to initiate a broader community development programmes in the area. The community development plan is based on the following principles

- Consultations with community members and key stakeholders through all the phases of the project
- Building trust among the company, community members and other stakeholders for successful implementation of the project as well as community development plan
- The project staff will have to develop adequate skills in implementation of the community development plan if it plans to implement the programme.
- The community will demonstrate its involvement in the programme through cash and labour contributions.

7.10.1 Community Development

The proposed Coal Mine Project activities would be spread over a few villages like Moher, Bengabasti, Amlohri and Naugarh. Some focus group discussions were held with the

community members separate discussions with women, Gram Panchayats, men, elderly people- to understand their apprehensions and expectations from the project.

This section presents a brief outline of the processes that would be adopted for planning and implementation of Community Development Plan (CDP), which would ensure that the apprehensions of the local communities, especially those not directly affected by the project are dealt with. Some major concerns expressed by the larger community included:

- Additional pressure on local resources like water, fuel wood, fresh vegetables, milk etc
- Loss of forests surrounding the villages

7.10.1.1 *Stakeholder Consultations*

The project proponents would need to initiate an on-going process to engage stakeholders in meaningful consultations. The main stakeholders for the project include;

- Local communities, both directly and indirectly affected by the project:
- The Gram Panchayats
- Local political groups
- The Land Revenue Department

7.10.1.2 *Initiate a dialogue with the (Gram Panchayat)*

Initiating the dialogue with the GP would ensure the local support and would also earn the trust of the local communities. While initially the meetings would involve only GP members to understand their concerns, gradually the larger community could also be involved in these consultations to gain their support.

7.10.1.3 *Trust building measures*

While the consultations with the community are being held, the project proponents can initiate small confidence building measures to prove their commitment to the community. These measures will also help to mitigate negative vibes, if any towards the project.

7.10.1.4 *Developing village specific micro plans for the CDP*

The stakeholder consultations will help the project proponent identify the development needs and prioritise them. The project proponents can decide to focus on few of those needs that can be managed at the community and the project. The micro plans would have the following details:

- The issues and problems identified by the community
- Process of selecting the issues that would be addressed by the CDP
- Implementation details like
- Role and responsibilities of the project proponents, community and the GP.
- Details of the intended beneficiaries

7.11 DEPENDENCY OF LOCAL COMMUNITY ON FOREST AND THEIR MANAGEMENT

As per the findings of R&R study it was found that the 13.1% of the total population depend on agriculture activity and 34.1% population are working in the nearby industrial and mining areas. Remaining 52.8% population comes under the category of student and house-wives. Thus the tribal population residing in the area have minimum dependence on the Minor Forest Produce for their sustenance and depend on either agriculture or mining/industrial activities. Therefore, proposed coal mining projects is expected to bring economic development for local population.

The Moher Coal mining project will make a significant positive impact on community life by providing direct and indirect employment, service and support opportunities. The envisaged coal mining project will bring about economic prosperity in the area. The projects in this region will be required to undertake special development programs to take care of health, education, communication and suitable livelihood of the tribal population living around coal bearing area. Such a scheme will reduce biotic pressure and help forest conservation.

In the view of above SPL have made a development plan to supply LPG connection, blanket and pressure cooker to reduce the dependency of the community on the forest produce.
A separate steering cell will monitor and ensure the execution of such development schemes and proper utilization of the funds earmarked for the purpose. The cell will be headed by the Chief Executive Officer of the SPL. SPL will also provide adequate fuel oil to the labourers and the staff working at the site so as to avoid any damage and pressure on adjacent forests.

7.12 RISK ASSESSMENT AND DISASTER MANAGEMENT PLAN

Coal mines have dangers or risk like fires, inundation, failure of machinery, which need be investigated addressed and it is important to mitigate them. Disaster management formulated with an aim of taking precautionary steps to avert disaster and also to take such action after the disaster which limits the damage to the minimum. Application of Information Technology will also lead to mechanized mining for improving the precision, safety and overall yield from mining.

7.12.1 Inundation

Inundation is caused by direct rainfall, seepage from the backfilled areas or flooding of neighbouring drainage systems. It may cause drowning of machineries, collapsing of mines benches, contamination of exposed coals, damage to roads and ramps, etc. Precautionary measures will be taken against the above during the actual operation of the mine.

However in the proposed mine, the possibility of inundation will be suitably addressed with state of art management system. Sufficient pumping capacity has been provided to preclude the possibility of inundation. Garland drain along periphery of the mine has been proposed to prevent the possibility of rain water ingress from adjoining areas.

7.12.2 Disaster Due to Failure of Pit Slope

The proposed mine is planned for 40 years in case of 12 MTPA and 29 years with 20 MTPA. The maximum quarry depth will be about 290 m.

Slopes of pits (opencast mine) with such depth can cause pit slope failure thus endangering the safety of the mine. This problem will be overcome by changing over to inside dumping (backfilling) at the early stage 4th year onwards or wherever de-coaled void is available for backfilling. Most of the overburden waste has been planned to be backfilled which will act as support to the pit slope. Out of 1893.73 Mm^3, 1693.73Mm^3 will be backfilled and the rest 200Mm^3 be accommodated in outside dump. Also the exposed ends of the coal seams and overburden will be left with a safe slope to avoid slope failure and collapse of benches.

Similarly, at the end of the mining operation, safe ultimate pit slope will be provided to avoid failure. To ensure safe slope of the mine, scientific slope stability analysis will have to be carried out based on the available geo-technical data and recommended slope will be implemented during actual operation.

7.12.3 Disaster Due to Failure of Waste Dump

The dump slopes will be prone to serious erosion during heavy rain and suffer from weathering if left exposed. The surface erosion and chances of skin failure will cause gully formation. The instability of the dump will be caused also by the rise in ground water level, reduction in spoil material strength or adverse geometry thereof. This instability will be counted upon by under-clay strength, material strength and placement method or designed geometry including topography of the foundation surface. For OB dump also, scientific slope stability analysis will have to be carried out and recommended slope will be maintained during actual operation.

Individual tiers of OB dumps would have maximum height of 30 m at an angle of 38°. Overall slope angle of OB dump would be about 27°. Maximum top level of internal dump will be +500 m. Plantation on the OB dump will be done as soon as ultimate height (surface level) is achieved.

Adequate planning has been made for drainage control and slope stabilization in the mine slopes and dumps. Surface run-off will be diverted away from the dump by garland drains at higher contour. The surface run-off from the overburden dump is to be collected in a garland

drain provided at the foot of the dump. This foot drain would carry water to a sedimentation tank from where the overflow would be directed into natural drain through controlled discharge outlets.

7.12.4 Disaster Due To Surface Fire/Coal Stockyard Fires

Accidental fires can be caused by various reasons, the main being spontaneous combustion of fire or accidental or open fires. Spontaneous combustion is caused as coal absorbs atmospheric oxygen and gets heated if exposed for period longer than the incubation period. Accidental or open fires are chemical reactions where a fuel reacts with atmospheric oxygen. Sufficient fire extinguishers will be installed at selected locations on surface like Electrical Sub-stations, work-shop, Garage, Stores, etc. Besides, sufficient number of water hydrants with sufficient hose pipes will be made available in the surface for fire protection. In order to prevent fire hazards in coal stock piles following types of precaution shall be taken.

- Prevent the happening or presence of any external source of fire in the vicinity of coal stockpiles i.e.
  - o Naked fire
  - o Electric fire
  - o Fuel oil fire
- Restrict the stacking height of the coal to below two meters. Higher height may only be attempted for shorter interval of stacking. The time and height shall be established with respect to spontaneous combustion which helps in restricting to safe parameters.
- In case of electric equipment operating in the vicinity of fuel oil being used or stored in the vicinity of the coal stock piles, appropriate types of fire extinguishers will be provided on or near such equipment in order to extinguish the fire at the very start.
- Appropriate arrangement will be made by inserting pipes in the stack to monitor the internal temperature of coal. In case, temperature is found to shoot above safe limits, the coal from the part of stack shall be immediately dug out and disposed safely.

The appropriate measures for management of fire at coal faces in the mine and coal stockyard would be adopted in the mining phase and there will be no safety hazards for the neighbouring community after the mine closure.

7.12.5 Pollution Prevention and Abatement

Mitigation measures related to pollution control measures including for fugitive dust emissions during mine preparation (construction phase) and operation phases need to be elaborated.

7.12.5.1 *Fugitive Dust Management*

Fugitive dust emissions from the dry surfaces of tailings facilities, waste dumps, stockpiles and other exposed areas will be minimized. Proposed dust management strategies include:

- Dust suppression techniques (e.g. wetting down, use of allweather surfaces, use of agglomeration additives) for roads and work areas, optimization of traffic patterns, and reduction of travel speeds;
- Exposed soils and other erodible materials will be revegetated or covered promptly;
- Other areas (Except excavating areas) will be cleared and opened-up only when absolutely necessary;
- Surfaces will be re-vegetated;
- Storage for dusty materials should be with efficient dust suppressing measures;
- Loading, transfer, and discharge of materials will take place with a minimum height of fall, and be shielded against the wind, and consider use of dust suppression spray systems ;
- Conveyor systems for dusty materials will be covered and equipped with measures for cleaning return belts.
- Coal from the mine will be transported to SUMPP through closed conveyor system.
- To reduce dust at crushing location sizers are proposed which crush the coall by shearforce.

7.12.5.2 *Explosives Handling*

The magazines will be designed as per the statutory requirements of the Indian Explosives Act 1884. All the statutory provisions for storage, transportation and use of explosives will be implemented. Vans of approved design would be provided for transportation of explosive. For blasting qualified blasting-in-charges will be recruited.

7.12.6 Risk Management

7.12.6.1 *Hazardous Substances*

Working areas will be provided with adequate ventilation and dust / fume extraction systems to ensure that inhalation exposure levels for potentially corrosive, oxidizing, reactive or siliceous substances are maintained and managed at safe levels as described in the General EHS Guidelines. In addition eye wash and emergency shower systems will be provided in areas where there exists the possibility of chemical contamination of workers and the need for rapid treatment.

Materials Safety Data Sheets (MSDSs) will be available for all hazardous materials held on site.

7.12.6.2 *Disposal Management of Hazardous Substances*

Prior to the surface demolition/restoration, a surface audit should be undertaken on all surface structures i.e. spoil heaps, lagoons etc. to assess whether there are any hazardous materials that could cause problems i.e. explosives, asbestos, chemicals, oil etc. The plan should indicate methods for disposal of hazardous materials include wastewater treatment

plant in the ESMP with quality of wastewater before and after treatment for reuse recycling of entire wastewater within the project premises.

7.12.6.3 *Use of Explosives*

Blasting activities that may result in safety impacts are typically related to accidental explosion and poor coordination and communication of blasting activities. Proposed explosives management practices will include:

- Using, handling, and transporting explosives in accordance with national explosives safety regulations;
- Certified explosives experts will be contracted to conduct blasts;
- Actively managing blasting activities in terms of loading, priming, and firing explosives, drilling near explosives, misfired shots and disposal;
- Adoption of consistent blasting schedules, minimizing blast- time changes;
- Specific personnel training on explosives handling and safety management would be conducted on regular basis;
- Blasting-permit procedures will be implemented for all personnel involved with explosives (handling, transport, storage, charging, blasting, and destruction of unused or surplus explosives);
- Blasting sites will be checked post-blast by qualified personnel for malfunctions and unexploded blasting agents, prior to resumption of work;
- Qualified security personnel should be used to control transport, storage, and use of explosives on site.

7.12.6.4 *Storage of Fuel Oil*

Fuel oil will be stored in a quantity below threshold limit. Therefore, no risk is envisaged due to onsite storage of flammables material.Fire protection system/extinguishers shall b eprovided.

7.12.7 Measures To Avoid Mine Accidents

With a view to avoiding mine accidents, the following safety precautions would be adopted:

- **Safety Equipments:** Safety equipments such as helmets, mining shoes, hand gloves, goggles will be provided. Safety belts are provided when working at height to prevent against danger from falling
- **First Aid Stations:** First aid stations with adequate medical equipments will be provided at vulnerable points. Sufficient trained persons will be provided for the same.
- **Road Accidents:** Sufficient arrangements for illumination of roads including haul roads will be provided. Warning placard would be installed at the entry point of the haul road that no pedestrians should enter the haul road. Dumpers and HEMM vehicles are fitted with sound warning while reversing.

- **Protection against noise:** Earplugs will be provided when working near noise generating areas and equipment.
- **Training:** Persons directly responsible for handling emergencies will be given training. However, following types of· training is suggested to be imparted to employees:-
  - Basic training to new entrants
  - Refresher training to old employees
  - First aid training
- **Safety Education & Awareness**: To create safety awareness and impart education on safe practices, the following steps are taken:-
- Holding annual safety awareness campaingns.
- Imparting basic and refresher training to new and old employees respectively.

7.12.8 On-Site Disaster Management Plan

The On-site and Off-site emergency plans cover personnel employed at the coal mines. The Emergency Plan is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operation in the same order of priorities. The objective of the emergency plan is to make use of the combined resources of the plant and the outside service to achieve the following:

- Reliable and early detection of an emergency and careful planning
- The availability of resources for handling emergencies
- Safeguard the personnel located in the premises
- Minimize damage to property and environment
- Organize rescue and treatment of affected persons
- Initially contain and ultimately bring the incident under control
- Identify any casualties
- Provide authoritative information to the news media
- Secure the safe rehabilitation of affected persons
- The command, co-ordination and response organization structure along with efficient trained personnel
- Regular review and updating of the DMP
- Preserve relevant records and equipment for the subsequent enquiry into the cause and circumstances of emergency.

7.12.9 Action Plan for On-site Emergency

7.12.9.1 *Identification of Responsibilities*

The onsite disaster management plan identifies Chief Incident Controller (General Manager of the Project), Work incident controller (AGM/DGM) and Designated Key Personnel of emergency control centre. The plan also specifies responsibilities of these personnel in case of an emergency and draws an action plan to be followed. Chief incident controller and works incident controller shall be assisted by two support teams as follows:

Support team to Chief Incident Controller {CIC}	Consisting of heads of personnel, Material and Finance Division: to function in consultation with CIC for the following • Contacting statutory authorities. • Arranging for relievers and catering facilities • Giving information to media. • Contacting media centers and nursing homes • Providing all other support, as necessary. • Arranging for urgently required materials through • Cash purchase or whatever means.
Support team to Work Incident Controller {WIC}	Consisting of Sr. Manager (Admn), Sr.Supdt. (Operation), Sr Supdt. (Elect. maintenance), Sr Suptd. (Mech. Maintenance) And any more persons depending upon the need to assist the (WIC) in manning communication and passing Instruction to the team. One steno secretary shall also be available with WIC for recording all information coming In and instruction going out.

In addition to the support teams mentioned above, there will be a team for each functional area, as described below:

Task Force	• To identify source of hazard and Try to neutralize/contain it. • To isolate remaining plant and keep that in safe condition. • To organize safe shutdown of plant, if necessary. • To organize all support service like operation of the fire pump, sprinkling system etc.
Maintenance Team	• Attend to all emergency maintenance jobs on top priority. • To take step to contain or reduce the level of hazard created due to disaster. • To organize additional facilities as desired.
Fire Fighting Team	• To rush to fire support and extinguish fire. • To seek help from outside fire fighting agencies. • To evacuate persons effected.
Auto base team	• To make the auto base vehicles ready to proceed for evacuation or other duties, when asked for • To send at least one mechanic at the site of incidence where he may help in attending minor defects in ambulance, fire tenders or other vehicles • To arrange petrol / diesel supply • Make all arrangements regarding transportation.
Communication team	• To maintain the communication network in working condition • To attend urgent repairs in the communication system, if required. • To arrange messengers for conveying urgent messages when needed.
Security team	• To provide two men at all gates. • To ban entry of unauthorized persons. • To allow the ambulance /evacuation vehicles etc. to go through the gates without normal check.
Administration team	• To rescue the casualties on priority basis • To transport casualties to first aid post, safe place or medical centers • To account the personnel.

	• To pass information to the kith and kin of fatal or serious injured persons.
Safety team	• To arrange required safety equipment • To record accidents. • To collect and preserve evidences in connection with accidents injuries • To guide authorities on all safety related issues.
Medical Team	• To arrange first aid material / stretchers immediately and reach to site of incidents • To arrange for immediate medical attention. • To arrange for sending the casualties to various hospitals and nursing homes etc. • To ask specific medical assistance from outside including through medical specialist in consultation with CIC / WIC
Monitoring team	• To measure gas concentration, in case of gas leakage at various places.

7.12.9.2 *Evaluation of Functioning of Disaster Plan*

In order to evaluate the functioning and effectiveness of procedure laid in disaster management plan; regular mock drills should be conducted. The Mock drills should be carried out step by step as stated below.

First Step	Test the effectiveness of communication system.
Second Step	Test the speed of mobilization of the plant emergency team
Third Step	Test the effectiveness of search, rescue and treatment casualties
Fourth step	Test emergency isolation and shut down the remedial measure.
Fifth step	Conduct a full rehearsal of call the actions to be taken.

Here are two types of mock drills recommended in disaster management plan- full Mock drill (to be conducted at least once in every 6 months) and Disaster management efficiency drill (to be conducted at least once in 3 months). The details of these drills presented as follows:

Full Mock Drill: This shall be conducted with plant head as Chairman: Head of O&M as Chairman; head of the Operation, Maintenance, Medical, personnel, CISF, Auto base and materials as members and head of safety as convener and it shall test the following:
Functioning of emergency control centre, very specifically availability of all facilities etc as mentioned in the plan and its functional healthiness.

- To evaluate communication of the Disaster plan to all segments of employees, to familiarize them about their responsibilities in case of any disaster including evaluation of behavior of the employees and other.
- To ensure that all facilities as required under the plan from within or from nearby industries /aid center under mutual assistance scheme or otherwise are available.
- To ensure that the necessities under material assistance scheme is properly documented and the concerned employees are fully aware in this regard.
- To ensure that employees are fully aware to fight any emergency like sealing of chlorine leakage, fire fighting other such cause.

Disaster Management Efficacy Drill: This shall be conducted with head of (O&M) as chairman and heads of personnel, Communication, CISF and Medical as Members and Head of safety as convener and it shall test the following:

- All employees will be trained about their responsibilities / duties. They all will be aware about evacuation routes, direction of evacuation of equipments to be used during evacuation or the method of evacuation.
- All employees will be fully trained to rescue their colleagues, who are effected due to cause of disaster. In case they are unable to rescue their colleagues, they should know to whom they have to inform about such persons.
- All employees will be fully trained in first aid use of desired equipments including breathing apparatus First Aid box etc. available at the desired location.
- All warning alarms and Public Address system should be functional.
- All telephone lines/ communication systems are provided in control rooms and there is no removal of the facilities (as prescribed) for the control rooms.
- It is very clear amongst the concerned managers who shall call for assistance under mutual aid scheme or the facilities from within.
- It is clear at the mines, who shall declare emergency.
- It is clear at the mines, who shall inform the district authorities, State authorities and corporate center.

The disaster management plan shall be periodically revised based on experiences gained from the mock drill.

7.12.9.3 *Off-Site Disaster Management Plan*

In the proposed mine, the following condition can ordinarily constitute an off-site emergency**:**

- Major fire involving combustible materials like oil, and other facilities.
- Under the Environmental Protection Act, the responsibility of preparation of Off-Site Emergency plan lies with the state government. The Collector/ Deputy Collector are ordinary nominated by State Government to plan Off-Site Emergency Plan.
- The District Collector or his nominated representative would be the team leader of planning team, who shall conduct the planning task in a systematic manner. The members of planning team for off-site emergencies are Collector / Deputy Collector, District Authorities in charge of Fire Services and police and members drawn from Medical Services, Factory Inspectorate, Pollution Control Board, Industries and Transport. In addition to these members, there are Co-opted Members also from district authorities concerned, civil defense, publicity department, Municipal Corporation, and non-official such as elected representative (MPs, MLAs, voluntary organization, non-governmental organizations etc).
- **Post emergency relief to the victims**: the public liability insurance act, 1991 provides for the owner who has control over handling hazardous substances to pay specified

amount of money to the victims as interim relief by taking insurance policy for this purpose. The district collector has definite role in implementation of this act. After proper assessment of the incident, he shall invite applications for relief, conduct an enquiry into the claims and arrange payment of the relief amount to the victims.

7.12.10 Responsibilities Of The Company

Sasan Power Limited shall take all such steps which are reasonably practicable to ensure best possible conditions of work, and with this end in view the company shall do the following:

- To allocate sufficient resources to provide and maintain safe and healthy conditions of work
- To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of plants, machinery and equipment.
- To ensure that adequate safety instructions are given to all employees.
- To provide wherever necessary protective equipment, safety appliances and clothing, and to ensure their proper use.
- To inform employees about materials, equipment or processes used in their work, which are known to be potentially hazardous to health or safety.
- To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety in the light of experience and up to date knowledge.
- To provide appropriate facilities for first aid prompt treatment of injuries and illness at work.
- To provide appropriate instruction, training, retraining and supervision in health and safety and first aid and ensure that adequate publicity is given to these matters.
- To ensure proper implementation of fire prevention and an appropriate fire fighting service, together with training facilities for personnel involved in this service.
- To ensure that professional advice is made available wherever potentially hazardous situations exist or might arise.
- To organize collection, analysis and presentation of data on accident, sickness and incident involving personal injury or injury to health with a view to taking corrective, remedial and preventive action.
- To promote through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees.
- To publish/notify regulations, instructions and notices in the common language of employees.
- To prepare separate safety rules for each type of occupation/process involved in a project.
- To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipments, work places and operations.

- To co-ordinate the activities of the company and of its contractors working on the Company's premises for the implementation and maintenance of safe systems of work, to comply with their legal obligations with regard to the health, safety and welfare of their employees.

7.12.11 Responsibilities Of The Employees

The establishment and maintenance of best possible conditions of work is, no doubt, the responsibility of Management, it is also necessary that each employees follows prescribed safe methods of work. He should take reasonable care for the health and safety of himself, or his fellow employees and of other persons who may be affected by his action at work.

Report	Potential Hazards
Observe	Safety rules, procedures and codes of practice
Use	With all responsibilities care the tools, equipments should be used
Participate	In safety training course when called upon to do so.
Make use	Of safety suggestion schemes.
Take	An active and personal interest in promoting health and safety

Responsibility for Implementation

- The ultimate responsibility for ensuring the implementation of the policy on health and safety at work rests on the SPL Management at the corporate level and concerned General Managers at the mines level. The Officers in charge of safety will be functionally responsible to the Corporate headquarter for ensuring that the policy is promulgated, interpreted and carried out in the manner expected.
- Immediate responsibility for safety at work is that of the Management/Executives of each department/section who are primarily responsible to prevent accidents involving members of their staff and other persons. It is their responsibility to issue clear and explicit working instructions, compliance with which will ensure safe working and to require the effective use of approved equipment.
- Accepted rules, procedures and codes of practice, which are formulated with proper regard to health and safety consideration, must be strictly observed by all concerned. Contracting Agencies executing works should be made responsible, through various measures including appropriate provisions in the contract, for discharging their safety obligations.
- In designated areas of particular hazard the appropriate Executives are required to authorize, in writing, the commencement of any work and, before doing so, personally to satisfy themselves that all necessary safety precautions have been carried out. Such executives must themselves be authorized, in writing as competent to perform these duties. Safety Officers will be appointed to advise Management on questions of safety at work including advice on the application in particular local situations of the system of work, implementation of Company's Rules and Relevant Codes of Practices in consultation with Area Engineer. They will be consulted in the interpretation of rules and

codes being formulated by the Corporate Management and shall advice Management in the investigation and analysis of accidents and circulation of appropriate statistics.

7.12.12 On-site crisis

On-site crisis management is the responsibility of the mines authorities, for which SPL should identify following persons for the assessment of responsibilities on specific function of coordinating authority. In order to combat the emergencies, an organizational chart for on-site emergency should be periodically reviewed and updated. Following co-coordinators are required to co-ordinate various activities during the emergency.

Chief coordinator: He shall be the Superintending Engineer (SE) and Incident Control Coordinator (ICC). The ICC should be as assisted by the following team members.

- Fire fighting System
- Safety Coordinator
- Security Coordinator
- Medical Coordinator
- Material Management Coordinator
- Relief Service Coordinator
- Transport and Communication Coordinator
- Public Relation Coordinator
- The hazards from the mines are contained well within the plant boundary and hence the DMP is presented for only the on-site crisis.

7.13 RESIDUAL IMPACT IDENTIFICATION

7.13.1 Basis

As discussed earlier the anticipated impact assessment was made using 'Modified Leopold Matrix Method'. The negative score of '-345.27' at premitigative stage indicated that the adverse impact is within "Appreciable but reversible impact and appropriate control measure are important" limit. This is mainly because care has been taken at the planning and engineering stage to incorporate environmental protection measures in the process involved. Control measures have been proposed for mitigating the degradation effects and improvement schemes such as afforestation programme and annual environmental management scheme. To predict the resultant effect at post-mitigation stage, same Matrix method is used details whereof are given in the following paragraphs.

7.13.2 Environmental Impact Matrix with Protection Measures

Components such as PIV, RPII, EII, WEII and sum of the above are arrived at and same are shown in **Tables 7.10**. It is seen that the total score which was originally '-345.27' without mitigation has improved to '-109.3'**.** This indicates that the overall impact from the project would be under the category 'No appreciable impact on Environment'. Rehabilitation and

Resettlement of the peoples contributed the major adverse impact. Reduction in total score is mainly on account of Water quality, Air quality, Noise Levels & Human settlement, etc. Measures undertaken for the same are summarized in **Table 7.9**.

Table 7-9: Impact Matrix with Mitigation Measures

Impact Area	WEII (RPII X EII)	PIV	Total (WEII X PIV)
Surface Water Resources	-0.2	81.6	-16.3
Ground Water Resources	-0.2	61.2	-12.2
Air Quality	-0.1	81.6	-11.4
Water Quality	-0.1	61.2	-8.6
Noise levels	-0.3	81.6	-21.2
Ground Vibration	-0.3	40.8	-10.2
Health	-0.1	40.8	-4.7
Public Utilities	0.4	40.8	14.3
Economic aspects	0.3	102	32.6
Land-use & Soil Characteristics	-0.1	61.2	-6.7
Flora	-0.1	81.6	-8.2
Wildlife	-0.1	61.2	-6.7
Human Settlement	-0.3	61.2	-15.3
Culture	-0.1	40.8	-4.1
Human Resettlement	-0.3	102	-30.6
Total		**999.6**	**-109.3**

Table 7-10: Potential impact identification impact matrix with mitigation measures

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
Social and Environmental Assessment and Management System										
1.	Air Quality	Blasting & Drilling	1	Dust & gases (NO_X) are produced during blasting & drilling. High SPM level is expected during these operations.	Adverse	0.50	Huge quantity of dust due to drilling and blasting	-0.25	40.0	Blasting will be done in control manner
2.	Air Quality	Transportation of overburden and coal	2	Causes dust nuisance and gaseous pollution due to transportation	Adverse	0.20	Insignificant increased in traffic density envisaged	-0.15	30.0	Insignificant impact on air quality as road transportation not envisaged. However, proper planning will be made to handle any situation.
3.	Air Quality	Transportation through conveyor system	3	Increase in dust level	Adverse	0.05	Covered conveyor system	-0.10	20.0	Covered conveyor system
4.	Air Quality	DG Set Operation	4	Gaseous emission	Adverse	0.05	Standby Operation	-0.00	<5.0	Adequate maintenance at regular interva

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
5.	Air Quality	Green belt development all along the periphery of the coal mine	5	It serves as a natural screen in attenuation of air pollution	Beneficial	0.20	Green belt will help to attenuate the dust particles inside the block boundary	0.10	20.0	No Green belt in primitigative stage
6.	Water Quality	Provision of civic amenities	1	Deterioration in water quality due to disposal of domestic waste water	Adverse	0.20	Release of domestic wastewater is relatively low	-0.10	20.0	Only treated water will be discharged
7.	Water Quality	Mining Operation	2	Impact due to run-off from OB dump area and pump-out water	Adverse	0.80	Significant quantity of pump-out water generated	-0.15	30.0	This water shall be passed through settling and sedimentation pond to control the solid matter
8.	Noise Levels	Blasting, drilling and loading during mining operation	1	Significant Impact	Adverse	0.50	Significant as high noise will produce due to mining operation	-0.50	50.0	Blasting will be done in controlled manner
9.	Noise Levels	Transportation	2	Increase in noise level due to vehicular traffic	Adverse	0.30	Less significant as road transportation of raw / material product not	-0.10	20.0	Insignificant increase in noise level due to movement of few

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
							envisaged			trucks and vehicles used for raw material transportation
10.	Noise Levels	Vegetative Plantation	3	It serves as barrier for noise propagation, thereby reducing noise levels	Beneficial	0.20	Less significant as compared to the noise sources	0.10	20.0	No plantation is proposed in pri-mitigative stage
11.	Ground Vibration	Blasting Operations	1	Impulsive ground vibration	Adverse	1.00	Only Interaction	-0.25	40.0	Controlled blasting will be done
Labor and Working Condition										
12.	Health	Mining Operation	1	Impact on health due to air & noise pollution and accidents & injuries	Adverse	0.50	Potential for exposure to noise, air pollution, accidents and injuries is high	-0.25	40.0	Adequate precautions in terms of PPE, air pollution prevention measures will be taken
13.	Health	Vegetative Plantation	4	Improves the health of inhabitants by acting as a barrier to air and noise pollution	Beneficial	0.20	More significant as compared to effects due to transportation and civic amenities	0.10	20.0	No plantation in pri-mitigative stage

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
Pollution Prevention and Abatement										
14.	Land use and Soil Characteristics	Exploration of coal	1	Impact due to opencast excavation	Adverse	0.30	Removal of the top-soil will create major impact on soil fertility of the area	-0.10	10.0	Excavation will confined to the mining lease area only. However, refilling will be done.
15.	Land use and Soil Characteristics	Overburden dumping	2	Soil and land degradation due to dumping of the overburden	Adverse	0.30	Dumping of solid waste (over burden) may have an impact on the landuse of the area	-0.20	20.0	Top soil excavated will be re-used and overburden will be dumped in planned manner and also be used for refilling
16.	Land use and Soil Characteristics	Provision of civic amenities	3	Domestic Waste Disposal	Adverse	0.10	Domestic waste will be generate through labor camp	-0.40	40.0	Potential for adverse impact under pri-mitigative stage
17.	Land use and Soil Characteristics	Vegetation Plantation	4	Beneficial effect on land as it improves aesthetics and provides shelter for wildlife	Beneficial	0.20	Moderate importance due to potential for soil erosion prevention	0.10	20.0	No impact in pre-mitigative stage
Community health, safety and security										

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
18.	Health	Transportation	2	Deteriorates health due to Air & Noise Pollution	Adverse	0.10	Insignificant increase in transportation activities	-0.10	20.0	Only PUC certified vehicle will be hired
19.	Health	Provision of civic amenities	3	Affects health through disposal of sewage on open land causing mosquito breeding & water borne diseases	Adverse	0.10	Less significant in comparison to mining operation	-0.15	30.0	Only treated water will be discharged through designed sewage system
20.	Health	Improvement in the medical facility	5	Ambulance and Other facility will improve the regional medical facility	Beneficial	0.10	Less significant as compared to the effects due vegetative plantation	0.15	30.0	Pre-mitigative Stage
Land Acquisition and Involuntary Resettlement										
21.	Human Resettlement	Land Acquisition for mining purpose	1	4 village is getting affected due to the project	Adverse	0.60	Significant	-0.70	70.0	R&R activities will take place in planned manner.
22.	Human Resettlement	Compensation and R&R Colony	2	Compensation and R&R colony facility will be provided as Govt.	Beneficial	0.40	Compensation at the time of rehabilitation and housing facility will lessen the	0.30	30.0	SPL will try their best to preserve PAFs customs and habitat

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
				directives			impact of R&R			Environment
Bio-diversity Conservation and Sustainable Natural Resource Management										
23.	Flora	Diversion of forest land	1	Impact due to diversion of forest area for industrial purpose	Adverse	0.50	Diversion of forest land for industrial purpose	-0.25	40.0	Compensatory afforestation and green belt will help to mitigate the adverse impact of forest diversion
24.	Flora	Mining and transportation purpose	2	Adverse impact of dust due to Air and Noise Pollution	Adverse	0.10	Dust ad gaseous pollution due to mining activity	-0.15	30.0	Low potential for negative impact on flora
25.	Flora	Compensatory afforestation & Vegetative Plantation	4	Creation of vegetative habitat	Beneficial	0.40	This interaction has high significance	0.10	20.0	No plantation in pre-mitigative stage
26.	Wildlife	Diversion of forest land	1	Diversion of forest land will have an impact on habitat of the wildlife of the core zone	Adverse	0.30	Will make an impact on wildlife of the area	-0.25	35.0	A wildlife conservation plan was prepared to mitigate any adverse impact on the wildlife of the area
27.	Wild Life	Mining	2	Adverse through	Adverse	0.30	Interaction has high	-0.15	25.0	Precautions will be

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
		operations		Air & Noise Pollution			significance			taken care to minimize the pollution level
28.	Wild Life	Transportation	3	Adverse effect due to air and noise pollution	Adverse	0.15	Not Significant	-0.10	20.0	Not significant
29.	Wild Life	Compensatory afforestation & Vegetative Plantation	4	Will improve the habitat	Beneficial	0.25	Compensatory afforestation in double of the forest land being diverted will restore the habitats for wildlife	0.10	20.0	No Plantation in the pre-mitigative stage
30.	Surface Water Resources	Mining operation	1	Diversion / Realignment of the drainage system	Adverse	0.4	No major nala is present, only first and second order streams are there.	-0.40	40.0	Streams are seasonal in nature
31.	Surface Water Resources	Disposal of Wash off dumps and mined out water	2	Water containing high amount of suspended solids	Adverse	0.40	Significant as this water contain high concentration of suspended solids	-0.20	20.0	Water shall be passed through settling and sedimentation pond to control the solid matter
32.	Surface Water Resources	Construction of water body in post mining	3	This will improve the water resource status of	Beneficial	0.20	As this will take place in the post mining stage	0.20	20.0	Water body in mine closure stage will be left

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
		stage		the area						
33.	Ground Water Resources	Pumping of water from Mine area	1	This can affect the water table in nearby areas	Adverse	0.50	High Significance	-0.40	40.0	Mining activity can affect the water table of the area
Indigenous Peoples										
34.	Public Utilities	Mining operations	1	Improved Public Utility Services and amenities in the area, e.g. Power Supply, Road Network, Water Supply, Sanitation, Medical Facilities & Communication	Beneficial	0.50	Significant as it covers the surrounding villages	0.40	40.0	SPL will facilitate improvement of amenities
35.	Public Utilities	Transportation	2	Provides better transportation System, Road Network and vehicular movement	Beneficial	0.50	Only two interactions	0.30	25.0	Access roads will be made to the project area, which will also be available to surrounding area
36.	Economic Aspects	Mining Activities	1	Increased employment opportunities, both direct and indirect,	Beneficial	0.60	Significant potential of Direct as well as Indirect Employment	0.40	40.0	Indirect and Direct employment, plus availability of power will enhance

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
				thereby increasing economic status						economic activities
37.	Economic Aspects	Transportation	2	Increased indirect employment opportunities and thereby increase in the economic status	Beneficial	0.30	Comparatively less influential interaction	0.20	20.0	The proposed mining activity will increase a number of Indirect Employment
38.	Economic Aspects	Provision of civic amenities	3	Increased employment both by direct and indirect ways. Employment in commercial services improved economic status of people	Beneficial	0.10	Employment is restricted to limited persons in commercial services	0.20	20.0	Marginal job opportunities are envisaged
39.	Human Settlement	Mining operations	1	Environmental degradation due to increase in population, impacting natural resources	Adverse	0.50	Significant Importance	-0.20	20.0	Influx of People in the project influence area. However proper management plan will be made to hade the influx.
40.	Human	Provision of	2	Increased	Adverse	0.50	Only two	-0.30	25.0	Low significance as

S. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
	Settlement	civic amenities		population puts the strain on existing transport facilities			interactions			marginal increase will take place
Cultural Heritage										
41.	Culture	Mining operations	1	Influx of people of various culture will have substantial effect on local culture	Adverse	1.00	Only one interaction	-0.10	10.0	Influx management plan will taken care the cultural issues of community

CHAPTER 8.
ALTERNATIVES

8. ALTERNATIVES

8.1 ALTERNATIVES FOR SITE

Coal mining is site specific in nature and the location of the proposed project is restricted to the geology and coal disposition of the area. Safety, economical and technical constraints determine the mining methods to be employed. Unlike other industries, the project cannot be shifted to other sites.

8.2 TECHNOLOGY OPTIONS

8.2.1 Continuous Mining Technology

Based on the available data on hardness of coal and OB, it can be concluded that total coal and OB will require drilling and blasting prior to excavation. In view of this, application of continuous mining technology like deployment of bucket wheel excavators etc is ruled out in the proposed mine.

8.2.2 Crushing & Conveying Technology

The size of the block is such that there is variation in the strike length and the topography of the block is extremely rugged and undulating. The location of the external dump is adjacent to the proposed mine boundary and maximum volume of OB (about 90%) is proposed to be accommodated in the internal voids with low transportation distance. Thus the primary advantage of long distance hauling relevant to conveyors for crushing and conveying is lost.

Also considering all the fact that conveyor technology requires comparatively much wider benches for operation and maintenance, total excavation required at any point will be more for conveyor application than a shovel-dumper system. In the hilly terrain, having wider bench mining system will result in adverse Techno-economics and thus not be suitable for this application.

8.2.3 Surface Miner Technology

Moher & Moher-Amlohri Extension Open cast Project attracts the deployment of draglines in each pit, which will expose bottommost Turra seam. The use of surface miner in the limited strike length for Turra seam and also with the prevailing geo-mining condition will affect the deployment of draglines. For upper thick Purewa Seam, the use of surface miner is restricted due to restriction in handling wider benches as mentioned above. However, use of surface miner may be considered for upper Purewa Seam during the actual course of mining.

8.2.4 Discontinuous Mining Technology

It is proposed to mine the deposit by a combined system of mining with the deployment of draglines and shovel-dumper combination. This is already proven technology in the adjacent

opencast mines. The points in favour of draglines and shovel-dumper combination are:

- Gentle gradient of strata, viz. 2^0-3^0 in South Pit and 3^0-5^0 in North-East Pit
- Mining of multiple seams viz. Turra (12.30-19.30m) and Purewa (19.50-26.15m)
- Overburden cover above Purewa Seam(84.70m to 198.47m)/ Parting between Turra and Purewa Seams is in the range of 51.97m to 68.70m
- Large volume of workload for 20MTPA ROM coal and 78.21Mm^3 (Peak) for overburden removal.

Shovel-dumper system for upper benches and draglines on the parting between Turra and Purewa Seams has been proposed, as this is the most suitable technology under the present geo-mining condition.

Considering the geo-mining conditions of the block, a combined system of mining deploying a dragline for the main bench over the Turra Seam for evacuating the parting inter-burden between Turra and Purewa Seams and bigger size shovel-dumper systems for advance benches in OB has been proposed. The extraction of coal is proposed by shovel/Front End Loaders in conjunction with 240ton coal body dump trucks.

8.2.5 Reasons for Choosing Discontinuous Mining Technology

Out of all the above-mentioned alternative technologies, discontinuous mining technology was adopted due to the following reasons:

- Geo-technical constraints
- Nature of deposits of coal seam
- Techno-economic considerations
- Proven technology
- Environmental Benefits like less fuel consumption, minimum wastages, optimum utilization of resources, low fugitive emission etc.