EIA Report

(In terms of provision of EIA Notification 2006)

For

Expansion of Lead-Zinc Ore

Underground Mine from 3.75MTPA to 4.5MTPA
&
Lead – Zinc Ore Beneficiation Plant from 4.25MTPA to 5.0MTPA

At
SINDESAR KHURD MINE (S K Mine),
Tehsil: Railmagra District: – Rajsamand (Rajasthan)

By

Wolkem Consultancy Services
NABET/EIA/RA0/021

Submitted to

Ministry of Environment, Forest & Climate Change (MoEF&CC)
New Delhi

September – 2016

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EXECUTIVE SUMMARY

1.1 INTRODUCTION

Hindustan Zinc Limited (HZL) is Asia's largest non-ferrous metal producer of Zinc and Lead and is Head office at Udaipur, Rajasthan. HZL is world's second largest integrated producer of Zinc with a global share of approximately 6.2%. HZL has its operations in exploration, mining, ore processing, smelting and refining of Zinc, Lead, Cadmium, Copper and Silver. It is also a major producer of sulphuric acid, as a by-product of lead-zinc metal processing. HZL also has interest in wind and thermal power generation.

The Sindesar Khurd deposit is located 6 km NNE of Rajpura Dariba Mines in Relmagra Tehsil of Dist Rajsamand, Rajasthan.

Mining lease was granted on 11.06.1998 and executed on 20.03.1999 for a period of 30 years which was subsequently extended for additional 20 years by Government of Rajasthan under the amendment of rule 8A of MMDR 1957 on letter vide no. M.E.-II/Raj/CC-Major/ML 7/1995/5308 dated 26.11.2015 Copy enclosed as **Annexure- I**. The lease is now valid upto 20.03.2049.

Environment Clearance was granted by MoEF&CC for 3.75 million TPA ore production & 4.25 million TPA ore beneficiation for Sindesar Khurd underground mine vide letter no. J-11015/ 10/ 2014-IA.II (M) dated 15-01-2016. Copy enclosed as **Annexure- II.** Consent to Operate was granted by Rajasthan State Pollution Control Board, Jaipur for carrying mining activities vide letter no. F (Mines)/ Rajsamand (Railmagra)/1714(1)/2015-2016/7455–7460 / 29.01.2016 & F (Mines)/ Rajsamand (Railmagra)/1714(1)/2015-2016/7449 – 7455 / 29.01.2016 Copy enclosed as **Annexure- III**

The present proposal is for expansion of Lead – Zinc underground mine from 3.75 million TPA to 4.5 million TPA ore production and beneficiation from 4.25 million TPA to 5.0million TPA, of which 4.5million TPA ore will be from Sindesar Khurd underground mine and 0.5 million TPA ore from BamniaKalan underground Mine. The ore concentrate produced shall be processed by the existing HZL smelters for refining of Lead & Zinc metal.

Sindesar Khurd Mine has received 5 star rating under Sustainable Development Framework (SDF) from Indian Bureau of Mines, Nagpur.

Existing facilities is certified for Integrated Management System (IMS) comprising four standards ISO 9001:2008, ISO 14001:2004, ISO 50001:2011 (Energy Management System) and OHSAS 18001:2007.

The Ministry of Environment and Forests, Govt. of India, through its EIA Notification of 14.09.2006 and its subsequent amendment on dated 1st December' 2009 and 04.04.2011 under the Environment Protection Act, 1986, classified the projects under two categories – A (more than 50 hect.) and B (less than 50 hect. and ≥ 5.0). ***The proposed project is categorized under category 1 (a) - A category {Mining of Minerals} as the lease area is 199.8425 ha*** *as per the Gazette Notification 14th Sep. 2006 and its subsequent amendment till date.*

1.2 PROJECT SITE LOCATION AND DESCRIPTION

SK Mine area falls in Sindesar Khurd Village of Relmagra Tehsil in Rajsamand District (Rajasthan), which is situated at a distance of about 45 km from Rajsamand District Headquarters. It is located at a distance of 6.0 km from existing RajpuraDariba Mine of HZL.

The area falls in Survey of India Toposheet Nos. 45L/1 and 45K/4 and lies between latitude 24° 59' and 25° 01' N and longitude 74° 09' and 74° 10' E. Location Map of the Project has been presented in **Error! Reference source not found.** and **Figure 2** Google Map

Nearest railway station is at Fatehnagar on Chittorgarh-Udaipur broad gauge railway line, 25 km from the site. Nearest airport is at Dabok (Udaipur) at a distance of 70 km. The nearest settlement/village to the mine lease is Sindesar Khurd located within the mine lease area.

Figure 1.1 Location Map

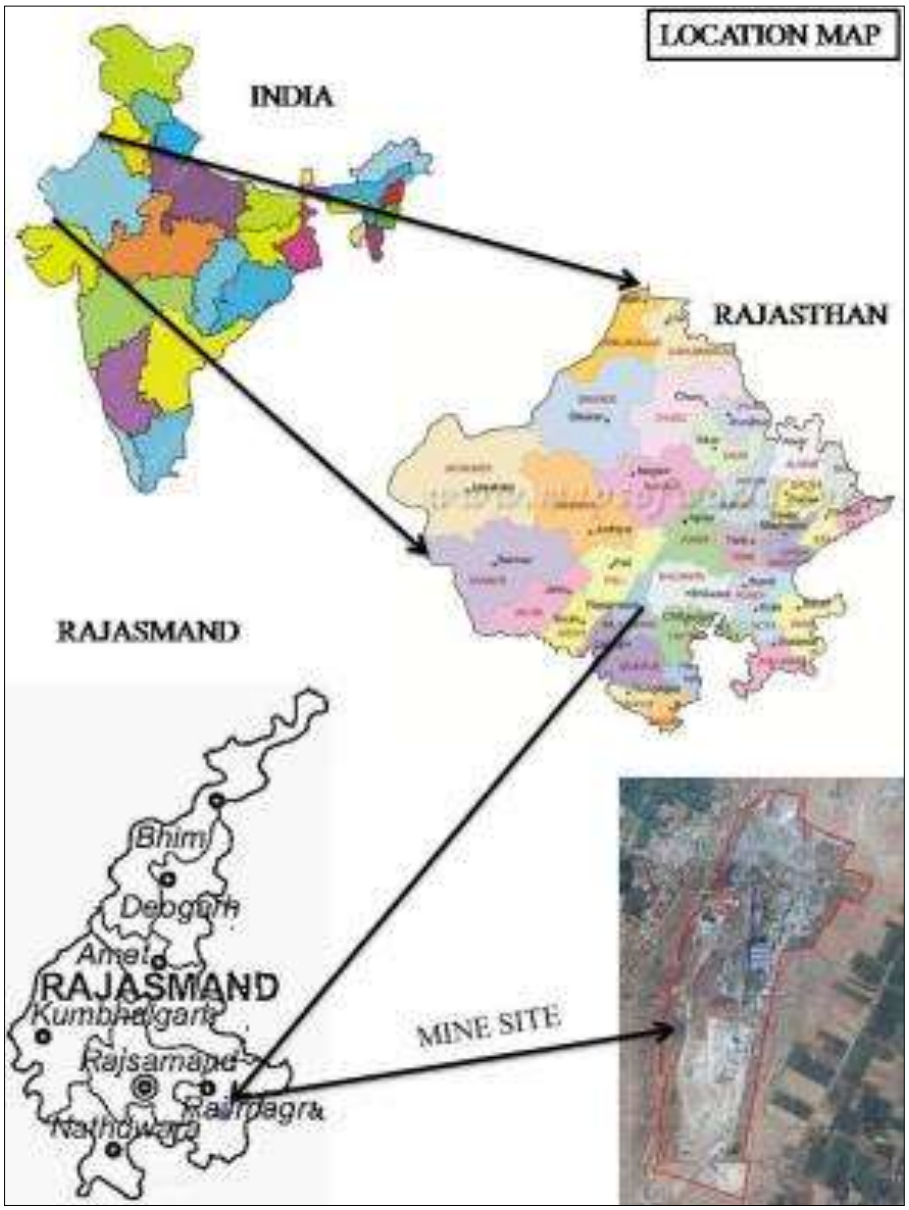

Figure 2 Google Map

1.3 Protected Areas in Study Area

The Project site and surrounding area of 10 km radius from the mining lease boundary does not have any protected areas such as National Parks or Wildlife Sanctuaries, reserve or protected forest.

1.4 Project Description

Salient feature of the existing operational project and proposed expansion Project is given below in

Table 1

Salient Features of existing and proposed capacity enhancement

S. N.	Description	For 3.75mtpa Mine & 4.25mtpa Mill operation	For 4.5mtpa Mine & 5.0mtpa Mill Operation	Changes
1	Mine lease area	199.8425 ha	199.8425 ha	No change
2	Land Requirement	148.84ha	148.84ha	No additional land requirement
3	Ore mineral	Sphalerite & Galena	Sphalerite & Galena	No change
4	Established Depth	About 1160m	About 1160m	No change
5	Reserves & Resources	99.07 million tons 4.32% Zn, 2.58% Pb	106.88 million tons 4.52% Zn, 2.70% Pb	Enhanced Reserves & Resources
6	Mode of Entry	By 2 Ramps & 1 Production Shaft	By 2 Ramps & 1 Production Shaft	No change
7	Method of Mining	Blast hole Stoping with filling	Blast hole Stoping with filling	No change
8	Ore Production	3.75 Mtpa	4.5 Mtpa	0.75 Mtpa
9	Ore Beneficiation	4.25 Mtpa	5.0 Mtpa (including 0.5 Mtpa from Bamnia Kalan mine)	Debottlenecking proposed to meet the increased capacity
10	Waste Rock Generation	4.8 million cum	7.4 million cum	All additional waste generated is

S. N.	Description	For 3.75mtpa Mine & 4.25mtpa Mill operation	For 4.5mtpa Mine & 5.0mtpa Mill Operation	Changes
				proposed to be used in filling underground voids.
11	Waste dump area	8.0 ha	8.0 ha	No change
12	Power requirement & Source	40.0MW, Captive generation& AVVNL	50.0MW, Captive generation & AVVNL	No change
13	Water requirement & Source	12000m^3/day, STP & Matrikundia	14000m^3/day, STP & Matrikundia	2000 m^3/day for Process related requirement. No wastewater related to process is anticipated to generate and all the water will be recycled and used in Process. No additional domestic water requirement and sewage is anticipated to be generated
14	Manpower requirement (Nos.)	1500	1500	No change
15.	Project Cost	Rs. 2240 crores	Rs. 2980 crores	740 Crores
16.	Environment Protection Cost	Rs. 165crores	Rs. 183.5 cr	18.5 Crores

1.5 METHOD OF MINING

The operation project is a fully mechanised underground Lead-Zinc mine and mined out with Blast hole Stoping method with back filling.Currently the mine is being worked out between 425-15mRL levels. It is divided into blocks i.e. 425-300mRL, 290-215mRL, 195-160mRL, 130-15mRL levels with crown pillars in between. Auxiliary lens, SKA2 is between 325-215mRL is also in operation.

Existing operational mine is having nine openings with two ramps, six ventilation raises & an incline. North Ramp & South Ramp (5.5m x 5.0m, 1 in 7 gradient) are suitable for deploying 30t/50t/60t/63t mine trucks & 7t/10t/17t/21t LHDs, North Ventilation Raise & South Ventilation Raise is equipped with 200 cum/sec and 233 cum/sec respectively as main exhaust fans and Central Ventilation Raise is equipped with exhaust fan of 100 cum/sec. SKA2 lens is being ventilated through a 630kW fan with capacity of 150 m^3/ sec.

It is proposed to enhance the ore production capacity of the mine from present production rate to 4.5mtpa by developing current & new mining blocks and the required infrastructure.

The proposed enhancement in ore production capacity as well for sustenance, it is proposed to further develop & deplete 425-315mRLblock, 290-215mRL block, 195-160mRL block, SKA8, SKA2, SKA6, SKA14, SKA11 lenses. It is planned to expand the mine laterally in upper mining block and develop the lower mining blocks for future mine production.Mining will be done using trackless operations upto55mRL - level using 2 declines for hauling. Mining below this level will be done using shaft hoisting system as the depth of hoisting will be increasing and service ramp will be available for the movement of machineries & services.

Lower blocks will also be brought into the production after developing them. Raises will be extended to lower levels as the access is available for extending raises for ventilation. Ramps will be further developed to lower levels for hauling as well as material movement to the lower block. Shaft will also be commissioned to haul the ore from lower block. Auxiliary lenses will be mined as the mining commences in the levels approximate to them. Mining of Sill/Crown pillar will be planned after due consideration studies of local & regional stability. Post filling will be done in all primary/ secondary stopes to enhance ore recovery keeping in view of mineral conservation.

1.6 Mineral Beneficiation

SK Mine has an operational 4.25 Mtpa ore beneficiation plant, the concentrate produced is send for metallurgical treatment at captive smelters for recovering final metal. It is proposed to debottleneck of existing ore beneficiation plant to increase capacity from 4.25 Mtpa to 5 Mtpa. This 5 Mtpa plant will get 4.5 Mtpa ore from proposed project and 0.5 Mtpa from Bamnia Kalan mine situated at 4 Km fromm existing operation (mine is presently not in operation).

1.7 Tailing Disposal, Hydraulic Filling &Paste Filling

Currently, the fine tails from SK Mine beneficiation plant is being pumped to existing lined tailing dam of Rajpura-Dariba Mine whereas classified tails are backfilled in underground stopes after mixing with cement from existing hydraulic fill plant. A paste fill plant is under construction to augment the backfilling capacity and to utilize fine tailings in backfilling in order to maximize ore recovery and overall stability of underground mines It is planned to increase the tailing dam height in sequential manner which will meet the tailing disposal requirement till mine life. It is also proposed to utilize 50% of the tailings in the stope backfill.

Hydro Fill: Tailings from floatation stream is be fed to hydro cyclones, where classification takes place and fine size overflow fed to HRT tailing thickener, after recovery of water the underflow of tailing thickener is withdrawn at 55% solids and sent to tailing dam by pumping in tailing lines. The recovered water will be recycled and used in plant to maintain zero discharge. The Coarser cyclone under flow is being collected in Fill Storage Tank and after cement addition and mixing at around 60% solids pumped in bore hole for mine back fill.

Paste Fill: The plant tailing generated shall be pumped to paste thickener. The underflow of paste thickener will be fed to the disc filters. The filter cake along with cement will be fed to the mixer unit and paste will be produced. The paste fed to underground reticulation system in mined out stopes. Paste fill is typically placed with a cement binder at a slump of 150 to 180mm to minimize water requirement and achieve required strength at an early date. The paste fill plant process circuit consists

of dewatering of the tails slurry in a conventional thickener to 50 to 60% by weight. The product is further dewatered in a disc filtration plant to produce a wet filter cake comprising of 80-85% solids. Batches of this filter cake are then mixed in a high intensity shear mixture with water and cement as required to make a consistent paste product of around 80% solids. For average stope width of 20-25m, the required fill strength is 400-500kpa. To achieve the proposed design strength the cement % varies from 5-8%. This plant is also has emergency power backup (2x 500 KVA Capacity) to take care of emergencies.

1.8 RESOURCE REQUIREMENT & SOURCES

Water requirement& its sources

An additional 2000 m3/d of water is required for proposed expansion for process related operation, in addition to approved 12000 m3/d water requirement for 3.75 Mtpa mining & 4.25 Mtpa Beneficiation capacity. Additional requirement will be met out from Udaipur Sewage Treatment Plant & Matrikundia dam. Zero discharge is being maintained. Mine dewatering due to intersection will also be consumed in the process. As reported no additional manpower is required and discharge of domestic wastewater is not anticipated.

Power Requirement & its sources

No additional power is envisaged for the proposed capacity expansion. For this proposed expansion power requirement will be met from existing 50.0MW approved for 3.75 MTPA mining & 4.25 MTPA beneficiation capacity from captive generation & AVVNL.

Emergency Power

DG set of 5.0MW capacity having acoustic enclosures for emergency power is introduced as a part of 3.75 MTPA ore production & 4.25 MTPA ore treatment plant.

Land requirement

The total land requirement for the existing operational facility is 148.84 ha and for the proposed capacity enhancement activity will be restricted within the above land and no additional land will be required.

Manpower requirement

As reported, No additional manpower is required for the proposed capacity enhancement.

Resource Optimization/ Recycle

Water from tailing dam is being recycled/ reused for the beneficiation purposes and the same will be continued.

1.9 Mine waste generation and management

The details of mine waste generated from existing operational facility and proposed expansion facility is given below

Table 2

Mine Waste Generation and Management

Particulars	**Existing 3.75 Mtpa** (m^3)	**Post expansion 4.5 Mtpa (**m^3)	**Additional Generation due to capacity enhancement (**m^3)
Total waste generation over life of mine	48,00,000	74,00,000	26,00,000
Waste disposal planned in underground voids	10,00,000	36,00,000	26,00,000
Waste to be utilized in construction of tailing dam	33,00,000	33,00,000	Nil
Total waste to be disposed externally	5, 00,000	5,00,000	Nil

Existing external waste dump will be provided with garland drain with water collection provision. Plantation has been proposed for inactive dump.

Per the above table, due to capacity enhancement of SK Mine, no additional waste will be dumped on the surface beyond the already approved waste quantity. The increased waste generated will be proposed to be used in underground voids.

1.10 ENVIRONMENT BASELINE

As part of expansion of existing 3.75 Mtpa mine and 4.25 Mtpa of beneficiation plant, Environmental, Ecological and social baseline study was conducted during the period March to May 2016 representing the pre-monsoon/summer season. Brief findings of the same is given below

1.10.1.1 Landuse

As per the classified image of April 2016 the percentage area under different LULC classes are as follows 6.53% Water Bodies, 6.41% Barren Land, 2.57% River//river bed/sand, 40.14% Agriculture Fallow land, 41.36% Agriculture crop land and 3.0% Settlement.

1.10.1.2 Soil Quality

The soil analysis results are presented in table. The result obtained is compared with the standard soil classification given in Agriculture Soil Limits. It has been observed that the soil is sandy loam in texture and neutral in nature. The nutrient and organic matter contents are medium and the soil is normally fertile.

1.10.1.3 Ambient Air Quality

The analysis results for the study period are presented in above monitoring tables. Various statistical parameters like 98^{th} percentile, average, maximum and minimum values have been computed from the observed raw data for all the AAQ monitoring stations. These are compared with the standards prescribed by Central Pollution Control Board (CPCB) for rural and residential zone.

1.10.1.4 Ambient Noise Level

The baseline noise monitoring in the study area was carried out at 10 locations during the study period. The day time and night time equivalent noise levels monitored at all the residential receptors were found within the prescribed norms. The noise levels within the ML were observed to be within the prescribed industrial noise limit during day and night time.

1.10.1.5 Groundwater quality

- pH of the groundwater samples were found in the range of 6.62 to 7.85 as against the drinking water norm of 6.5 to 8.5. The level of dissolved solids in the groundwater samples varied from 445 mg/l to 2802 mg/l. GW-2 (Bamnia Kalan) and GW-3 (Raghunathpura) were observed to have TDS within acceptable limit, while GW-4 (Amarpura), GW-5(Rajpura),and GW-8(Shivpura) were observed to have TDS above the acceptable limit, however within the permissible limit of 2000 mg/l. Groundwater sample at GW-6 (Mahenduria) and GW-7(Relmagra) was found to have TDS above the permissible limit.
- Total hardness in the groundwater samples varied from 51mg/l to 972 mg/l. Groundwater at GW-2 (Bamnia Kalan) and GW-4 (Amarpura) site was observed to be within the acceptable limit of 200 mg/l, whereas groundwater samples, GW-3 (Raghunathpura), GW-5 (Rajpura), GW-7 (Relmagra) and GW-8 (Shivpura) observed to have total hardness above the acceptable limit, however within permissible limit of 600 mg/l. Groundwater sample at GW-1 (Sindesar Khurd) and GW-6(Mahenduria)was found to have total hardness above the permissible limit.
- The chloride concentration ranged from 110.50 mg/l to 810.60 mg/l in the groundwater samples. Most of the groundwater samples had chloride concentration was found to be below the acceptable limits (250 mg/l) except GW-1 (Sindesar Khurd), GW-6 (Mahenduria) and GW-7(Relmagra), however these samples were found to have chloride within the permissible limit of 1000 mg/l.
- Alkalinity varied from 245 mg/l to 1240 mg/l in the groundwater samples. Total alkalinity was found to be exceeded the acceptable limit (200 mg/l) in all the water samples, however most of samples except GW-7 (Relmagra) and GW-8 (Shivpura), were observed to have alkalinity concentration within permissible limit of 600 mg/l. The fluoride level in the most of the groundwater samples was observed to be Below

Detectable Limit of 1.14 mg/l. GW-1(Sindesar Khurd) have fluoride concentration below the acceptable limit, however, at GW-2 (Bamnia Kalan) and GW-3 (Raghunathpura) the fluoride concentration is found to have above the acceptable limit, but found within permissible limit of 1.5 mg/l.

- The Sulphate and nitrate concentrations in the groundwater samples was observed to be in the range of 30.2 mg/l to 250 mg/l (for Sulphate) and from 0.37 to BDL (for nitrate). Sulphate at most of the locations except GW-1 (Sindesar Khurd), GW-2 (Bamnia Kalan), GW-3 (Raghunathpura) and GW-4(Amarpura) were found to be within the acceptable concentration limit of 200 mg/l.
- Level of Phenolic compounds was observed to be BDL in all the groundwater samples.

1.10.1.6 Surface Water quality

SW-1 Anjana Tank

The pond has limited use in terms of human consumption and is one of the surface water resources where water was observed during the summer season. During monsoon and post-monsoon, when water body receives rain water and runoff, this water body can be utilised as outdoor bathing (Category B) and propagation of wildlife and fisheries (Category D). The monitoring result shows that pH value was 7.85. The DO and BOD level was 4.8mg/l and 6.8 mg/l respectively. The coliform was <2. The analyzed water quality of the Anjana Tank sample indicates water was not suitable for outdoor bathing, i.e. Class 'B', however, it is fit for propagation of wildlife and fisheries, i.e. Class 'D'

SW-2 Bharai Dam

The dam water is used for irrigation and cattle drinking and is one of the surface water resources where water was available during the summer season. The monitoring result shows that pH value was 7.22. The DO and BOD level was 5.2 mg/l and 16 mg/l respectively. The Coliform contents were observed to be 400 organisms/100ml. The Sodium and chloride content was 180.20 mg/l was 255.50 mg/l respectively. The analyzed water quality of the Bharai Dam sample indicates water was not suitable for irrigation purpose, i.e. Class 'E', however, it is fit for propagation of wildlife and fisheries, i.e. Class 'D'.

1.11 ANTICIPATED IMPACTS

Anticipated key environment, ecological and social issues associated with proposed capacity enhancement are listed below in table

Components	Key Impacts
Land and soil Environment	• Impact on soil and land environment due debottlenecking process and associated activities; • Storage and handling of hazardous materials (e.g., fuel and lubricant) and waste generated from operation of construction equipment and machinery and their maintenance may lead to soil contamination due to leaks/ spillage; • Land Subsidence due to blasting;
Ambient Air Quality	• Dust emissions due to movement of machinery and vehicles; • Indoor fugitive dust emissions due to blasting, excavation and back filling activities etc; • Fugitive dust emission due to operation of primary and secondary crusher in underground and above ground, loading & unloading and transport of ore and concentrate;
Ambient Noise and vibration	• Noise generation due to movement of vehicles and heavy machineries; • Noise from debottlenecking activities; • Noise from additional ore handling, crushing of ore both underground and above ground, • Vibration due to blasting;
Water Environment	• No additional domestic wastewater and process related wastewater is anticipated to generated; • It's also propose to use treated water from STP of Udaipur to reduce the intake on freshwater; • No process related wastewater is anticipated to generated;
Ecology	• No change in surface infrastructure or surface related activities are anticipated to cause impact on surface ecology;
Visual Landscape	• No change in surface infrastructure or structure is anticipated.

Components	Key Impacts
Occupational health and safety	• Occupational health hazards due to dust and noise pollution; • Safety risk due to wrong handling of construction machinery,
Demographics	• No additional manpower or influx is anticipated;
Social and cultural fabric	• No influx of Labour or manpower due to capacity enhancement is anticipated.
Economy and Employment	• Indirect impact on local economy through development of secondary facilities.
Land based Livelihood	• No land acquisition is associated with proposed activity and no impact is anticipated; • The project is proposed to implement R&R plan as per the request of Sindesar Khurd village and allocated budget for the implementation of the same;
Community health and safety	• Transportation of concentrate components and associated increased vehicular movement will lead to traffic hazards for community residing close to the access roads;

1.11.1 ENVIRONMENTAL MANAGEMENT PLAN

SK Mine is currently implementing the Environmental and social management plan approved by MOEF&CC and regularly submitting the compliance report to RO of MoEF&CC. Also Vedanta Resources Plc has Sustainability Governance System for all its operations globally which provides an overarching umbrella for environment, health, safety and social management for all its assets and subsidiary companies.

Various impacts associated with proposed capacity enhancement activities are similar to the impact and mitigation measures of existing operational project. The project is continued to implement the various mitigation measures and comply with EC conditions and various conditions of other approvals obtained earlier.

As committed during the earlier public hearing, the project is proposed to implement R&R plan for shifting of Sindesar Khurd and the budget allocated for the different activities is given below

Table 2

EMP Cost for Existing and Proposed capacity enhancement

Particulars	**Approved**		**Proposed**	
	Cost in cr.		**Cost in cr.**	
	Capital	**Recurring**	**Capital**	**Recurring**
Excavation & installation of Dust control/suppression systems for crushers & cement silos	5	2	5	2
Tailing Dam management (height raising, HDPE lining on side wall, pumping system and water recycle line)	55		61.5	
Tailing thickener	5	5	5	5
Surface water sprinkler	1	0.1	1	0.1
Mechanical road sweeper	1	0.1	1	0.1
Ventilation System	68	4.1	80	4.8
Rainwater harvesting	1	0.2	1	0.2
Plantation/Green belt development and drip irrigation system	1	0.5	1	0.5
Different Environmental Monitoring equipment	1	5.1	1	5.1
Automation in Environment Monitoring & Safety	17		17	
Construction of Garland drain and silt settling tank and recycle system for waste dump management	1	0.1	1	0.1
Schedule-I fauna conservation plan cost	2	0.4	2	0.4
Installation of Sewage treatment plant and Oil grease trap system	3	0.5	3	0.5
Water hydrant system	1	0.1	1	0.1
Water tanker with pumps	3	0.1	3	0.1
Grand Total (Rs. in cr.)	**165**	**18.3**	**183.5**	**19.0**

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CHAPTER -1

INTRODUCTION

1.1 INTRODUCTION

Hindustan Zinc Limited (HZL) is Asia's largest non-ferrous metal producer of Zinc and Lead and is Head office at Udaipur, Rajasthan. HZL is world's second largest integrated producer of Zinc with a global share of approximately 6.2%. HZL has its operations in exploration, mining, ore processing, smelting and refining of Zinc, Lead and Silver. It is also a major producer of sulphuric acid, as a by-product of lead-zinc metal processing. HZL also has interest in wind and thermal power generation.

The Sindesar Khurd deposit is located 6 km NNE of Rajpura Dariba Mines in Relmagra Tehsil of Dist Rajsamand, Rajasthan.

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Existing facilities is certified for Integrated Management System (IMS) comprising four standards ISO 9001:2008, ISO 14001:2004, ISO 50001:2011 (Energy Management System) and OHSAS 18001:2007.

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1.2 BRIEF DESCRIPTION OF PROJECT AND PROJECT PROPONENT

1.2.1 Project details

The project is a mechanised underground Lead-Zinc mine project and is classified as **"Category-A"** by Ministry of Environment & Forests& Climate Change, New Delhi as per EIA Notification dated on 14th September 2006 and its amendment till date. Sindesar Khurd deposit extends over a lease area of 199.8425ha with estimated in-situ ore Reserves &Resources of 106.88 million tons with grades of 4.52% Zinc and 2.70% Lead. The proposed expansion of mine is from 3.75 to 4.5 Mtpa of Lead-Zinc Ore Production &Lead-Zinc ore Beneficiation from 4.25 to 5.0 Mtpa of which 4.5 Mtpa ore will be beneficiated for SK Mine and 0.5mtpa from Bamnia Kalan Mine (4km from SK Mine).The major cost of this expansion project is already incurred as a part of 3.75 Mtpa Mine & 4.25 Mtpa Beneficiation Plant. Additional, it is envisaged that we will spend Rs. 600 Crores towards this expansion project. No additional land will be acquired for the proposed expansion

The total mineable reserves available are 78.73million tons. Life of Mine has been estimated more than 25 years with current Reserves & Resources, which is sufficient for the life of mine. The total waste generation during the life of the project will be 74,00,000 cum. In the proposed expansion, no additional waste will be dumped on the surface beyond the approved waste quantity and hence no additional waste dump is envisaged. The increased waste generated will be disposed off into the underground voids. Additional water requirement for the proposed expansion will be 2000 KLD, which will be met from STP Udaipur treated water and Matrikundia dam.

Mining Lease is demarcated on part plan of Survey of India Topo sheet No. 45/L1 and 45K/4. It lies between Latitudes 24°59'N-25°01'N and Longitudes: 74°09'E-74°10'E on Survey of India topo sheet No. 45/L1 and 45K/4.

1.2.2 Project proponent

HZL is one of the world's largest integrated producers of Zinc and is among leading global Lead and Silver producers. The company has more than 60 years of experience in mining and smelting. Core business of HZL comprises of mining and smelting of Zinc and Lead along with captive power generation. HZL currently has nine operating mines and three smelting complex's under operations. The mines are situated at Rampura Agucha (the largest zinc producing mine in the world), Sindesar Khurd, Rajpura Dariba, Zawar Group, Kayad and Maton in the State of Rajasthan, while the smelters are located at Chanderiya, Debari and Dariba in the State of Rajasthan. As on 31.03.16, total reserves and resources of HZL are 389.9 Mt which is sufficient for more than 25 years of mine life The Government of India has disinvested HZL in April 2002. The fiscal and financial performance of the company for the past ten years has shown remarkable upsurge. The company has come a long way with technology update, research and development activities, up keeping of environmental safety and ecological balance besides exploring new business opportunities.

1.2.3 Location of the Project

SK Mine area falls in Sindesar Khurd Village of Relmagra Tehsil in Rajsamand District (Rajasthan), which is situated at a distance of about 45km from Rajsamand District Headquarters. It is located at a distance of 6.0km from existing Rajpura Dariba Mine of HZL.

The area falls in Survey of India Toposheet Nos. 45L/1 and 45K/4 and lies between latitude 24° 59' and 25° 01' N and longitude 74° 09' and 74° 10' E. Location Map of the Project has been presented in Error! Reference source not found. and Google Earth image of the area showing the three mine lease areas has been presented in Error! Reference source not found..

Figure 3.1.1 Location Map

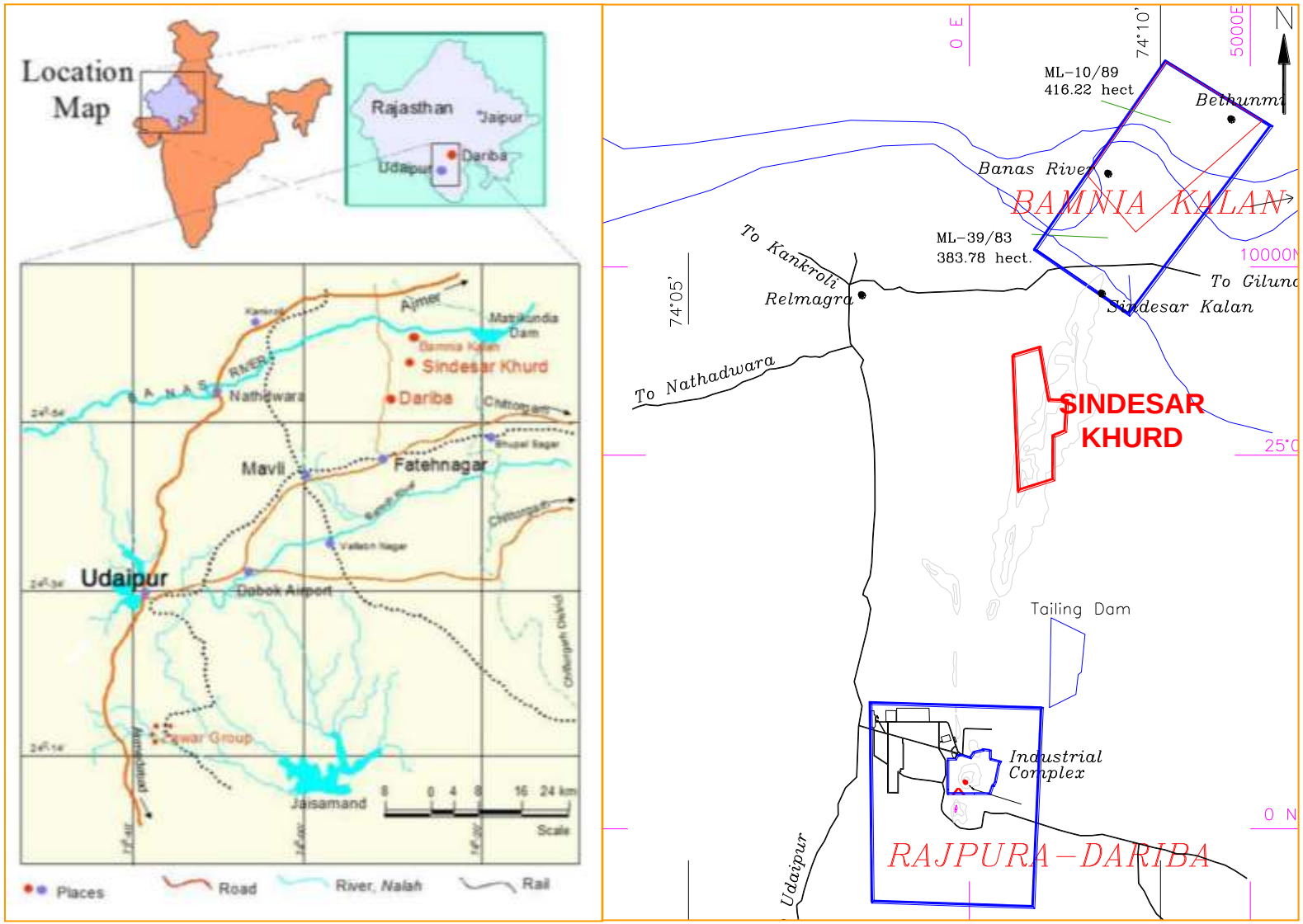
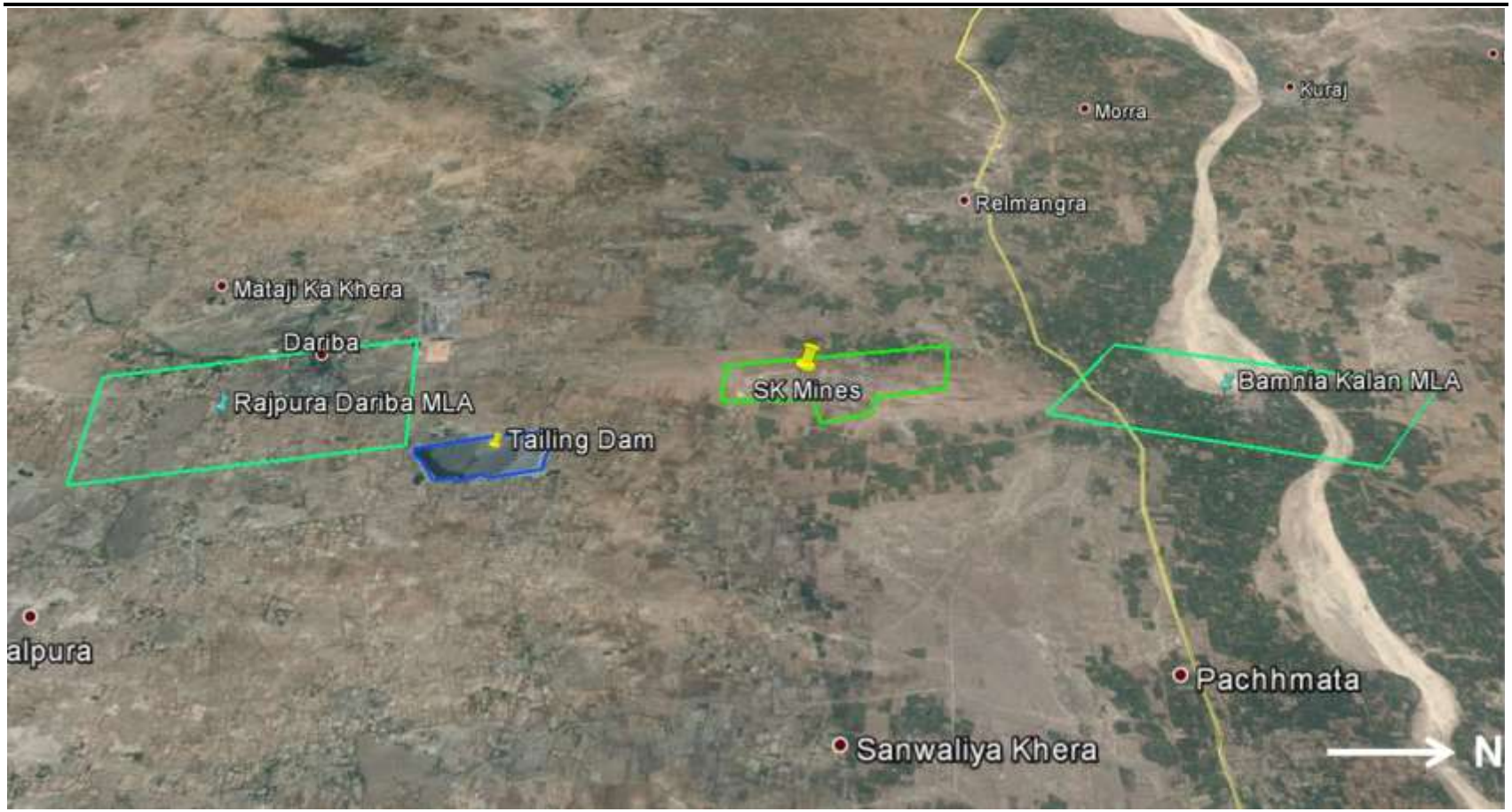


Figure 3.1.2 Google Earth Image of the Area



Source: Google Earth imagery dated 2 March 2014

Nearest railway station is at Fatehnagar on Chittorgarh-Udaipur broad gauge railway line, 25 km from the site. Nearest airport is at Dabok (Udaipur) at a distance of 70 km. The nearest settlement/village to the mine lease is Sindesar Khurd located within the mine lease area.

1.2.4 NEED FOR THE PROJECT AND ITS IMPORTANCE TO THE COUNTRY

Zinc is a very versatile non-ferrous metal. Zinc's different applications rank it as the 4th most common metal in use after iron, aluminium and copper.

Global zinc consumption is forecast to grow at a compound average annual rate of 1.8% p.a. with per capita zinc consumption increasing from the current level of 1.9 kg to 2.3 kg over the period 2015-2035. Global zinc consumption is projected to grow to 20 MT in 2035 representing an average annual increase of 0.3MT. However, with most of the world's developing economies facing economic headwinds there is a near-term downside risk to the outlook for global zinc consumption.

Consumption growth sets a requirement for extra raw material supply to smelters (concentrate and secondary materials) of 0.3 MTA Zn. Whilst some of the extra mine capacity will come from expansions and mine life extensions of existing producers, the majority will be from new mines.

Globally, the sustained growth from the developing world is forecast to result in global consumption growing by an average annual rate of 2.4% p.a. from 13.9Mt in 2015 to 16Mt in 2020. Over the balance of the forecast period the pace of expansion is projected to moderate and average 1.5% p.a., this compares with the 1970-2014 average of 2.3% p.a. These forecast growth rates are projected to lift global consumption to 20Mt in 2035. In terms of per capita zinc consumption this equates to an increase in the global average from 1.9kg in 2015 to 2.3 kg. Still well below the 4.4kg per capita consumption averaged in the world's developed economies over the period 1990-2010.

Domestic demand and supply

In the aftermath of the Great Financial Crisis of 2008-2009, the Indian economy lost momentum. Growth in industrial production slowed from an average of 7.9% during 2000-2008 to 3.9% over the period 2010-2015.

Table 2: Domestic refined zinc supply & demand (ktzn)

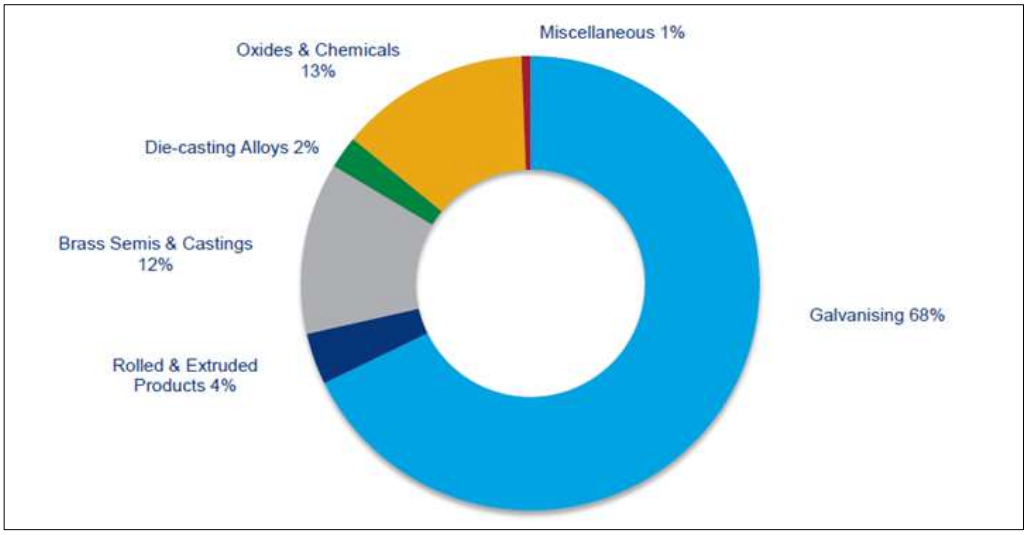
Year	2016	2017	2018	2019	2020	2025
Demand (kt)	691	744	799	847	901	1205
Supply (kt)	843	843	843	843	843	843

(Source: Wood Mackenzie Long Term Outlook)

Galvanized steel content rising in cars, photo-voltaic power plant constructions and use of post-fabrication galvanizers in road and rails are increasing.

Another source of demand growth in Indian zinc consumption will come from the country's agricultural sector. Following a mandate from the country's government that provides for an additional subsidy for the use of fertilizers containing zinc as a micro-nutrient, the consumption of zinc by the sector has climbed from just over 40kt in 2008 to 90kt in 2015. According to the International Zinc Association (IZA), some 80M hectares of Indian agricultural land are zinc deficient. This will support the increased production of zinc chemicals for use in fertilizer. The IZA estimates that the startup of a 16.5Kt/a plant in 2016, together with increased utilization rates at other plants, could result in the sector consuming 120kt of zinc units in 2016 it also estimates that market in India for zinc micronutrients could grow to 200kt/a.

Figure 3: Indian first use consumption



(Source: Wood Mackenzie Long Term Outlook)

The struggles of India's continuous galvanizers in overseas markets resulted in Indian zinc consumption contracting by 1.9% to 640kt in 2015. In 2016 and beyond as the slow but steady progress in upgrading India's infrastructure continues, zinc demand is forecast to rebound, growing by an average annual rate of 7.1% p.a. lifting consumption to 900kt in 2020. In the long term, growth is forecast to gradually moderate, however, at a compound average annual growth rate of 5.8% it will remain robust.

To address the cost escalation due to various factors, cost projection has been attempted on the proposed Mining plan duration.

1.2.5 PURPOSE OF THE EIA REPORT

The project proponent intended to obtain Environmental Clearance for the proposed expansion by submitting the EIA/EMP report based on model TOR provided by MoEF&CC. The work order to prepare the EIA report to undertake EIA and EMP preparation as per model Terms of Reference (ToR) prescribed by the MoEF&CC for assessing the impact of the proposed expansion of Lead-Zinc underground mine project production and construction of beneficiation plant activities, to obtain Environment Clearance from Ministry of Environment and Forests & Climate Change (MoEF&CC) Government of India, New Delhi.

The proposed expansion of mining project will require an Environmental Impact Assessment (EIA) study to be undertaken as per requirement of the EIA Notification 2006 and as amended, which notifies all mining projects having a mining lease area of 50 ha or more as **category A** under item **1(a) of the** EIA Notification 2006 and as amended.

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CHAPTER-2

PROJECT DESCRIPTION

2.1.1 Type of Project

The present proposal is for expansion of Lead – Zinc underground mine from 3.75 million TPA to 4.5 million TPA ore production and beneficiation from 4.25 million TPA to 5.0million TPA, of which 4.5million TPA ore will be from Sindesar Khurd underground mine and 0.5 million TPA ore from Bamnia Kalan underground Mine. The proposed will incur an incremental load of approx 20%. The ore concentrate produced shall be processed by the existing HZL smelters for refining of Lead & Zinc metal. The salient features of the project along with the proposed incremental load are elaborated in following Table no.1.

Table No.1 Salient features of the project

S. No.	Description	For 3.75 million TPA Mine & 4.25 million TPA Mill operation	For 4.5 million TPA Mine & 5.0 million TPA Mill operation	Incremental Load
1.	Mine lease area	199.8425 ha	199.8425 ha	NIL
2.	Land Requirement	148.84ha	148.84ha	NIL
3.	Ore mineral	Sphalerite & Galena	Sphalerite & Galena	--
4.	Established Depth	About 1160 m	About 1160 m	NIL
5.	Reserves & Resources	99.07 million tons 4.32% Zn, 2.58% Pb	106.88 million tons 4.52% Zn, 2.70% Pb	Approx 8 %
6.	Mode of Entry	By 2 Ramps&1 Production Shaft	By 2 Ramps&1 Production Shaft	--
7.	Method of Mining	Blast hole Stoping with filling		
8.	Ore Production	3.75mtpa	4.5 Mtpa	20%
9.	Ore Beneficiation	4.25mtpa	5.0Mtpa (including 0.5 Mtpa from Bamnia Kalan mine)	20%
10.	Waste Rock Generation	4.8 million cum	7.4 million cum*	55 %
11.	Waste dump area	8.0 ha	8.0 ha*	NIL
12.	Power requirement & Source	40.0 MW, Captive generation & AVVNL	40.0 MW, Captive generation & AVVNL	NIL

13.	Water requirement & Source	12000 m^3/day, STP Udaipur & Matrikundia dam	14000 m^3/day, STP Udaipur & Matrikundia dam	16.6%
14.	Manpower requirement (Nos.)	1500	1500	NIL
15.	Project Cost	Rs. 2240 Cr	Rs. 2980 Cr	740 Cr
16.	Environment Protection Cost	Rs. 165 Cr	Rs. 183.5 cr	18.5 Cr

*In the proposed expansion of SK Mine, no additional waste will be dumped on the surface beyond the approved waste quantity and hence no additional waste dump is envisaged. The increased waste generated will be disposed off into the underground voids.

2.1.2 Location

The Sindesar Khurd deposit is located 6 km NNE of Rajpura Dariba Mines in Relmagra Tehsil of Dist. Rajsamand, Rajasthan. The nearest connectivity details are given as under:-

- **Nearest Airport**- Dabok (Udaipur) at 49.19 km towards SSE from mine site and
- **Nearest Railway Station** - Bhupelsagar at 18.3 km on Chittorgarh-Udaipur broad gauge railway line towards WNW from mine site and
- **Nearest Bus Stand** Railmagra at 4.5 km towards NW from mine site
- **Nearest Highway** - 4 Lane State Highway (RJ SH-9).

The deposit forms a part of Rajpura-Dariba Bethumni metallogenic belt. The deposit is concealed at a depth below 120m from the general surface profile. Mining Lease is demarcated on part plan of Survey of India Toposheet No. 45/L1 and 45K/4. It lies between Latitudes 24°59'N-25°01'N and Longitudes: 74°09'E-74°10'E on Survey of India topo sheet No. 45/L1 and 45K/4.

Table 2: Latitude & Longitude of Lease Boundary Pillars

Lease pillar	Local Grid		Latitude			Longitude		
	Northing	Easting	Deg	Min	Sec	Deg	Min	Sec
A	5765.38	773.61	24	59	32.47	74	8	23.22
B	8426.15	848.25	25	0	58.98	74	8	25.28
C	8194.00	1568.49	25	0	51.57	74	8	51.03
G	7343.67	1568.49	25	0	23.94	74	8	51.22
H	7250.01	1800.29	25	0	20.94	74	8	59.51
I	6650.84	1831.69	25	0	1.47	74	9	0.77

J	6638.62	1481.85	25	0	1	74	8	48.29
K	5604.73	1299.66	24	59	27.35	74	8	42.02

Figure 1: Location Map

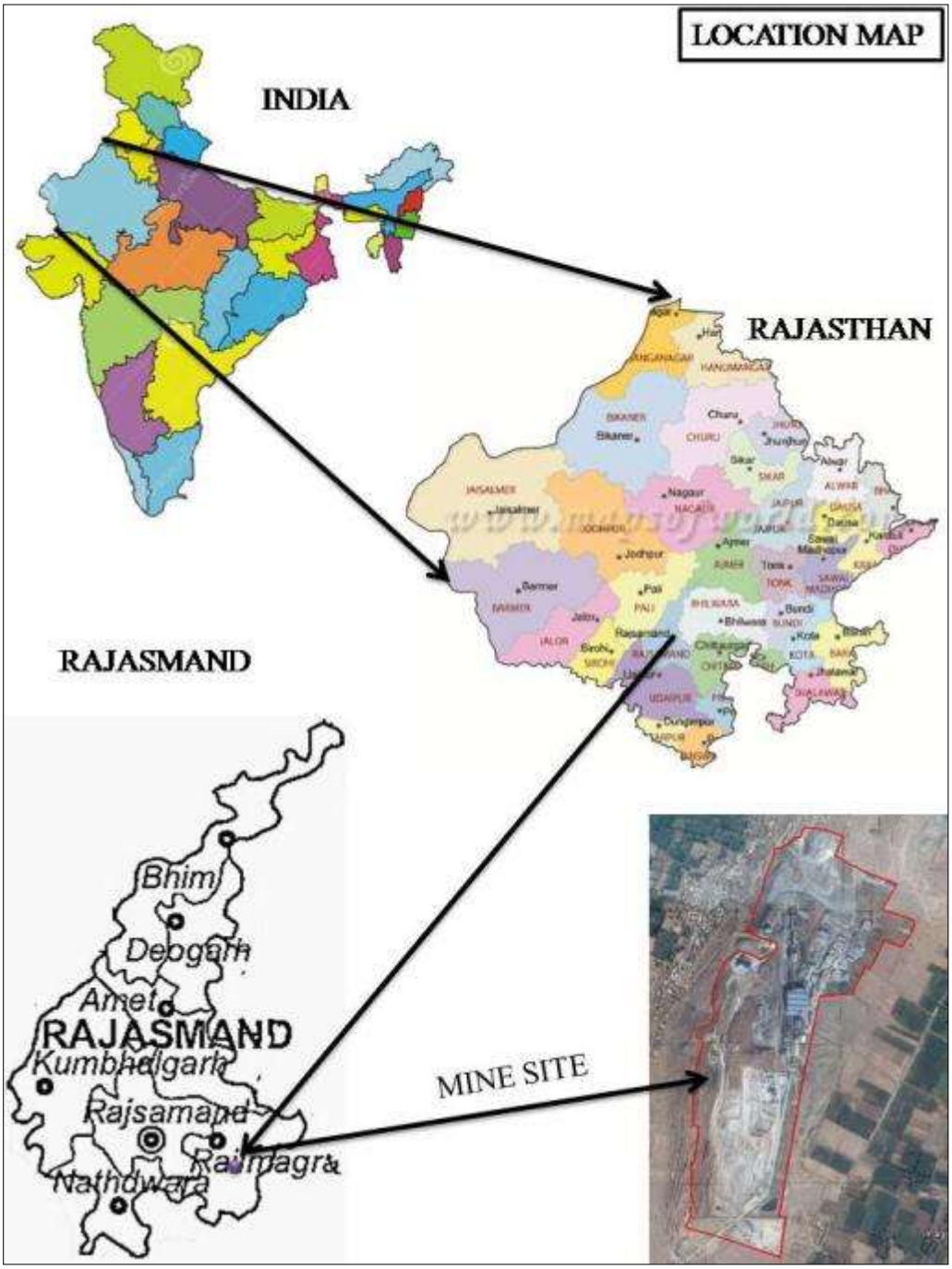
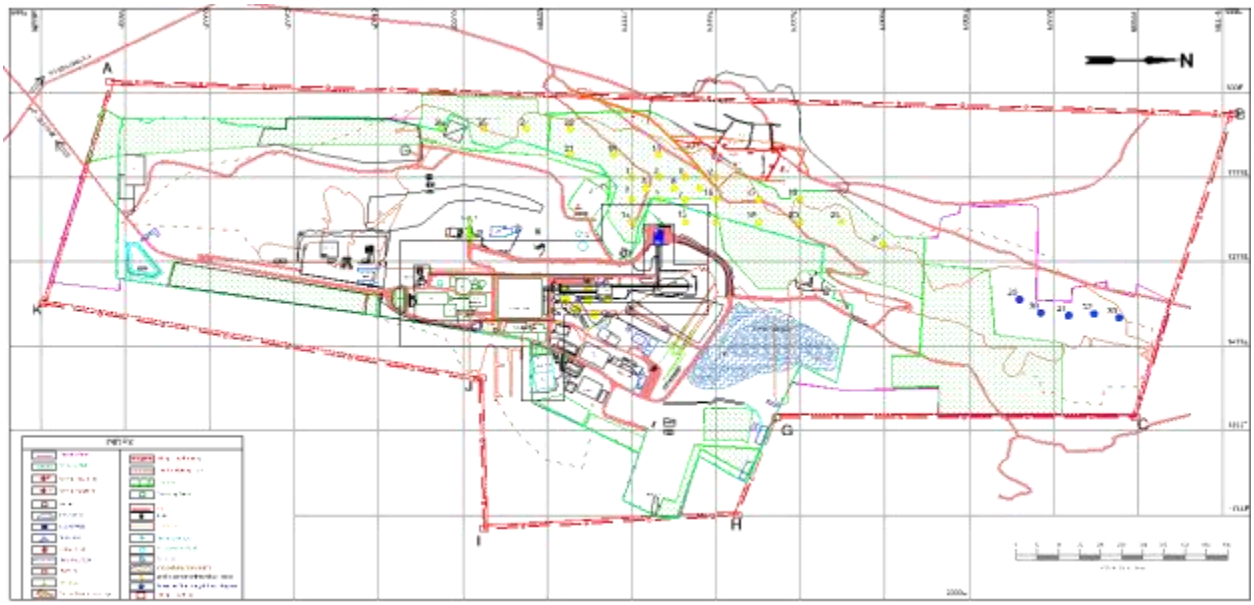


Figure 2: Surface Layout



2.1.3 Existing Land use pattern

Out of 199.8425 hectares lease area only 125.52 hectares is acquired for the mining. The breakup of lease and acquired area is as follows:

Table 3: The Breakup of Lease and Acquired Area

S. No.	Land Use	Mining Lease (ha)	Acquired Land (ha)
1	Irrigated agricultural land	20.6	0
2	Un-irrigated agricultural land	18.4	0
3	Grazing land	6.5	0
4	Settlement	5.5	0
5	Barren land	148.84	125.52
6	Forest land	0	0
7	Water-bodies	0	0
8	Protected areas	0	0
	Total	**199.84**	**125.52***

*remaining 23.32 Ha Govt. land under allotment

The topography of area is generally gently sloping (about 500mRL) against which the NNE-SSW trending ridges of Sindesar hill attain a maximum elevation of 567.48mRL near Dhunimata. The mining activity is restricted to a limited area due to underground mining, mostly in ridge area.

Out of the acquired area, currently 77.2 ha land under use, it is proposed to bring additional 51.8 hectares in to use for proposed expansion as per earlier EC for SK Mine. Total construction is on hilly

terrain which is rocky area and does not have any top soil. The water drainage is towards hill slope which joins small ponds located in the nearby area. The study area within 10 km comprises of ephemeral Banas River with its bed at 485mRL, flows 6km north of the deposit. There is no other major river in the study area.

The existing land in use and proposed land use in the acquired area within the mining lease is shown under.

Table 41: Land Use in Acquired Area

S. No.	Particular	Existing Area (ha)	For 3.75 million TPA Mine & 4.25 million TPA Mill operation Area (ha)	For 4.5 million TPA Mine & 5.0 million TPA Mill operation Area (ha)
1	Beneficiation Plant	12	26	No change
2	Ore Stock Yard	5	15	No change
3	Concentrate Yard	2	4	No change
4	Waste Dump	4.2	8	No change
5	Utilities	8	26	No change
6	Plantation Area	46	50	No change
7	Open Area	48.32	19.84	No change
Grand Total		**125.52**	**148.84**	**148.84**

2.3 GEOLOGY

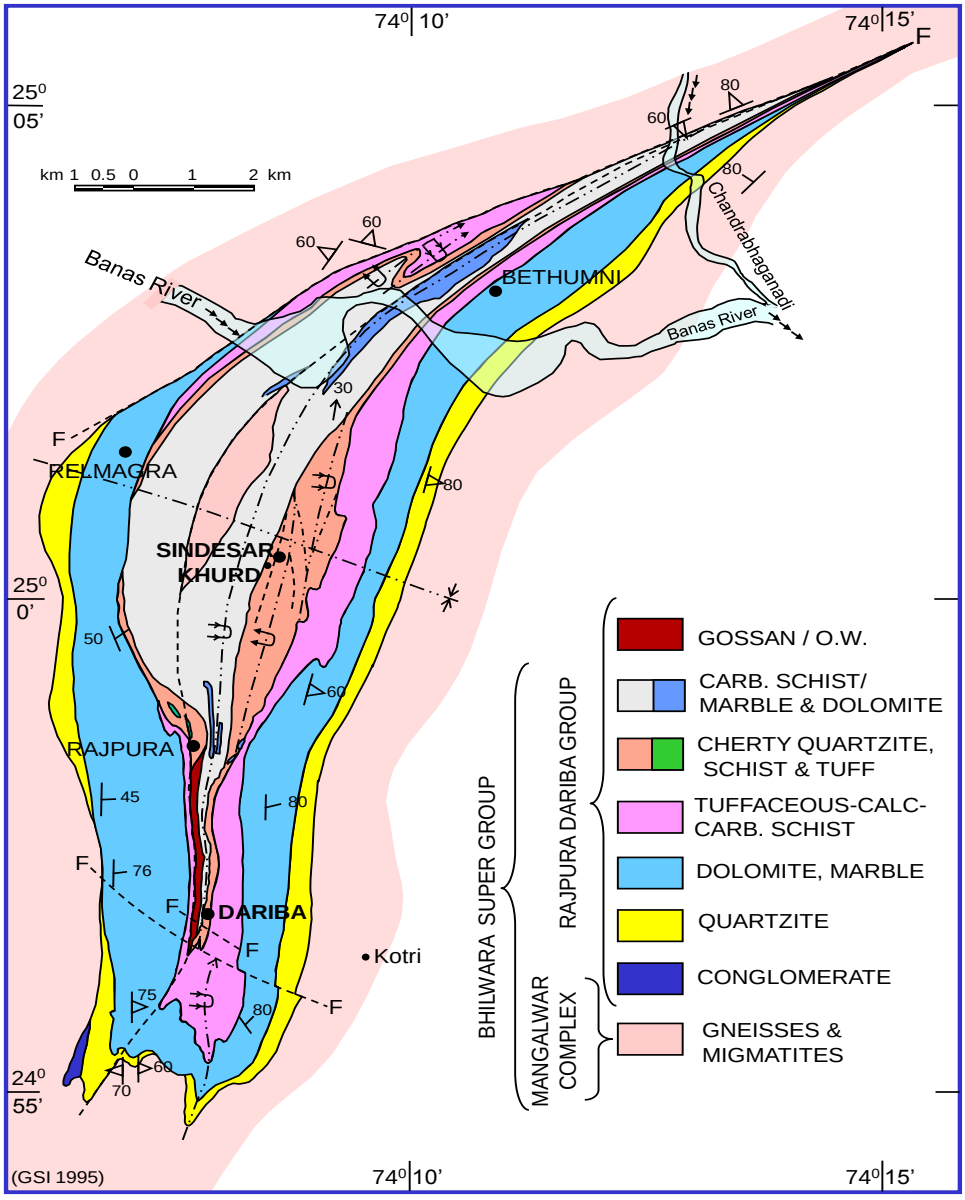
Dariba-Bethumni metallogenic belt comprises an assemblage of medium to high-grade metamorphic equivalents of orthoquartzites, carbonates and carbonaceous facies rocks belonging to Bhilwara Super-Group (3.5-2.5Ga) and extends for about 19 km in north-south direction. This cover sequence is underlain by basement rocks (gneisses and schists) of Mangalwar Complex. The geology of the area is summarized in following table (Table-5, Figure-2.

Table 5: Summarized Geological Succession

Era	Age	Super Group	Group/ Formations	Rock Types
Quaternary	Sub-Recent to Recent	Fluvial & Colluvium	Alluvium	Sand, silt, clays, graveletc
Unconformity				
Intrusives				Pegmatites, quartz Veins.

	Bhilwara super group	Rajpura-/ Dariba group	Dolomitic marble, Graphitic kyaniteschists,quartzites,
Archaeans		Mangalwar Complex	Migmatite, gneiss, mica, schsits,quartzites
		Banded gneissic complex	Gneisses , schists, etc.

Figure 3: Regional Geological Map (GSI) of Dariba-Bethumni Mineralised Belt



The structure of the belt is as an isoclinal fold (GSI, 1990) having synformal closure at Dariba in south (steep plunge 55°-60° towards ENE) and antiformal closure (shallow plunge 15°-20° towards NE).at Bethumni in north. The rocks have suffered at least three phases of deformation resulting in culminations and depressions.

The regional trend of the formations veers from N-S between Dariba and Rajpura in the south, to N15°E-S15°W between SindesarKhurd and Sindesar Kalan in the middle and finally to N50°E-S50°W around Bethumni in the north. The rocks generally show moderate to steep dips towards E/SE.

Base metal deposits of various sizes and grades occur throughout the belt in calc-silicate bearing dolomite and graphite mica schist horizons, the latter in general containing low grade disseminated sulphides of large volumes. At the south end of the belt in particular, contains multi-metallic sulpho- salt association.

Mineralisation exhibits lithological, stratigraphic and structural controls and occurs in the form of fracture-filling veins, stringers and disseminations forming tabular to lenticular ore bodies

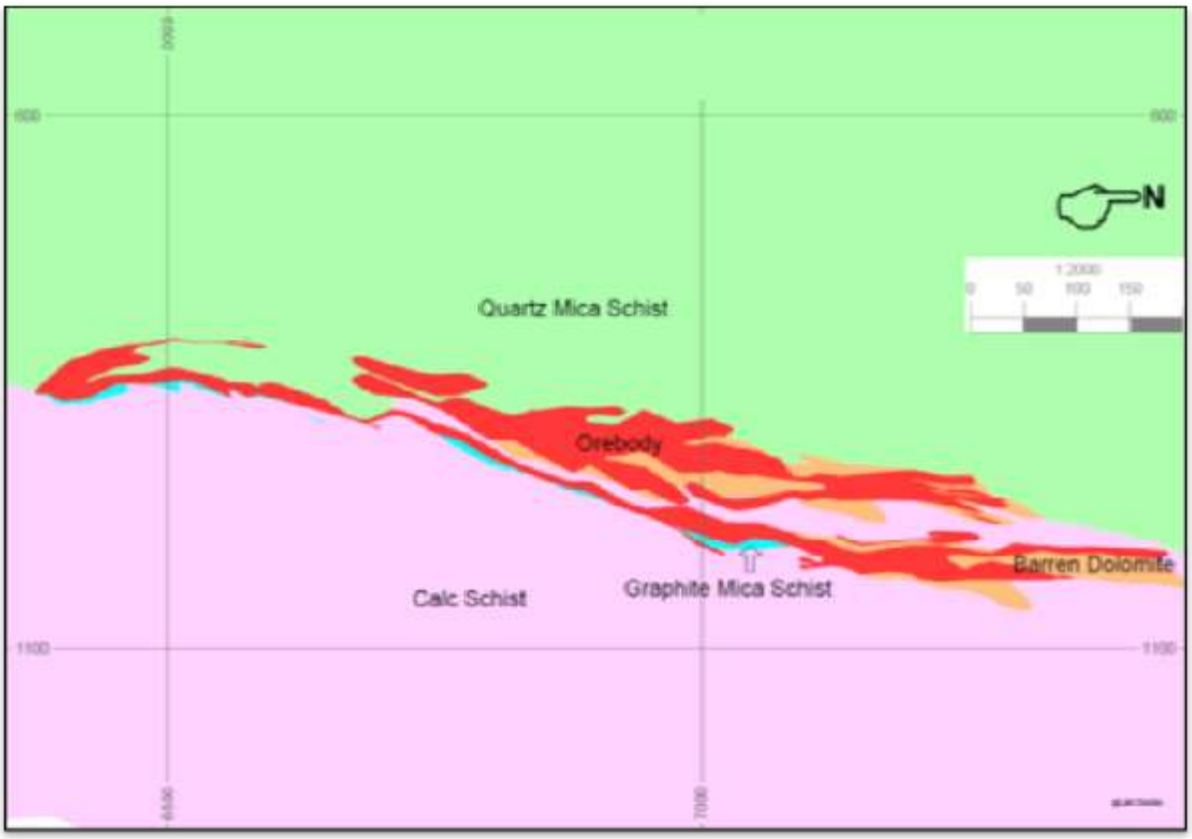
The assemblage of metamorphic minerals suggests that the area has undergone medium to high grade regional metamorphism up to amphibolite facies.

2.4 ORE BODY AND ITS BEHAVIOR

The mineralisation forms the western limb of a concealed NNE-SSW trending broad, open and asymmetric anti formal fold with sub-horizontal to gently northerly plunging fold axis. The upper limit of mineralisation lies at a depth of about 100m below surface. The recent exploration from surface within leasehold between 5700 – 8200N, revealed the continuity of mineralisation in the southern extension. Besides main lens, 15 auxiliary lenses have also been delineated (figure 6). The ore bodies dip westerly in the upper part (up to 200 mRL) and dip changes to steep easterly in the lower part thereafter. The ore body has been proved up to -800 mRL level. The ore body lies close to the contact of quartz mica schist envelope with dolomite/ graphite schist.

The general strike of the ore body is N10°E to N15°E while dips vary from 45° to 60° towards west and in deeper levels steep easterly. Pinching and swelling is also observed in the ore body. The thick footwall barren dolomite, occurring east of mineralisation along the strike, is sparsely mineralised. Average width of the main ore body is about 30 m and shows remarkable variation both along strike and dip. The ore body is open at a depth of 1200 m below surface in the southern extremity of leasehold.

Figure 4: Typical Orebody Plan



2.5 RESERVES & RESOURCE AS PER UNFC CLASSIFICATION

Sindesar khurd deposit is well established for mineral presence on the basis of surface exploration carried out by GSI, MECL & Hindustan Zinc Limited. The potential deposits are well outlined and are under active extraction by underground mining. Therefore, up-gradation of reserves & resource requires extensive underground exploration. However, surface exploration is also applied to find depth potential of already established ore bodies and satellite lenses exist around the main lense. To carry out underground exploration the deposit has been divided on 25mX15m horizontal & vertical grids and all exploration data is collected on these grids to decipher geological parameters in 3D. All data is electronically translated and is being used to create ore body model & mine designing using Datamine software.

Based on exploration drilling from surface and underground the ore reserves and resource computed on 01-04-2016 stand at 106.88 million tonnes with 2.70% Pb, 4.52% Zn.

Table 6: Resource and Reserve

Classification	UNFC Code	Quantity(in million tonnes)	Grade (As per NMI grades as indicated in the mining plan)
Total Mineable Reserve		78.73	
Total Mineral Resources (A + B)		106.88	2.70%Pb, 4.52%ZN, 140 Ag (g/t)
A. Mineral Reserve			
1. Proved Mineral Reserve	111	7.89	2.85%Pb, 4.93%ZN, 157 Ag (g/t)
2. Probable Mineral Reserve	121 and 122	22.70	3.91%Pb, 5.59%ZN, 235Ag (g/t)
B. Remaining Resources			
3. Measured Mineral Resource	331	5.04	2.78%Pb, 5.43%ZN, 151Ag (g/t)
4. Indicated Mineral Resource	332	18.55	2.81%Pb, 4.51%ZN, 134Ag (g/t)
5. Inferred Mineral Resource	333	52.70	2.11%Pb, 3.92%ZN, 98Ag (g/t)

For projecting reserves for conceptual production for long term planning, Measured (331) & Indicated (332) are considered 70% recoverable whereas inferred (333) are considered 60% recoverable, total mineable reserves available for mining will be about 78.73 million tonnes sufficient for till lease period.

2.6 MINING

a. Underground Mining

The deposit is concealed 100m below the surface and thus amenable to underground mining only. The deposit is shallow seated and hence initial feasibility study was carried out for mode of entry and mining method. Due to shallow depth of deposit and low cost of production with decline mining by trackless operations, it was decided to open North decline/ramp for ore production with secondary access via incline. Further, with expansion of mining operation, south decline/ramp was developed to add to ore production capacity.

Mine is having nine openings with two Ramps, six ventilation Raises & one Incline. North Ramp & South Ramp (5.5m x 5.0m, 1 in 7 gradient) are suitable to deploy 30t/50t/60t/63t mine truck & 7t/10t/17t/21t LHDs.

Table 7: List of Primary entries to Mine

S. No	Primary entry	Location	HFL	Current Extent
1	North Ramp (Gradient 1 in 7)	7117N & 512mRL	484mRL	15mRL
2	South Ramp (Gradient 1 in 7)	6615N & 521mRL	484mRL	27mRL
3	Incline (30˚ dip)	6900N & 511.5mRL	484mRL	286mRL

Table 8: List of Ventilation Raises

S. No	Ventilation Raise	Nature	Location	Current Extent	Capacity
1	Central ventilation raise (CVR)-2	Intake Raise	6775N	65mRL	
2	SKA8 Raise	Intake Raise	6999N	375mRL	
3	North ventilation Raise (NVR)	Return Raise	7425N	130mRL	200 cum/sec
4	Central Ventilation Raise (CVR)-1	Return Raise	6795N	100mRL	100 cum/sec
5	South Ventilation Raise (SVR)	Return Raise	6525N	180mRL	233 cum/sec
6	SKA2 exhaust raise	Return Raise	7500N	215mRL	150 cum/sec

The present three primary entries, Ramps and incline, to the deposit cater the following services/ requirements:

- Hauling mined out ore/waste from underground to surface.
- Provides access for men & material to mine.
- Provide intake & return for ventilating air.
- Supply of mine services like power, compressed air, drilling water, drinking water and dewatering supply line etc.

The mine has currently six active mining blocks as described below:

1. 425-315mRL block: Strike 6737.5N- 7590N, Open Stopes BH1 to BH11, N1-N2 and Main Levels developed are 425mRL, 400mRL, 375mRL, 350mRL and 315mRL. The ore body in this block is divided into 14 Open stopes with 13 intervening rib pillars. The stopes have strike length between 30m to 70m while the rib pillars are 10m to 20m thick based on numerical modeling study.

2. 290-215mRL block: Strike 6686N-7710N, Primary Stopes P1 to P15, Secondary Stopes S1 to S13 and Main levels developed are 290mRL, 265mRL, 240mRL and 215mRL.The Primary stopes have strike length of 20m to 38m while the Secondary stopes have strike length of 25m based on numerical modeling study.

3. 195-160mRL block (‘A’ Block): Strike 6420N-7455N, Primary Stopes AP1 to AP16, Secondary Stopes AS1 to AS15 and Main levels developed are 195mRL and 160mRL.The Primary stopes have strike length of 45m to 70m while the Secondary stopes have strike length of 10-12m based on numerical modeling study.

4. SKA8 block: Strike 6825N-6950N, Primary Stopes 8P1 to 8P3 between 400mRL and 375mRL.

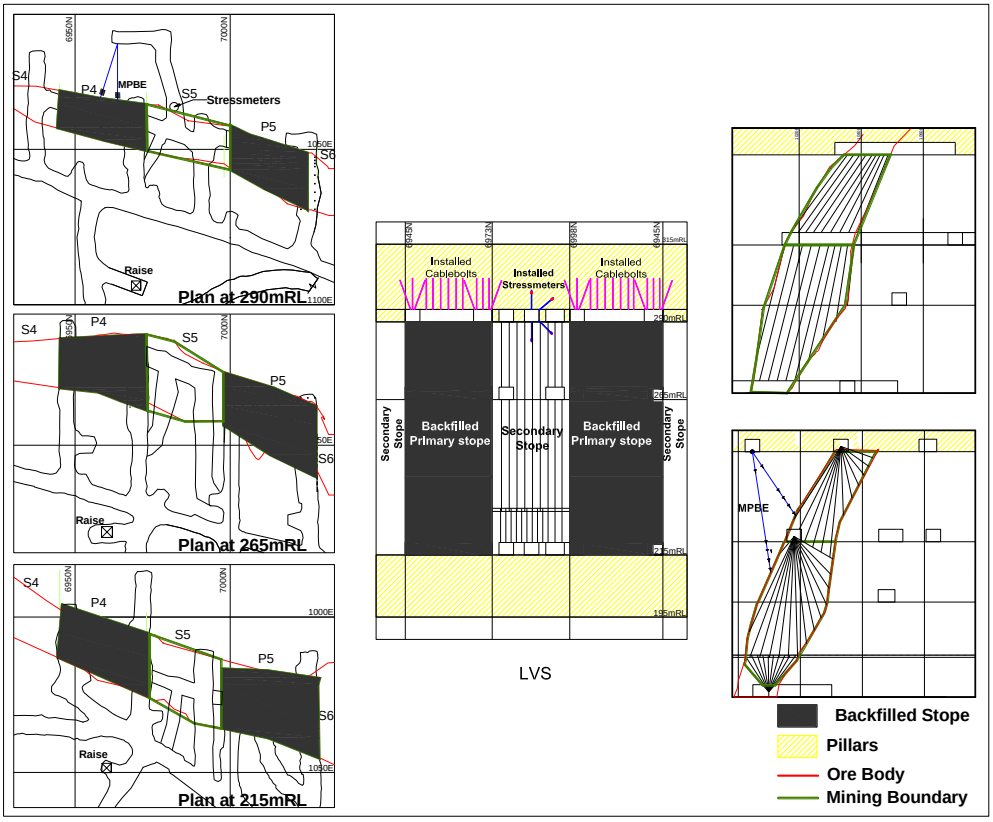
5. 130-15mRL block (‘B’ Block): Strike 6680N-7170N, Primary Stopes BP1 to BP7, Secondary stopes BS1 to BS7 between 130mRL to 15mRL. All primary and secondary stopes have 35m strike length.

6. SKA2 block: Strike 7829N-8234N, Primary Stopes 2P01 to 2P07 and Secondary stopes 2S01 to 2S06 between 300mRL and 215mRL.Primary stopes are 43m to 45m wide along strike and secondary stopes have 15m to 18m strike length.

2.6.1 Method and sequence of stoping

The orebody dips varies from shallow to moderate in all the mining blocks. The ore body configuration & geotechnical parameters of orebody & wall rocks are favourable for adoption of open stoping method as well as open stoping with post filling. As such, blast hole open stoping method has been adopted for extraction of ore in upper block and in lower blocks blast hole stoping with post filling in primary/ secondary sequence to maximize ore recovery. RMR is good to fair. Central Institute of Mining & Fuel Research (CIMFR) has been engaged to carry out ground stability analysis independently to find out possibility of any sort of physical disturbance of the ground surface in the mining area due to the underground mining.

Figure 5: Location Map



Stopes are being mined using EHS drilling (64mm) for trough drilling at extraction level and DTH/ITH (115mm)/ EHS drill machines (102/89mm) holes for down drilling from upper level. Blasting is done against a slot raise. For preparation of slot at each level in the mining block, a cross cut is developed first across the strike of the ore in full width of the orebody from footwall to hanging wall and later stripped to 6m width. A raise is opened from lower level to drill level by

drop raising technique. Subsequently parallel holes are blasted against this raise for making a slot over the width of ore body. This slot provides free face for subsequent blasting of drill rings.

After the stopes are mined out, stopes are back filled and thereafter secondary stopes / rib pillars are mined out, in case mining is feasible.

2.6.1 Mucking and Haulage

As blasting progresses, the stopes will be emptied of broken ore using 7t/10t/17t/21t capacity diesel LHD. Remote control operation of the LHD will be used to recover ore from the hanging wall side of the slot area at the final clean up stage. For rest of the stope area complete ore is recovered from the trough drives and cross cuts.

The ore will be directly loaded into 30t/50t/60t/63t LPDTs through 7t/10t/17t/21t LHDs. Ore will be hauled out through both the ramps to surface stock pile. Run of mine from stockpile is fed to the primary crusher for ore treatment after secondary breaking. The waste from underground will be either transported to surface or disposed off in void stopes as per requirement.

2.6.2 Filling System

Back filling of stope voids will help increase the extraction of the orebody and stabilize the mining areas. This will be achieved by filling the mined out voids with tailings and adequate cement/binder(Hydraulic filling & Paste Filling) &cemented rock fill to allow extraction of pillars and adjacent secondary panels.

Cemented Rock fill or hydraulic fill or paste fill are to be used as per back filling requirement to ensure stability of mine and to meet the back filling requirement of the mine.

Cemented Rock Fill: It is proposed tobackfill the stopes, using cemented rock fill. In this process, waste rock is mixed with the cement and poured into the stope.

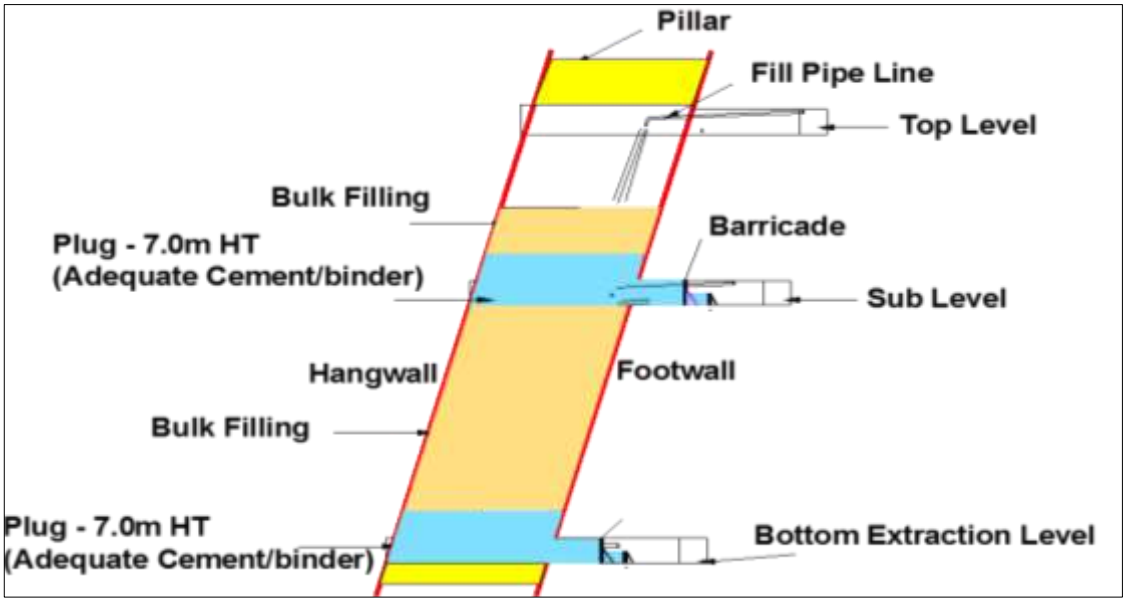
Hydraulic Fill: Tailings from floatation stream will be fed hydro cyclones, where classification takes place and fine size overflow fed to *HRT* tailing thickener, after recovery of water the underflow of tailing thickener is withdrawn at 50-60% solids and sent to tailing dam by pumping in tailing lines. The recovered water will be recycled and used in plant to maintain zero discharge. The Coarser cyclone under flow is being collected in Fill Storage Tank and after cement addition and mixing at around 60% solids pumped in bore hole for mine back fill.

Paste Fill: The plant tailing generated is pumped to paste thickener. The underflow of paste thickener will be fed to the disc filters. The filter cake along with cement will be fed to the mixer unit and paste will be produced. The paste fed to underground reticulation system in mined out stopes.

Paste filling has been commissioned and in operation. Paste fill is defined as dewatered tailings that are non-segregating in nature and bleed little or no water. Paste does not segregate during low velocity transport, making its conveyance through pipes practical.

Paste fill is placed with adequate cement/binder slump to minimize pressure losses in the pipes and maximize the final paste strength.

Figure 6: Typical filling system layout



The paste fill plant process circuit will consist of dewatering of the tails slurry in a conventional thickener to 50 to 60% by weight. The product is further dewatered in a disc filtration plant to produce a wet filter cake comprising of 80-85% solids. Batches of this filter cake are then mixed in a high intensity shear mixture with water and cement/binder as required to make a consistent paste product. The required fill strength is 1000kPa. To achieve the proposed design strength adequate cement/binders will be added.

The paste will be conveyed in the mine through directly dropping into paste holes or pumping to destination. Paste backfill will be reticulated underground from surface plant as shown under.

The paste reticulation system would use main levels as the main conduit for the steel and HDPE paste pipes. From the main levels the paste will be reticulated down the central line of each ramp between the sublevel accesses. Each access will have a cut out to receive the paste pipe from above

and this pipe will enter the floor of the same cut out to be sent to the sublevel below. It would be from these cut outs that paste would be directed to fill stopes. Paste would be poured into stopes sealed off with barricades made from timber, concrete blocks or shotcrete and mesh.

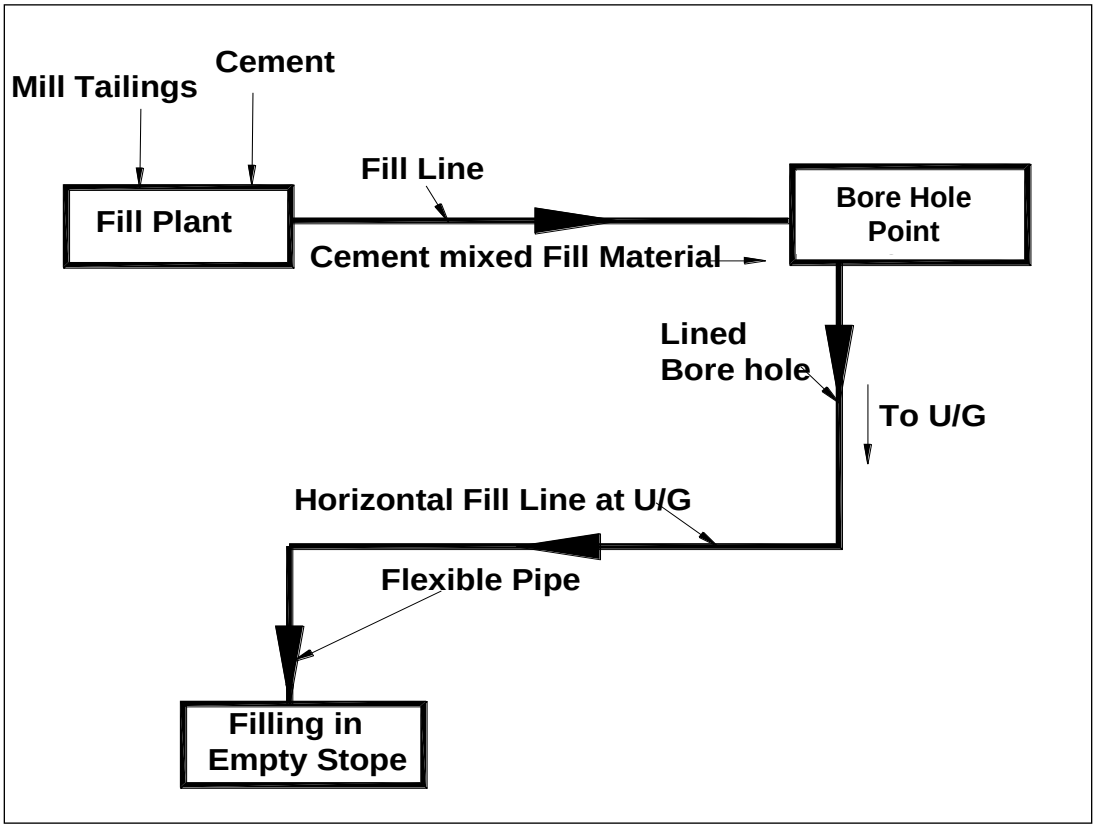


Figure 7: Schematic Flowsheet of Backfilling

2.9 EXTENT OF MECHANIZATION

The mine development is being carried out using combination of drill jumbo and LHD. In stopes, for production drilling Electro hydraulic Solo, V-30 and ITH drill machines are being used. For mucking diesel LHDs are being deployed. The ore is mainly transported to surface through ramp by diesel LPDT's (Low Profile Dump Trucks). The ore after breaking on surface is loaded into dumpers and transported to beneficiation plant. For enhancement of mine production, additional major mine equipments will be required. The status of existing and proposed mine equipment is illustrated in Table below:

S. No.	Particulars	Capacity
1	LPDT (63t/60t/ 50t/30t/ 20t)	63t/60t/50t/30t/20t payload
2	LHD (21t/ 17t/ 10t/ 7t)	21t/17t/10t/7t payload
3	Drill Jumbo	32-45mm ϕ holes
4	Electro Hydraulic Drill	64-102mm ϕ holes
5	ITH Production Drills	102-165mm ϕ holes
6	Main Ventilation fans	100-233cum/sec
7	Pumps	50-100cum/hr
8	Skip Winder	4400kW (30t payload)
9	Cage Winder	800kW (80 persons capacity)
10	Road Grader	Maintaining haul roads
11	Rock Bolter	32-38mm
12	Mobile Carrier Exploration Rig	38mm
13	V30 Slot Raising Drill Rig	115mm-760mm
14	Charmec	For mechanized charging
15	Scaler	For loose scaling
16	Personnel Carrier	16 & 32 persons
17	Lifting Equipment	3000 kg
18	Light Motor Vehicles	5 persons
19	Explosive Carriers	3.9t
20	Water Sprinkler	3.0 cum
21	Compressors	1000cfm-2500cfm

Underground maintenance workshop is fully functional and located at 254 mRL, maintenance of Jumbos is being done in underground.

2.10 Mine Ventilation

A detailed study of ventilation requirement of future expanded mine to determine fan and airways sizes have been carried out with the following assumptions:

- Population of major mining equipment
- Air requirement for diesel emission dilution

- Use of 30t/50t/60t/63t diesel LPDT
- Use of 7t/10t/17t/21t diesel LHD

Currently the mine is ventilated through North Ventilation Raise(NVR) at 7425N and South Ventilation Raise(SVR) at 6525N as main exhaust raises where the main ventilation fan of 630kW of the capacity 200 m3/ sec and with ventilation fan of 1500kW of the capacity 233 m3/ sec respectively. Central ventilation raise at 6770N is also equipped with 100m3/sec each to supplement the mine ventilation. Main levels 400, 350, 315, 290, 265, 240, 215, 195, 160mRL are connected with NVR and 135, 100mRL, 65mRL are connected with SVR & partially ventilated by NVR and CVR facilitates SKA6 and main levels 375, 290, 265 and 215mRL. SKA2 lens is being ventilated through a 630kW fan with capacity of 150 m3/ sec. South Ventilation Raise-2 & South extreme raise will be raise bored from surface to 135mRL and will be equipped with 1500kW fans respectively to facilitate lower blocks.

South ramp, North ramp & an incline and two raise bored raises (surface to underground) acts as intake airway for mine. The air is routed through these entries. Auxiliary fans are installed on development headings to provide ventilation on blind faces. Air is routed through regulators, doors and stoppings at different locations as per requirement.

Adequacy of Ventilation: At the full production rate, maximum total primary air requirement has been estimated to be approximately 1000m³/sec

At present the incline, ramps and raises from surface are the main intake of fresh air for the mine. The ventilation raises at 7425N is equipped with a fan of 200m3/sec capacity and the ventilation raise at 6525N is equipped with a fan of 233m3/sec serves as main exhaust systems. At main levels air control gates have been installed for proper and effective ventilation.

To augment the mine ventilation an additional raise 6525N South ventilation raise-2 of 3.5m diameter at southern extremity of ore body from surface to 135mRL level. In the existing 425-300mRL block, NVR is duplicated to reduce friction losses. When the mine is fully developed, the SER (South Extension Raise), NVR & SVR and SVR-1 will be main exhaust raises and CVR, ramps, shaft etc will work as main intake for the mine. High capacity exhaust fans will be installed on the top of these raises. The combined capacity of all these fans will be about 1000m3/sec.These raises will be developed along with the development of mine to cater the ventilation requirement of the mine.

During mine development auxiliary ventilation system will be used. Additional auxiliary ventilators are provided at the working faces for adequate supply of air in all parts of the mine and prevention of noxious gases produced and excessive rise of temperature or humidity to ensure required ventilation of the mine.

2.11 BENEFICIATION PLANT DETAILS

The existing beneficiation plant capacity installed at the site is 2.75 million TPA and a new beneficiation plant for which EC has been obtained of capacity 1.5 million TPA is under construction with specifications similar to existing plant. The existing plant and under construction plant has the capacity to cater the additional proposed capacity of 0.0.25mTPA & 0.5mTPA respectively. Thus, final beneficiation capacity will be 5.0 mTPA.

The ROM ore from the mine is being dumped into primary crusher. After primary crushing, the ore is being stacked at coarse ore stockpile.

The Plant includes following sub-sections:

1. Crushing & screening section
2. Grinding section
3. Lead flotation section
4. Zinc flotation & regrinding section
5. Lead & zinc concentrate thickening & filtration section
6. Tailing Thickener, dewatering & disposal.
7. Reagent section

2.11.1 Crushing & screening section

Run-of-mine (ROM) ore is dumped into a hopper ahead of the primary gyratory crusher. The crusher reduces ROM ore to approximately -150mm size. Crushed ore is transported to the coarse ore stockpile by a belt conveyor. The belt conveyor is provided with belt weigher to get record & control the amount of ore transported.

The primary crusher house (PCH) has been provided with dust suppression system where water is being added in mist form at different points to suppress dust.

The primary crushed ore from COSP (Coarse Ore Stock Pile) is fed to double deck scalping screen. Oversize of this screen is fed to the secondary crusher. The intermediate product is being fed to the secondary crusher product conveyor. Screen under size is fed to fine ore bins through belt conveyors. Secondary crusher output is fed to a tertiary crusher. The material from tertiary silo bin is being fed to two tertiary crushers. Tertiary screen undersize sent to fine ore bins. Tertiary screen over size is fed to tertiary crushers. Tertiary crusher output recycled back to tertiary screen & crusher.

A wet type dust extraction system provided in COSP tunnel, Secondary & tertiary. Crusher house and Fine Ore Bin (FOB) to remove fugitive dust at dust generation points. Dust slurry pumped to the grinding circuit.

2.11.2 Grinding section

The fine ore of P80 20mm size from FOB. Extracted by belt feeders and fed to the Rod mill by feed conveyors. The mill feed conveyor provided with a belt weigher to measure the ore treatment.

1st stage grinding carried out in a Rod mill in open circuit & 2nd stage grinding carried out in a Ball mill in closed circuit with hydro cyclone classification system. The rod mill and ball mill product discharge in a common sump and pumped to the cyclone cluster from where underflow return to ball mill and the overflow from cyclone cluster constitute feed to the flotation circuit. During operation, process parameters have been adjusted to produce anMesh Off Grind (MOG) of 80% passing 75 micron.

Control of cyclone overflow particle size through PSI (Particle Size In-stream analyser): PSI will measure the 80% passing size o cyclones o/f which is ideally be 75micron. If PSI detects that the cyclone o/f 80% passing is below 75 micron, it will increase the speed of belt feeder below FOB to add more ore in rod mill feed. Vice versa, if PSI detects that the cyclone o/f 80% passing is coarser than 75micron, it will decrease the speed of belt feeder below FOB to lower the feed in rod mill.

2.11.3 Lead flotation section

The lead flotation stream comprise of conditioning, roughing, scavenging and 3-stages of cleaning. The hydrocyclones overflow from the grinding along with the lead scavenger concentrate & lead 1st cleaner tails conditioned with reagents in a conditioner and subjected to flotation in lead rougher scavenger bank. The rougher concentrate is being cleaned in 3 stages of lead cleaners. The lead rougher concentrate fed to the 1st cleaner cells. The concentrate from the 1st cleaner shall be pumped to the 2nd stage flotation cells and the concentrate from the 2nd stage cleaners shall be fed to the 3rd cleaner flotation cells. The 3rd stage cleaner concentrate is the final lead concentrate.

2.11.4 Zinc flotation & regrinding section

The Zinc flotation section treating lead scavenger tails from the lead flotation circuit shall comprise of conditioning, roughing, scavenging, 3 stages of cleaning and regrinding. The lead scavenger tails along with the reground Zinc scavenger concentrate and Zinc Cleaner-1 tailings has been conditioned with reagents in two stages of conditioning and subjected to flotation in Zinc rougher-scavenger banks of cells. The zinc rougher concentrate fed to the 1st cleaner cells. The concentrate from the 1st cleaner pumped to the 2nd stage flotation cells and the concentrate from the 2nd stage cleaners fed to the 3rd cleaner flotation cells. The 3rd stage cleaner concentrate shall be the final zinc concentrate.

2.11.5 Lead & zinc concentrate thickening & filtration section

Lead and zinc concentrates sent to their respective high rate thickeners installed each for lead concentrate & zinc concentrate generated from the plant.

The underflow of Lead and Zinc thickeners pumped to their respective holding tanks.

Overflow from lead thickener collected in suitable tank which will have at least one partition to take out sedimented lead in overflow coming from lead high rate thickener. The partition has suitable drain arrangement with drain valve from where the deposited lead shall be collected from time to time. The lead thickener overflow pump shall discharge to main process water tank i.e. tailing thickener o/f tank.

Overflow from zinc thickener collected in suitable tanks which will have at least two partitions to take out sedimented zinc in overflow coming from zinc high rate thickener. The partitions have suitable drain arrangement with drain valve from where the deposited zinc collected from time to time. The zinc thickener overflow pump gives discharge to zinc circuit in floatation area. There is suitable flocculent system for thickeners.

2.11.6 Tailing dewatering and disposal

Tailing dewatering & disposal section comprise of tailing thickener, neutralization tank, pumping of tailing to tailing pond/dam and reclaimed water pumping.

There are three tailing disposal lines each capable of handling the tailing generated from 1.13mtpa plant capacity. The two tailing lines are in operation while one in standby mode.

Water is being reclaimed from tailing pond and pumped back to process water tank (i.e. tailing thickener o/f tank). Makeup water is fed from the 2000- cum reservoir to process water tank by gravity and zinc thickener o/f tank.

2.11.7 Reagent section

Reagents Zinc Sulphate (ZnSO4), Sodium Isopropyl Xenthates (SIPX), Sodium Cyanide (NaCN), Copper Sulphate (CuSO4), Methyl isobutyl carbinol (MIBC), Aero3410, Nigrosine and lime are used in the main process plant. The reagent system comprise of preparation tank, storage tank & day tank. There are agitators in the preparation & storage tanks.

For all reagents being supplied from day tanks, there are two pumps (1 op + 1standby). MIBC does not require preparation.

All reagents are added at required points at the required dosages in the flotation circuits by use of flow meter and control valve in closed loop. There are suitable metering types dosing pumps (8 op+ 2 standbys) for control of MIBC flow.

Lime slurry prepared in ground level sump pump and transferred to holding tank after suitable classification in cyclones to take out grits.

From the holding tank, the lime solution transferred to the lime distribution tanks. From this distribution tank, lime pumped through a ring main with return line to the respective addition points.

Table 2.11.1 List of Major Equipment's

S. No.	Particulars	Approved Equipment as per EC of 3.75 MTPA Mine & 4.25MTPA Mill	Addition
1	Primary Crusher	3	0
	Secondary crusher	2	0
	Tertiary crusher	4	0
2	Rod Mill	4	0
3	Ball Mill	4	0
4	Flotation Streams	4	0
5	Pressure Filter	8	0
6	Air Blower	5	0
7	Air Compressors	12	0
8	Thickeners	6	0

* No additional equipment is envisaged however it is proposed to debottleneck existing equipment of 4.25MTPA to upgrade up to 5.0MTPA

Salient features of Existing & Proposed Beneficiation Plant:

• A highly automated and instrumented process control has been envisaged in the beneficiation plant.

• On-line Stream Analysis System for measurement of elements concentration in slurries to control metal losses.

• Advanced Process Control operating system is designed to optimize, stabilize and control individual unit operations as well as the entire plant for optimum metal recovery.

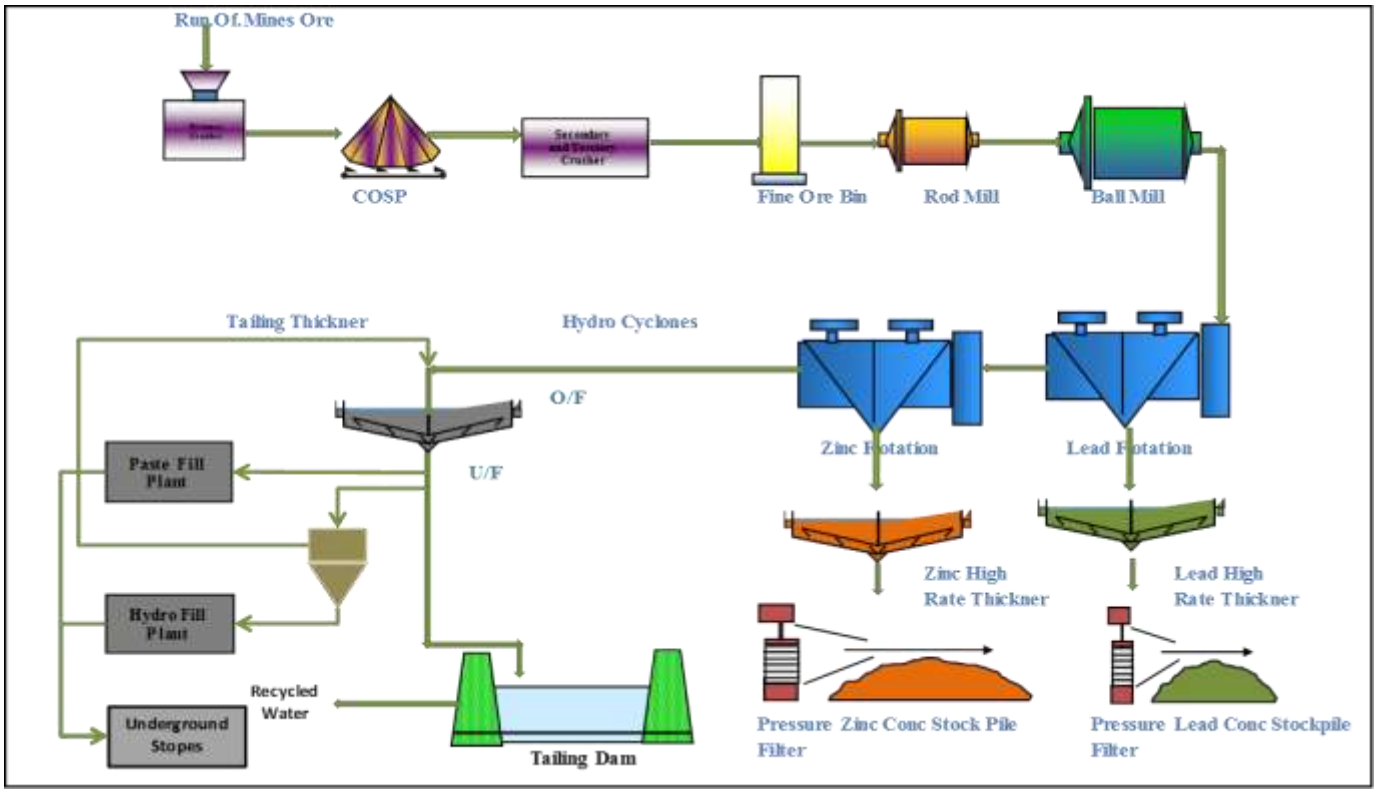
• Froth Camera System makes use of machine vision technologies to measure the speed of the froth.

• Particle Size Analyzer is a sizing system installed in grinding circuit for mineral slurries. It takes automatic samples from streams and measures their particle size distribution for liberation of minerals.

• Magnetic Pro flot system for fine particle recovery in zinc flotation.

• Any drive will be in running condition if all the start permissive conditions are simultaneously fulfilled.

Figure 8: Mill Flow Sheet



Currently, the tails from plant is being pumped to exiting tailing dam of Rajpura-Dariba mine through pipelines. It is also proposed to utilize 50% of the tailings in the stope backfill.

2.11.8 Chemical required

Reagents Zinc Sulphate, Sodium Iso Propyl Xanthate, Sodium Cyanide, Copper Sulphate, Methyl Iso Butyl Carbinol and AEROPHINE-3410 shall be used in the flotation process.

The Reagent categorize in three category based on their application in flotation Zinc Sulphate & Sodium Cyanide act as depressant for Zinc in Lead Flotation. Sodium Iso Propyl Xanthate act as collector for lead and zinc, Methyl Iso Butyl Carbinol act as surface modifier it gives stability to froth, Copper Sulphate act as activator in zinc flotation and aerophine 3410 use as silver promoter. The reagent pumping system will comprise of preparation tank, storage tank & day tank. There will be agitators in the preparation & storage tanks.

The required solution strengths for all of the reagents will be prepared in preparation tanks by addition of fresh water.

The main raw materials used for the project will be different chemicals and cement. The quantities of Chemicals in terms of grams per ton of ore treatment are as follows:

Chemical	Gram per ton
Copper Sulphate	350
Zinc Sulphate	150
Sodium Isopropyl Xenthates	60
MIBC	50
Sodium Cyanide	20
Nigrosine	25

All the raw material will be arranged indigenously and transported by road. The Run of Mine will be transported to beneficiation plant by dumpers and conveyor. The concentrate will be transported to own smelters by covered trucks/ dumpers.

2.12.1 Subsidence Control: Followings current practices are being used to control of the subsidence-

- CIMFR, Dhanbad & AMC Consultants, Australia carried out the study.
- Studies & Design Considerations
    - Intact surface cap of ~130m of quartzite/ quartz mica schist.
    - Determination of Geotechnical and Physico-mechanical properties.
    - Insitu stress gradient determined upto 1000m depth.
    - Stable stope geometry designs based on Geo tech studies and Insitu pillars of designed thickness are left.
- Conclusion
    - Empirical method & Non-linear numerical modeling with FLAC-3D for LOM design has confirmed that no mining induced surface subsidence is expected for this mine
    - Surface crown pillar has a FoS greater than 1.5 therefore, surface cap rock will be long term stable.
- Operations
    - Backfilling of stope voids with cemented tailings.
    - Reinforcement of crown using cable bolts.
- Monitoring & Control
    - Hangwall movement monitoring with Multi Point Bore Hole Extensometers.
    - Stress monitoring with Uniaxial Borehole Stressmeters in pillars.
    - Subsidence monitoring above stoping area at designated locations.

2.12.2 Blast Vibration Control: Followings current practices are being used to control of the Blast Vibration-

- Blast design parameters have been decided based on extensive studies carried out by CMIFR, who are also involved in validation/ analysis & monitoring on regular basis.
- Regular vibration monitoring at surface on fixed stations by standard seismographs.
- Determination of predictor equation.

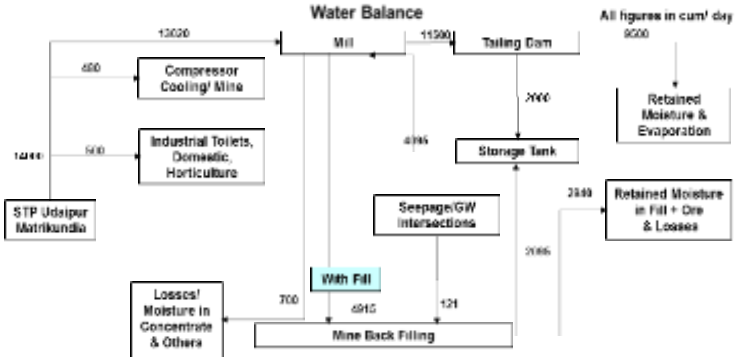
- Total charge and Maximum Charge per delay (MCPD) for each stope is decided based on its location derived from predictor equation.
- Use of Non electric/electronic detonator.
- Quality drilling and charge per delay optimized as per design.
- Ground vibrations are kept within statutory limits.

2.12.3 Traffic Management: Due to proposed expansion in the Mine & Mill production, traffic will be increased marginally. As the road condition is very good as per IRC Guidelines, so post expansion will have minimal impact on the current traffic as most of the traffic will be restricted between SK mine and Dariba complex and to the tailing dam to some extent.

2.13 UTILITIES REQUIRED

2.13.1 Water

Fresh water required for the proposed expansion will be 2000 m^3/ day in addition to existing 12000 m^3/ day, sourced from STP Udaipur and matrikundia dam. NOC issued by CGWA for inflow of ground water of 121 m^3/day, stipulated water recharge 88,330 m^3/year. As per hydrogeological study carried out during earlier EC, conceptual mine planning was considered so no additional ground water will generate due to this 20% expansion project. No groundwater will be extracted for meeting the water requirement. Zero discharge is being maintained. Mine dewatering due to intersection will also be consumed in the process.



2.13.2 Power requirement& supply/ source

Additional power is not envisaged. For this proposed expansion power requirement is met through existing 40.0MW approved for 3.75 MTPA mining & 4.25 MTPA beneficiation capacity from captive generation & AVVNL.

DG set of 5.0MW capacity having acoustic enclosures for emergency power is introduced as a part of 3.75 MTPA ore production & 4.25 MTPA ore treatment plant.

2.13.3 Green Belt:

Time bound Green Belt action plan is already incurred as a part of 3.75 Mtpa Mine & 4.25 Mtpa Beneficiation Plant project. The Project area has no protected sensitive areas like National Park, Sanctuaries, RF, Wetlands etc. Status of Green Belt development is given below-

S.No	Particulars	Existing	Proposed	Total
1	Acquired Area (ha)	148.84	0	148.84
2	Area under plantation (ha)	46	4	50
3	No. of Plants	70,000	6,000	76000
4	% Area	30.91%	-	33.59%
5	Major Plant species	Fruit Trees: Ber (*Ziziphus mauritiana*), Jamun (*Syzygium cumini*), Mango (*Magnifera indica)*, Sitafal (*Annona squamosa*), Amrood (*Psidium guajava*) Native Species: Neem (Azadirecta Indica), Kachnar (Bauhinia varigata), Shisham (Delbergia sisso), Dhaak (Butea monosperma), Amaltas (Cassia fistula), Bauhnia (Bauhinia purpurea) etc		
S.No.	Particulars	2017 -18	2018-19	2019-20
1	No. of Plants	3000	3000	3000
2	Area to be covered in plantation (in ha)	2	2	
3	Total Area under plantation	48	50	

Note: 1. Local plant species will be planted with drip irrigation system for better plant survival rate. 2. From 2020-21 onwards plantation will be done for gap filling and taking care of survival rate of plants.

2.13.4 Quantity of Waste to be generated (Solid & Liquid) and its Management

Solid Mine Waste

In overall mine life the details of waste generation is shown as under:

- Total waste generation over mine life 74,00,000cum

- Waste disposal planned in underground voids 36,00,000cum
- Waste to be utilized in construction of tailing dam 33,00,000cum
- Total waste to be disposed externally 5,00,000cum
- Surface area earmarked for waste dump 8.0ha
- Area occupied of existing waste dump 4.2ha
- Avg. dump height at present 16.0m
- Height of lift 6 lift of 10m
- Garland drain around the waste dump along with a pond for collection of rain water
- Plantation will be done on inactive waste dump

In the proposed expansion of SK Mine, no additional waste will be dumped on the surface beyond the already approved waste quantity. The increased waste generated will be disposed off into the underground voids.

Details of Other Waste Generation and Management/ Disposal

The proposed increment will be achieved by debottlenecking of existing process.

Tailing Disposal

The tailing from existing beneficiation plant is being pumped to the existing lined tailing dam. It is proposed to continue the same and the capacity of lined tailing dam is sufficient till the mine life as the tailings generated are utilized in filling the underground mine voids.

2.13.5. Employment Generation (Direct & Indirect)

The proposed debottlenecking will be managed by the existing resources but there is an ample opportunity for increase in indirect employment due to mining related activities like transport, small workshops, garages, and due to development of local area.

2.13.6 Existing Infrastructure

At mine & mill area, site Offices, Canteen, Rest Room, Washrooms, Ambulance, First-aid facilities, Fire Tender, Road Sweeper are available.

Residential facilities along with school, hospital, bank, post office, police station, shopping market, club, gym, football ground and other recreational facilities etc. are available at Rajpura Dariba Complex which is 6.0km from SK Mine.

2.14 Project Cost

S. No.	Particulars	For 3.75 million TPA Mine &4.25 million TPA Mill operation Cost (in Rs. Crore)	For 4.5 million TPA Mine & 5.0 million TPA Mill operation Cost (in Rs. Crore)
1	Mine Development	385	466
2	Equipment	220	337
3	Shaft	1000	1,399
4	Beneficiation Plant-2	350	350
5	Infrastructure	120	244
6	Env Protection	165	183.5
	Total	**2240**	**2980**

- **Capital Cost of Project- Rs. 2980 cr**
- Recurring Cost of Project- Rs.300 cr./ per annum

2.15 Occupation Health and Safety Facility

Occupation Health Risk Assessment process at SK Mine is currently practiced in a systematic way. As part of this assessment HRA are conducted at different levels and at different times:

- Baseline HRAs;
- Issues based or targeted HRAs; and
- Continuous HRAs.

A baseline HRA is used to determine the current status of occupational health risks associated with various activities carried out at SK Mines. This tends to be a very wide ranging assessment that encompasses all potential exposures and associated hazards.

An issues-based or targeted HRA is designed to provide a detailed assessment of specific processes, tasks and areas that have been identified as priorities in the baseline assessment.

A continuous HRA is an ongoing monitoring program or a schedule of regular reviews to determine whether conditions have remained the same, whether changes in processes, tasks or areas have occurred and whether these changes have modified any hazardous exposures and hence any potential health risks. A management of change program will also be considered as being part of a continuous HRA program.

All these three types of HRA are being carried out by occupational health experts of HZL and Hospital facility available at Dariba for the existing operation at SK Mine and the same service will be extended to

proposed expansion facility. SK Mines actively involved in implementation of various recommendations proposed at conference on safety of mines held over a period of time.

Various occupational health services available for SK Mine employees will include the following:

- Identification and assessment of the risk from health hazards at work place;
- Surveillance of the factors in working environment and work practices which may affect workers health;
- Education of workers on sanitation, cleanliness, hygiene and health care;
- Collaborate in providing information, training and education in the fields of occupational health, industrial hygiene and ergonomics;
- Organization of first aid in mines including training;
- Prepare report of P.M.E (Pre Medical Examination) /Notified diseases/status of first aid /results of airborne dust/noise/temperature sanitation at work place; and
- Computerized documentation of all medical records.

2.16 ENVIRONMENTAL COMPLIANCE

HZL carried out the periodical environment compliance monitoring (6 monthly) and compliance reports were submitted to Regional office of MoEF&CC and Rajasthan State Pollution Control Board. HZL has submitted the six monthly compliance report (October 2015-March 2016) to RO of MoEF&CC and RSPCB on 20 May 2016. Certified half yearly EC compliance report dated 27 June 2016 is annexurd as **Annexure 4**

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CHAPTER-3

DESCRIPTION OF ENVIRONMENT

3.1 INTRODUCTION

The anthropogenic activities related to mining activities cause impacts on environmental components in and around the project site. However, the intensity of environmental impacts vary from project to projects, depends upon several factors like; Physical, Chemical, & other, etc. involved in the project, processing capacity (scale / size of the project), type and extent of pollution control measures, project location surrounding geomorphology etc. To assess environmental impacts from proposed project (specific), it is essential to monitor the environmental quality prevailing in the surrounding area prior to implementation of the proposed project. The environmental status (baseline status) within the study area is used for prediction of anticipated environmental impact assessment study. The impacts from an existing mining project on its surrounding environment are due to the nature of pollutants, their quantities discharged to the environment, existing environmental quality, assimilative capacity of the surrounding environment and topography.

A regional background to the baseline data is being presented at the very onset, which will help in better appreciation of micro-level field data, generated on several environmental and ecological attributes of the study area. The baseline status of the project environment is described section wise for better understanding of the broad-spectrum conditions. The baseline environment quality represents the background environmental scenario of various environmental components such as air, noise, land, ecological and socio-economic status of the study area.

3.2 BASELINE DATA GENERATION:

Field monitoring studies for collection of primary data to evaluate the base line status of the project site were carried out covering March, April & May' 2016 representing the primary data.

Environmental data has been collected in relation to given mine for:-

a. Land
b. Water

c. Air

d. Noise

e. Biological

f. Socio-economic

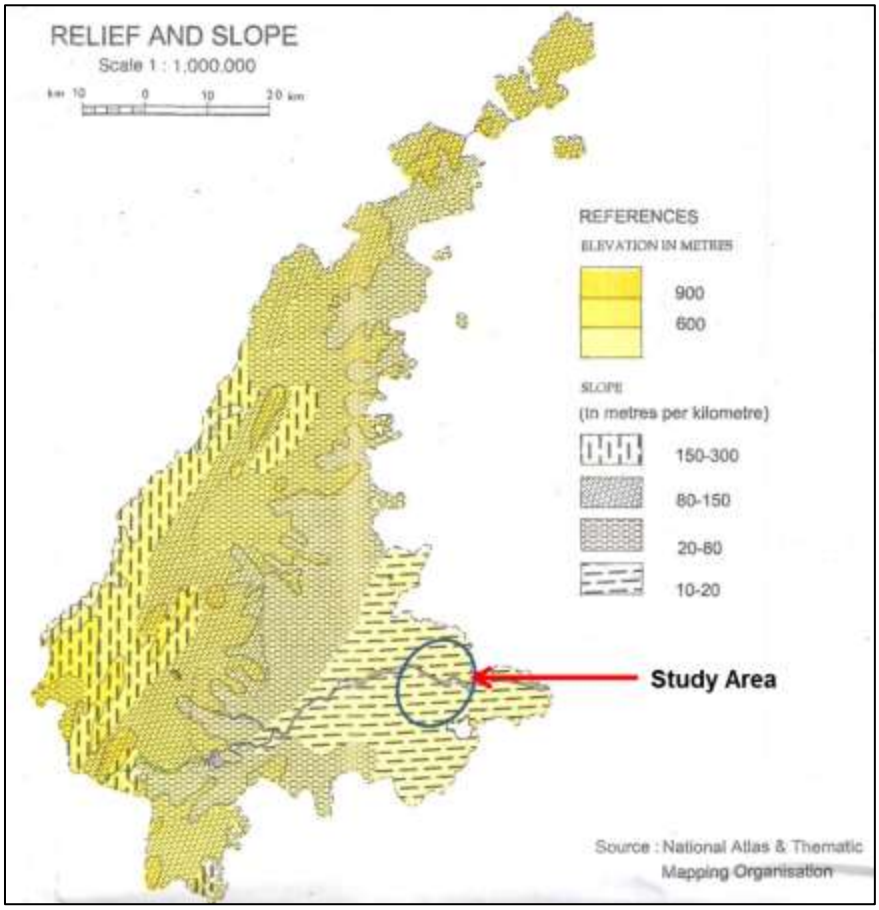
3.3 LAND ENVIRONMENT:

3.3.1 TOPOGRAPHY

1.1 REGIONAL TOPOGRAPHY

The Rajsamand District consists of rolling topography intersected by shallow valleys. Towards the western part of the district, Aravalli hills and a series of ridges run diagonally in the NE and SW direction. The Project mine lease area is located about 45 km from Aravali hills with reference to Fort Kumbhalgarh towards NW. The highest portion of Aravallis occurs South of Kailwara near Kumbhalgarh fort (25°08':73°35') with an altitude of 1293 m above msl towards NW at a distance of 65 km. A typical gneissic plain bearing irregularly carved of gneisses and granites without any alluvium cover is observed to the highest altitude of above 600 m amsl. The Central and Eastern part of the district is relatively plain area forming the foot hill of the Aravalli ranges. This plain gently slopes towards the East and Northeast. In the higher and more rugged part towards the west, alluvium is scanty whereas in the eastern flank the alluvium is more continuous and reasonably thick. Regional relief and slope map highlighting the study area is given in Fig 3.1**.** The study area of the Project is relatively a plain with intermittent small hillocks including the SK Mines leas area having slope of 10 to 20 m/km.

Figure 3.1 Regional Relief and Slope Map

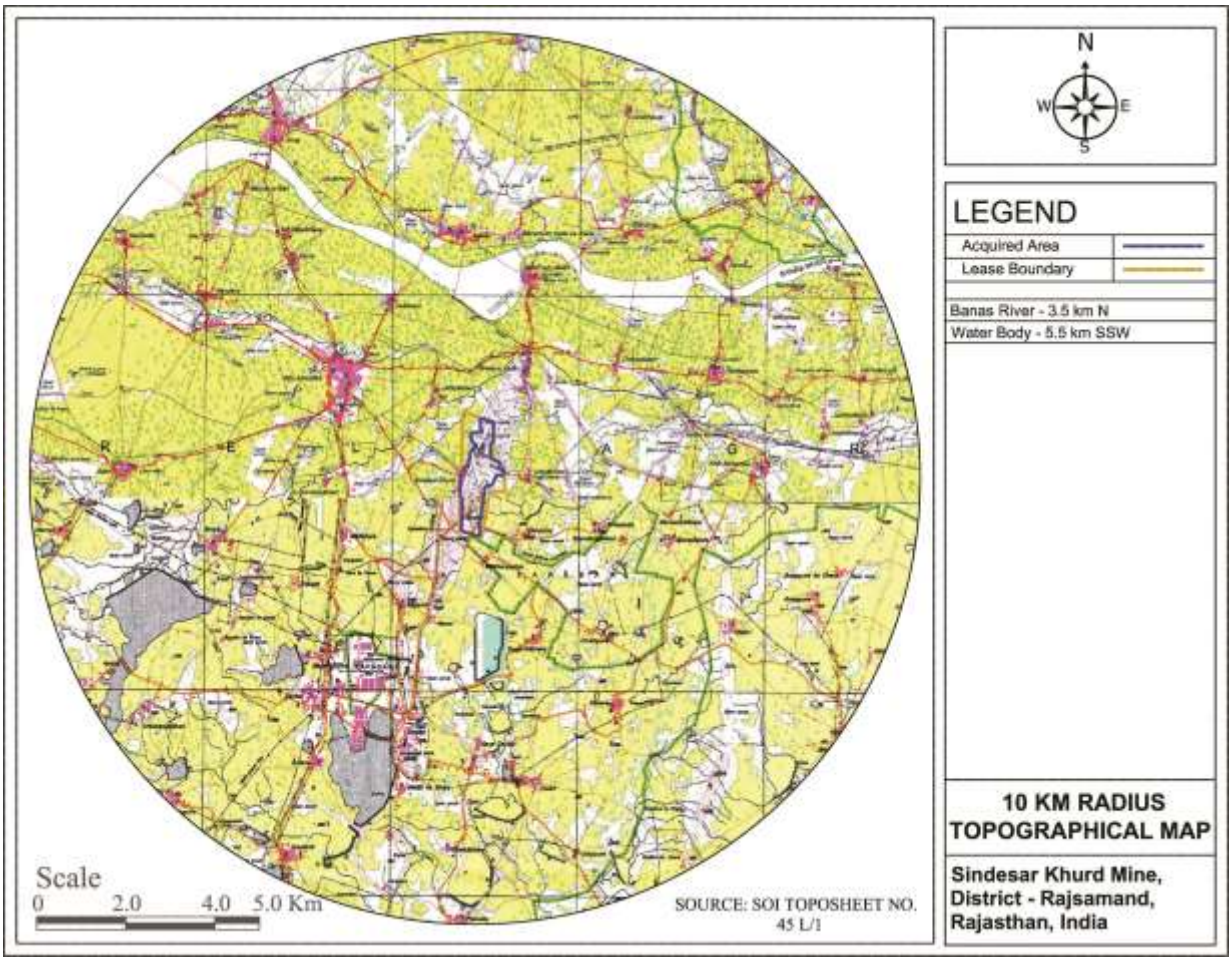


Source: SOI

1.2 *STUDY AREA TOPOGRAPHY*

The topography within the study area of 10 km is generally plain, expect for a small ridge in the central portion, with elevation ranging from 463 m to 573 m. The highest elevation is observed within the mine lease area, whereas lowest elevation of 463 m is observed towards South East of study area near Lunera village. The slope of the study area follows the drainage within the study area of 10 km generally towards Banas River located at 4.4 km from mine lease area and its various tributaries located on the North and NE of the study area and towards extreme Southern area drainage is towards Berach river. General topography of the study area is shown in **Error! Reference source not found.** 3.2

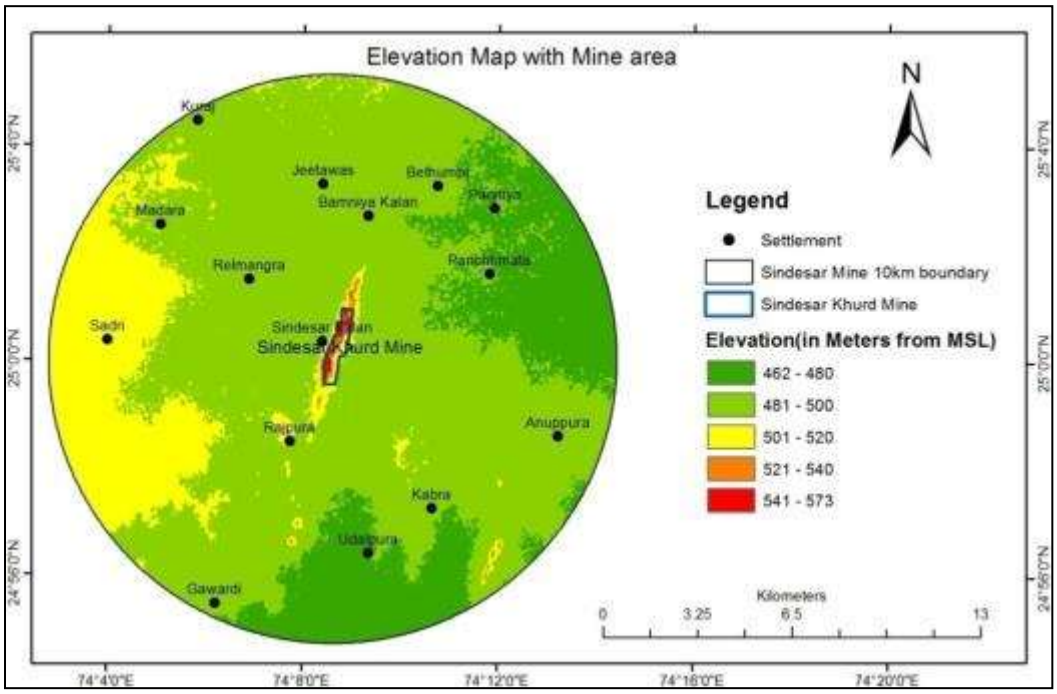
Fig. 3.2: Topography map of study area



1.3 *DIGITAL ELEVATION MODEL:*

The elevation data is collected from the Advanced Space-borne Thermal Emission and Reflection Radiometer (ASTER) Digital Elevation Model (DEM) and verified through contours from toposheet. DEM provides the elevation details in the study area.

Fig.-3.3: Digital Elevation Model (DEM)



1.4 *ASPECT MAP:*

An aspect-slope map simultaneously shows the aspect (direction) and degree (steepness) of slope for a terrain (or other continuous surface). Aspect categories are symbolized using hues and degree of slope classes are mapped with saturation (or brilliance of color) so that the steeper slopes are red.

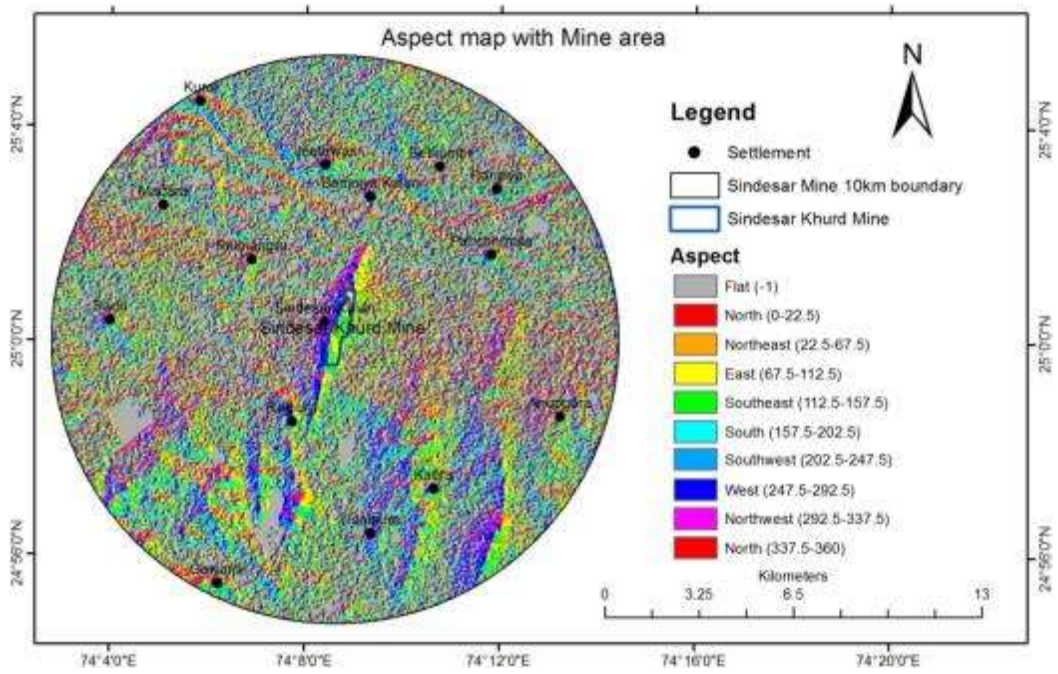


Fig.-3.4: Aspect Map

1.5 *SLOPE MAP:*

This map provides a colorized representation of slope, generated dynamically using a server-side slope function on the Terrain layer followed by the application of a color map. The degree of slope is represented by a color map that represents flat surfaces as green, shallow slopes as light yellow, and steep slopes as red.

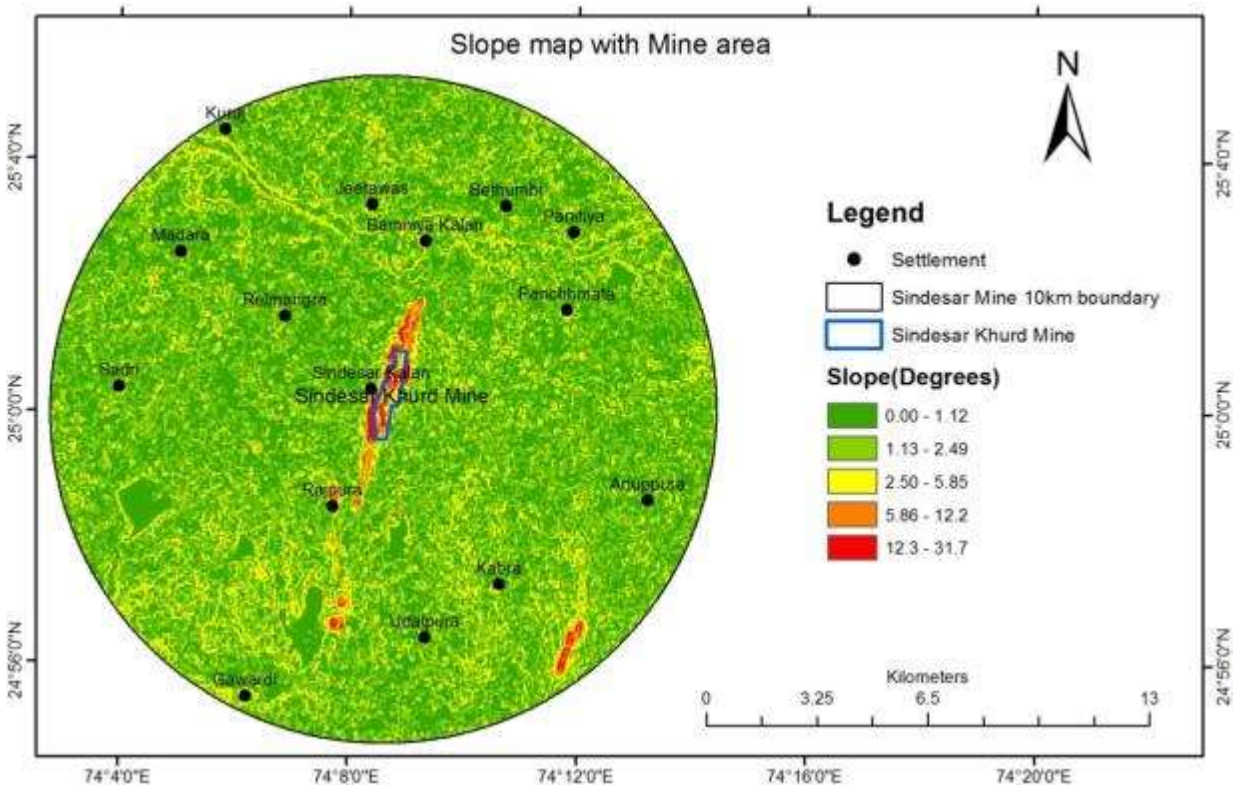


Fig.-3.5: Slope Map

3.3.2 GEOLOGY:

Regional Geology

The oldest formation exposed in the area belongs to Bhilwara super group of Archean age. The northern, central and western part of the district are occupied by the younger formations of Aravalli super group and Delhi super group of Proterozoic age. Quaternary and recent alluvium overlies most of the formations in isolated pockets, along river courses and in shallow depressions[1].

Archeans: Archaeans are represented in the district by formations of Bhilwara Super Group comprising younger Rajpura Dariba group overlying the older Mangalwar complex and Sandmata complex. The formations of Bhilwara Super Group are intruded by mafic and

ultramafic bodies and synorogenic granites. Mangalwara and Sandmata complexes are exposed in the eastern part of the district and occupy fairly good area where as formation belonging to Rajpura Dariba Group occurs in isolated pockets. Mangelwar Complex comprises mainly migmatite, gneisses, mica schist, quartzites, impure marble whereas Sandmata Complex Comprises gneisses, biotite schist, marble and quartzites, Rajpura Dariba group comprises mainly dolomitic marble, micaschist and quartzites.

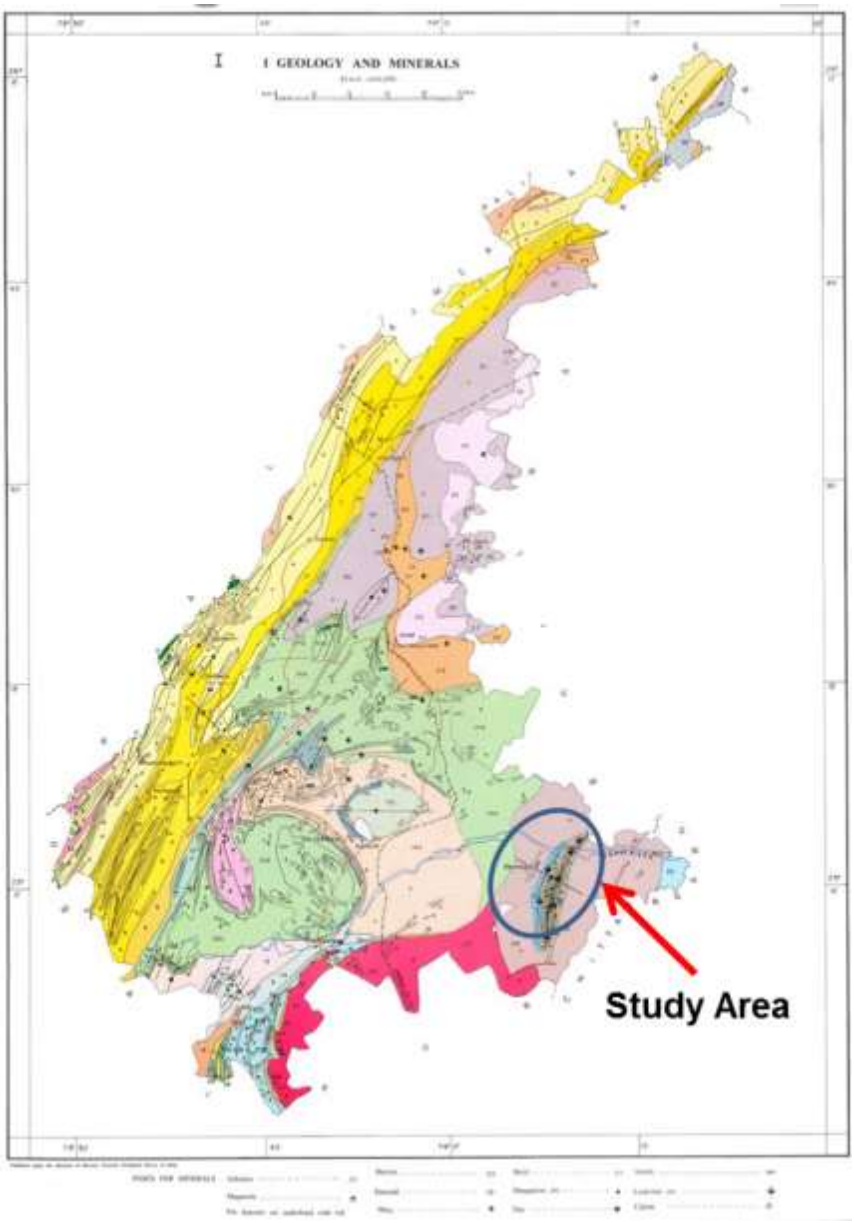
Proterozoics: Proterozoics are represented in the district by formations of older Aravalli Super Group and younger Delhi Super Group. Aravalli Super Group comprising of Bari lake group, Kankroli group, Jharol group, Devda group. Aravalli Super Group in the district is located in the southern part in the form of an inverted cone roughly separated in the east by Bhilwara Super Group along Delwara lineament and from the Western Delhi Super Group by Kali Guman lineament. The younger Bari lake Kankroli, Jharol, Devda and Nathdwara groups are located in the southern part of district, north of Udaipur. Kankroli Group represents garnetiferous schist, marble and quartzites. Jharol group which is exposed along a north-south treading belt consist of chlorite, phyllite, quartzites and micaschists. Devda group located west and north of Kankroli comprises quartzites, dolomitic marble, horn-blende, mica schists and gneisses. Nathdwara group located around Nathdwara comprises dolomitic marble, quartzites, phyllites and schists.

The entire western belt of Rajsamand district extending from the north eastern tip to the South-Western edges are occupied by rocks belonging to Delhi Super Group. The younger Gogunda group consists of quartzites, biotite schists and calc silicates rocks. These formations extend from west of Khamnor to west of Devgarh formatting a continuous elongated belt trending north east south west. Western extremity of the district is occupied by formations belonging to Kumbhalgarh group which are mainly calc schist – calc gneisses, quartzites and marbles.

The study are of 10 km forms the alluvial deposit of recent origin occurs in narrow discontinuous bends along the channel of Banas, Khari, and other rivers in the form of valley fills. They are composed of unconsolidated stream laid sand and gravel and occasionally silt clay and kankars. Their lateral extent is very limited, maximum being about 1 km. from river bank while vertically they do not extend beyond 15 metres depth. Besides, blown sands occur in localised patches.

Recent alluvium in the form of valley fills is found along the Banas river near Relmagra in the study area. The alluvium occupies the buried river channel of Banas River and stream laid unconsolidated deposits are found along the other rivers. This is main valley fill which occurs in the district. The geological map of Rajsamand District with study area marked is presented in Fig. 3.6

Fig. 3.6 Regional Geology



Geology of Mine Lease Area

Sindesar Khurd deposit is located in the central part of the eastern limb of the major Dariba Bethumni synformal fold. The rocks belong to Bhilwara Super Group. The best-exposed rock unit in the area is inter-banded mica – schist/ chert/ quartzite and forms a prominent

NNE-SSW trending ridge. The economic concentrations of lead-zinc-silver mineralization are hosted by calc-silicate bearing dolomite and graphite mica schist. The host rock is concealed 100m below the above unit. Graphite mica schist and calcareous quartz biotite schist, exposed further east of the area are intersected in the drill holes and mine developments

3.3.3 LAND USE:

The base map of the study area is prepared considering the Survey of India toposheet 45 L/1 (1:50,000 scale) and remote sensing images and is presented.

1.1 *SOURCE OF INFORMATION:*

The data in this work is collected from the following sources

1. Topographic data - From Survey of India Toposheet
2. Remotely Sensed Data - From Resource Sat-2– LISS IV Data

All the data used in this work have been supplied by National Remote Sensing Centre, Hyderabad, India.

1.2 *METHODOLOGY:*

For assessment of LULC in the study area satellite images of the study area were collected based on the availability of the data from the National Remote Sensing Centre (NRSC), Hyderabad. The methodology for remote sensing analysis of satellite imageries is categorized as follows:

- Acquisition of satellite data
- Collection of ground truth and ground control points (GCPs)
- Pre-processing of data
- Geo-referencing and rectification
- Supervised classification
- Estimation of area usage and coverage

- Accuracy assessment

1.3 *CLASSIFICATION CRITERIA:*

- A land use and land cover classification system which can effectively employ orbital and high-altitude remote sensor data should meet the following criteria *(Anderson, 1971)*:
- The minimum level of interpretation accuracy in the identification of land use and land cover
- Categories from remote sensor data should be at least 85 percent.
- The accuracy of interpretation for the several categories should be about equal.
- Repeatable or repetitive results should be obtainable from one interpreter to another and from one time of sensing to another.
- The classification system should be applicable over extensive areas.
- The categorization should permit vegetation and other types of land cover to be used as surrogates for activity.
- The classification system should be suitable for use with remote sensor data obtained at different times of the year.
- Effective use of subcategories that can be obtained from ground surveys or from the use of larger scale or enhanced remote sensor data should be possible.
- Aggregation of categories must be possible.
- Comparison with future land use data should be possible.
- Multiple uses of land should be recognized when possible.

1.4 *CLASSIFICATION SCHEME:*

Sr. No.	Description – I	Description – II
1.	**Built-up**	Urban
		Rural
		Mining
2.	**Agriculture**	Crop land

		Plantation
		Fallow
		Current Shifting Cultivation
3.	**Forest**	Evergreen/ Semi evergreen
		Deciduous
		Forest Plantation
		Scrub Forest
		Swamp/ Mangroves
4.	**Grass/ Grazing**	Grass / Grazing
5.	**Barren/ Unculturable/ Waste Land**	Salt affected Land
		Gullied / Ravenous Land
		Scrub Land
		Sandy Area
		Barren Rocky
		Rann
6.	**Wetlands/ Water Bodies**	Inland Wetland
		Coastal Wetland
		River / Stream / Canal
		Water Bodies
7.	**Snow and Glacier**	Seasonal and Permanent Snow

Table: Classification Scheme

1.5 *LAND USE/ LAND COVER:*

Based on spatial extent of LULC classes and variability of distribution across the study area, a suitable sample size of 40 was used for the accuracy assessment. Accordingly, an error matrix was generated to assess the overall accuracy. The overall accuracy of supervised classification is found to be 86%.

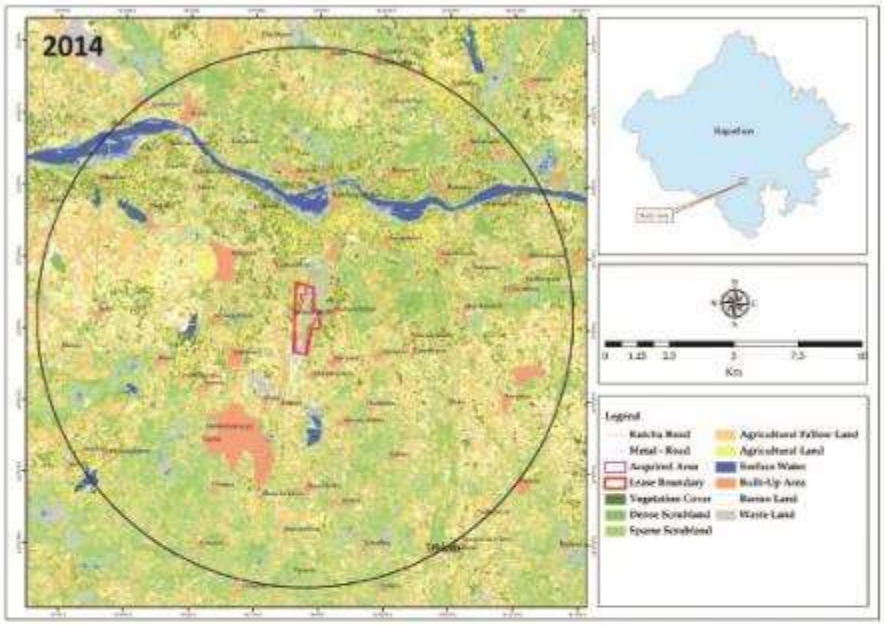
The classified images indicate the following Inventory of areas (per cent under different classes of LULC):

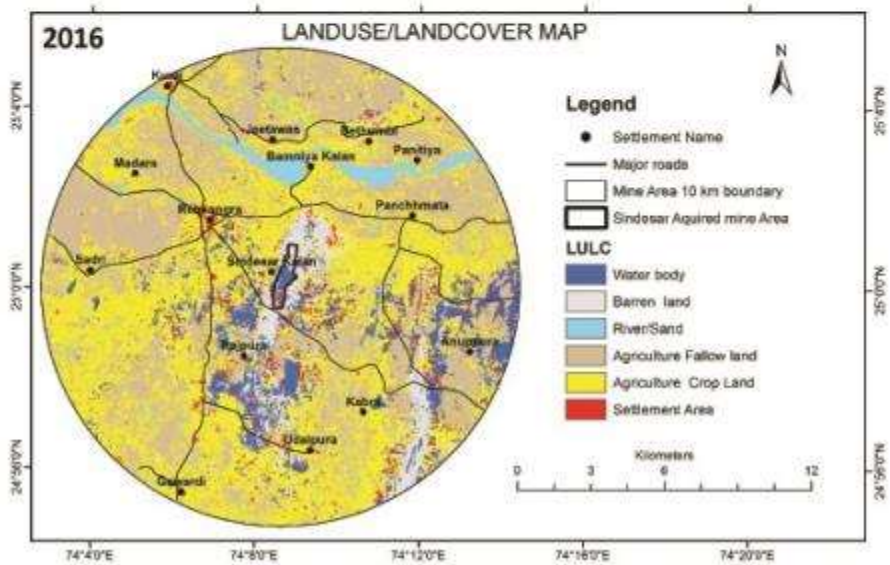
Sr.No.	LULC Classes	Land use Area (Ha.)	Land use Area (%)
1.	Water Body- Lake/Pond	2051.73	6.80
2.	Waste Land- Barren	2013.93	6.68
3.	River/River bed/Sand	807.93	2.68
4.	Agriculture Fellow Land	12619.00	39.88
5.	Agriculture Crop Land	13001.00	40.82
6.	Settlement- Rural/Urban	943.83	3.13

	Total	**31437.42**	**100**

Table: LU/LC Area calculation

Fig: TEMPORAL CHANGES IN LAND USE AND LAND COVER





The overall inventory of LULC in 2014 and 2016 in project study area is depicted in Figure 4.0. Classified image of April, 2014 indicates 18.39% Agricultural, 10.22% Vegetation, 19.64% Sparse Scrub, 28.89% Fellow Land, 13.05% Dense scrub, 3.26% waste land, 2.91% built-up land and 2.77% as water body.

As per the classified image of April 2016 the percentage area under different LULC classes are as follows 6.53% Water Bodies, 6.41% Barren Land, 2.57% River//river bed/sand, 40.14% Agriculture Fallow land, 41.36% Agriculture crop land and 3.0% Settlement.

The overall inventory of LULC from 2014 to 2016 in study area indicates that total settlement area and water bodies has been increased and maximum scrub and vegetation land has been converted to Agriculture land for cultivation purposes.

3.3.4 SOIL CHARACTERSTICS

Soil may be defined as a thin layer of earth's crust, which serves as a natural medium for the growth of plants. The soil characteristics include both physical and chemical details. The soil survey was carried out to assess the soil characteristics of the area. For studying soil quality of the region four samples were collected to assess the existing soil conditions in and around the area.

The sample was collected by driving an auger into the soil up to the depth of 90 cms. The present studies on the soil quality establish the baseline characteristics and identifies the incremental concentrations if any, due to the expansion project. The objective of the sampling is:-

- To determine the baseline soil characteristics of the study area;
- To determine the impact of proposed activity on soil characteristics and;
- To determine the impact on soil, more importantly from agriculture production point of view.

The soil sample is collected from three different depths viz: 30cm, 60cm and 90cm. The sample was than packed in polythene plastic bags and sealed. The sample from three different depths is homogenized and then is analyzed.

1.1 *BASELINE SOIL STATUS*

Soil Types in the Study Area

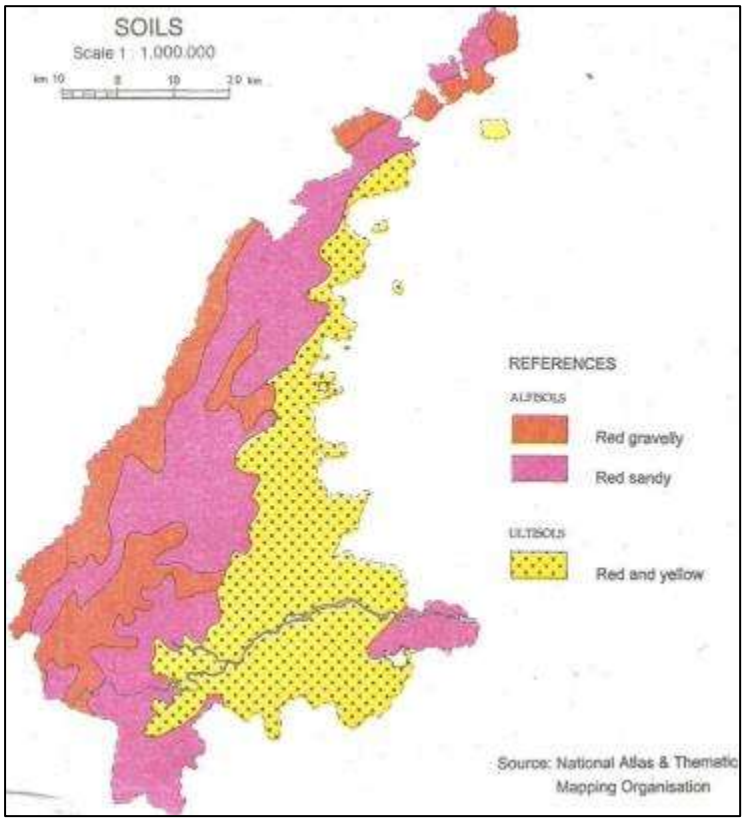
The soils of the Rajsamand district vary from sandy loam in Bhim, Deogarh & Amet blocks to heavy clay in Kumbhalgerh block. The types of soil occurring in the district are;

- Sandy loam in Bhim, Deogargh and Amet blocks
- Clay Loam in Rajsamand, Relmagra and Khamnor blocks and
- Heavy clay in Kumbalgarh block.

Broadly, the northern, southern and eastern part of the district possesses loam, foot hill soils and black cotton soil with moderate run off, where as in the western part of the district lithosols and regosols of hills and rocky outcrops having very high run off are prevalent. Soil infiltration rate varied from 0.6 cm/hr to 4.2 cm/hr with average infiltration rate of 2.35 cm/hr. The cumulative depth to which vertical infiltration took place varied from 3.6 to 16.2 cm by which time, constant infiltration rate was also achieved.

Based on National Bureau of Soil Sciences and Land Use Planning (NBSS & LUP) Regional Centre, Udaipur, the soil of the study area is classified as deep and medium brown loamy soils. The soil map of the district with study area marked on it is shown in Fig below:

Fig: Soil Map of the Rajsamand District



Soil quality analysis (Study Area):

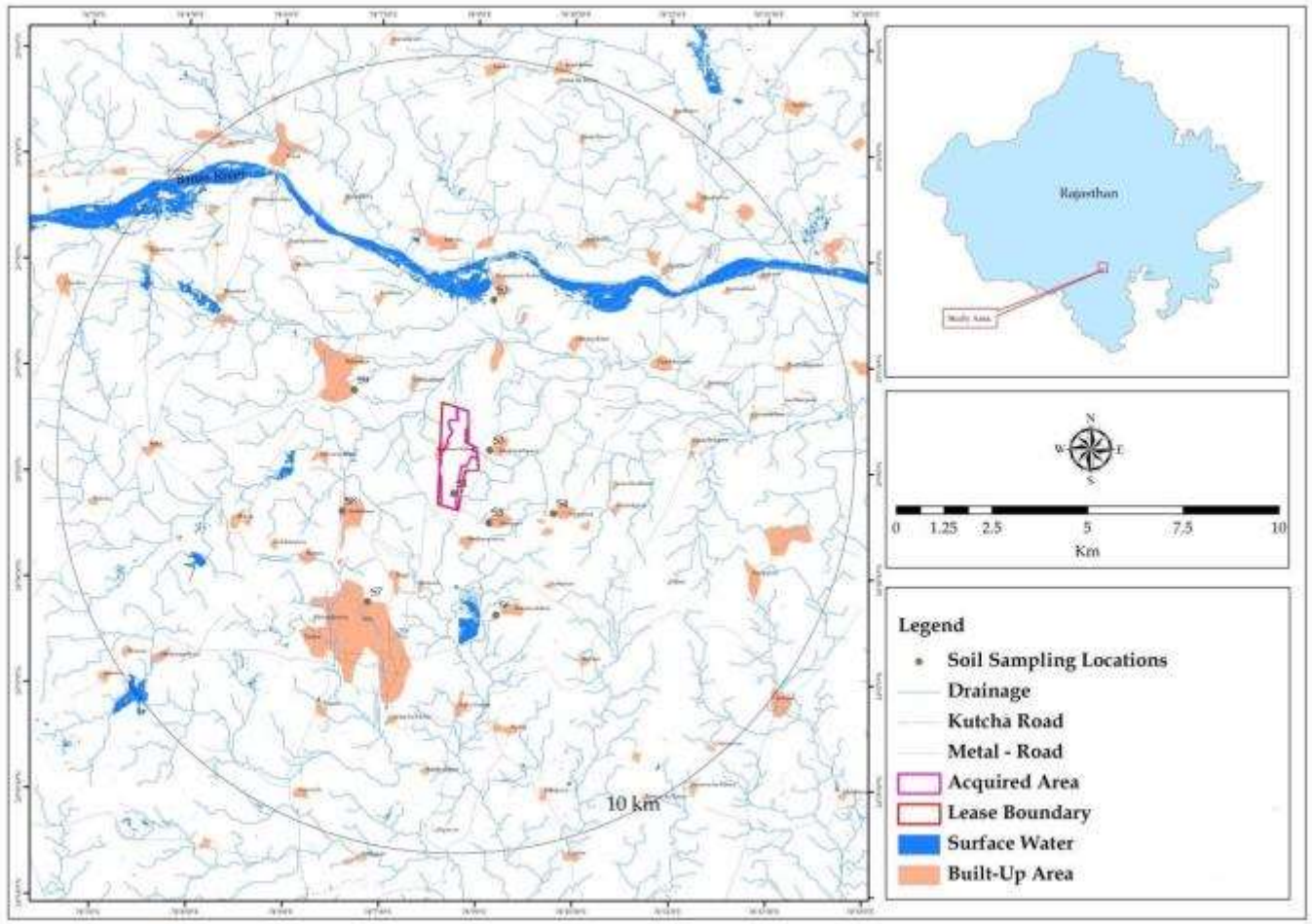
The soil study was carried out to analyze the soil characteristics of the study area. For studying soil quality of the region 6 samples (including site) were collected, description of the same as follows:

Table: Details of Soil Sampling Locations

S.N.	Sampling Location	Station Code	Geographical Coordinates	Distance w.r.t ML Area	Direction w.r.t ML Area	Landuse
1	ML Area	S1	24°59'40.29"N 74° 8'39.39"E	Within ML	-	Open area
2	Bamnia Kalan	S2	25° 2'26.63"N 74° 9'14.62"E	2.9 km ;	NNE	Agriculture
3	Raghunathpura	S3	25° 0'18.78"N 74° 9'11.66"E	0.3 km ;	E	Agriculture
4	Amarpura	S4	24°59'25.27"N 74°10'11.51"E	2.3 km ;	ESE	Agriculture
5	Shivpura	S5	24°59'16.99"N 74° 9'11.33"E	1.0 km ;	SE	Agriculture

S.N.	Sampling Location	Station Code	Geographical Coordinates	Distance w.r.t ML Area	Direction w.r.t ML Area	Landuse
6	Sunariya khera	S6	24°57’58.71”N 74° 9’18.42”E	2.9 km ;	SSE	Agriculture
7	Rajpura	S7	24°58’9.30”N 74° 7’18.70”E	3.2 km ;	SW	Agriculture
8	Malikhera	S8	24°59’26.47”N 74° 6’54.41”E	2.6 km ;	WSW	Agriculture
9	Relmagra	S9	25° 1’9.27”N 74° 7’5.08”E	2.3 km ;	NW	Agriculture

Soil Sampling Locations of the Study Area



Source: Survey of India toposheet and IRS LISS IV dated 09 April 2014

Table: Results of soil analysis

S. No.	PARAMETERS		Unit	Sindesar Khurd (Opposit S.K.Mines)	Bamnia Kalan	Raghunathpura	Amarpura	Shivpura	Sarvaria Khera	Rajpura	Malikhera	Relmagra
				S-01	**S-02**	**S-03**	**S-04**	**S-05**	**S-06**	**S-07**	**S-08**	**S-09**
1	Particle size distribution	Sand	(%)	78.6	66.8	70.4	85.6	75.5	81.7	81.4	77.7	75.3
		Silt		13.6	25.5	20.2	10	18.5	12.8	12.8	14.9	17.4
		Clay		7.8	7.7	9.4	4.4	6	5.5	5.8	7.4	7.3
2	Texture		-	Sandy Loam	Sandy Loam	Sandy Loam	Loamy Sand	Sandy Loam	Loamy Sand	Loamy Sand	Sandy Loam	Sandy Loam
3	pH (1:5 Solution)		-	7.89	7.61	6.88	6.45	7.28	7.09	7.55	6.88	7.72
4	Electrical Conductivity		µS/cm.	125.5	128.4	88.2	240.5	120.5	380	145	100.2	135.5
5	Cation Exchange capacity		meq%	1.18	2.43	1.45	1.1	1.45	1	0.85	0.99	8.25
6	SAR		-	0.9179	2.2495	3.0474	1.2639	1.3238	2.7347	1.5979	1.3073	1.0324
7	Permeability		(cm/ hr.)	125.8	170.5	188.4	1520.8	452.2	1110	1340.4	1480	1720
8	Water Holding Capacity		(%)	20.2	28.9	18.5	38.2	32.2	36.6	45.7	56.4	50.2
9	Porosity		(%)	4.4	6.5	5.8	10.2	6.9	7.8	11.4	8.5	10.2
10	Bulk Density		gm/cm^3	1.89	1.66	1.80	1.77	1.42	1.50	1.34	1.35	1.56
11	Nitrite		mg/kg	BDL	0.65	0.45	0.64	0.33	0.45	0.6	2.2	1.4
12	Nitrate		mg/kg	2	1.88	2.25	2	2.26	1.4	1.6	3.55	3
13	Phosphate		mg/kg	0.91	1.25	5.56	2.55	1.45	3.22	2.54	6.99	4
14	Sodium (Na)		mg/kg	480.5	720.9	700.5	715.4	655	810	725	555.8	620.8
15	Calcium (Ca)		mg/kg	20201	3025	312	12544	7844	800	3100	3250	13250
16	Magnesium (Mg)		mg/kg	312	255	2210	7009	6400	3500	7480	6250	8455
17	Potassium (K)		mg/kg	155.89	489.80	140.40	210.40	355.50	300.60	460.80	325.50	358.80
18	Lead (Pb)		mg/kg	35.50	12.80	20.80	18.40	22.90	38.40	40.20	30.30	26.40
19	Iron (Fe)		mg/kg	6510	7088	6210	6215	7050	48500	6523	8044	6844
20	Arsenic (As)		mg/kg	BDL	BDL	BDL	0.60	BDL	0.60	0.42	BDL	0.45
21	Cadmium (Cd)		mg/kg	2.00	1.20	0.65	0.76	0.65	0.75	1.20	0.68	0.88
22	Total Chromium (Cr)		mg/kg	6.6	10.45	8.45	12.1	10.44	8.44	8.23	14.4	7.65
23	Copper (Cu)		mg/kg	15.5	12.6	12	20.2	18.4	12.4	32.4	38.5	36.2
24	Nickel (Ni)		mg/kg	20.7	38.4	20.4	15.4	16.4	28.4	44.6	48.4	55.5
25	Manganese (Mn)		mg/kg	165.5	170.4	188.6	190.7	210.4	178.6	55.2	620.4	590.8

26	Zinc (Zn)	mg/kg	55.8	80.4	48.2	35.6	44.9	55.6	784	45.8	20.9
27	Barium (Ba)	mg/kg	89.9	110.4	120.6	140.4	110.6	120.6	145.6	155.5	100
28	Selenium (Se)	mg/kg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
29	Mercury (Hg)	mg/kg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
30	% Moisture	%	1.8	6.9	5.5	4.5	4.8	10.5	16.9	10.4	8.8
31	Total Alkalinity	%	0.98	0.88	0.45	0.66	0.84	0.42	0.78	0.45	0.99
33	Available Nitrogen	%	2.6	7.6	5.8	14.5	8.7	5.8	12.8	10.4	8.2
34	Available phosphorous	mg/kg	12.4	55.5	54.6	42.3	22.6	25.8	55.4	77.4	101.4
35	Salinity	ppt	0.6285	0.0642	0.0461	0.1161	0.0606	0.1829	0.0717	0.0515	0.0674
36	Organic Matter	%	66	1.87	1.45	3.66	2.2	1.56	3.35	2.25	2.05
37	Boron	mg/kg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
38	Chloride	%	2.2	1.8	1.68	2.8	1.6	2.56	1.58	2.21	2.6
39	Sulphate	mg/kg	77	65	30	44	25	45	66.5	42.5	72
40	Carbonate	%	11	0.88	0.89	8.40	4.80	2.20	3.40	3.80	6.40

Results & Conclusion

The soil analysis results are presented in table. The result obtained is compared with the standard soil classification given in Agriculture Soil Limits. It has been observed that the soil is sandy loam in texture and neutral in nature. The nutrient and organic matter contents are medium and the soil is normally fertile.

Table 3.3.1 Standard Soil pH Classification

pH	**Classification**	**Sample**
<4.5	Extremely acidic	-
4.51- 5.00	Very strong acidic	-
5.01- 5.50	Strongly acidic	-
5.51- 6.00	Moderately acidic	-
6.01- 6.50	Slightly acidic	**S-4**
6.51- 7.30	Neutral	**S-3, S-5, S-6, S-8,**
7.31- 7.80	Slightly alkaline	**S-2, S-7, S-9**
7.81- 8.50	Moderately alkaline	**S-1**
8.51- 9.00	Strongly alkaline	-
> 9.00	Very strongly alkaline	-

Source: Agriculture Handbook, 2011

3.4 AIR ENVIRONMENT

Climatology and Meteorology:

The atmosphere is the medium in which air pollution transported away from the source. Meteorology influences the way air pollution is dispersed, including wind direction and wind speed, type of terrain and heating effects. Atmospheric stability affects pollution released from ground level and elevated sources differently.

In unstable conditions, ground level pollution is readily dispersed thereby reducing ground level concentrations. Elevated emissions, however, such as those released from a chimney, are returned more readily to ground level, leading to higher ground level concentrations. Stable conditions mean less atmospheric mixing and therefore higher concentrations around ground level sources, but better dispersal rates, and therefore lower ground level concentrations, for elevated plumes.

The climate of the study area is semi-arid type where seasons can be classified as[2]:

- Summer : March – May;
- Monsoon : June – September;
- Post monsoon : October – December;
- Winter : January – February.

3.4.1 METEOROLOGY

An automated weather monitoring station was installed during the study period to record various meteorological parameters on hourly basis to understand the wind pattern, temperature variation, solar insulation and relative humidity variation etc.

Meteorology plays a vital role in affecting the dispersion of pollutants. Since meteorological factors show wide fluctuation with time, meaningful interpretation can be drawn only from long term reliable data.

[2]Climate Profile of India, IMD 2010

3.4.2 WIND ROSE DIAGRAM

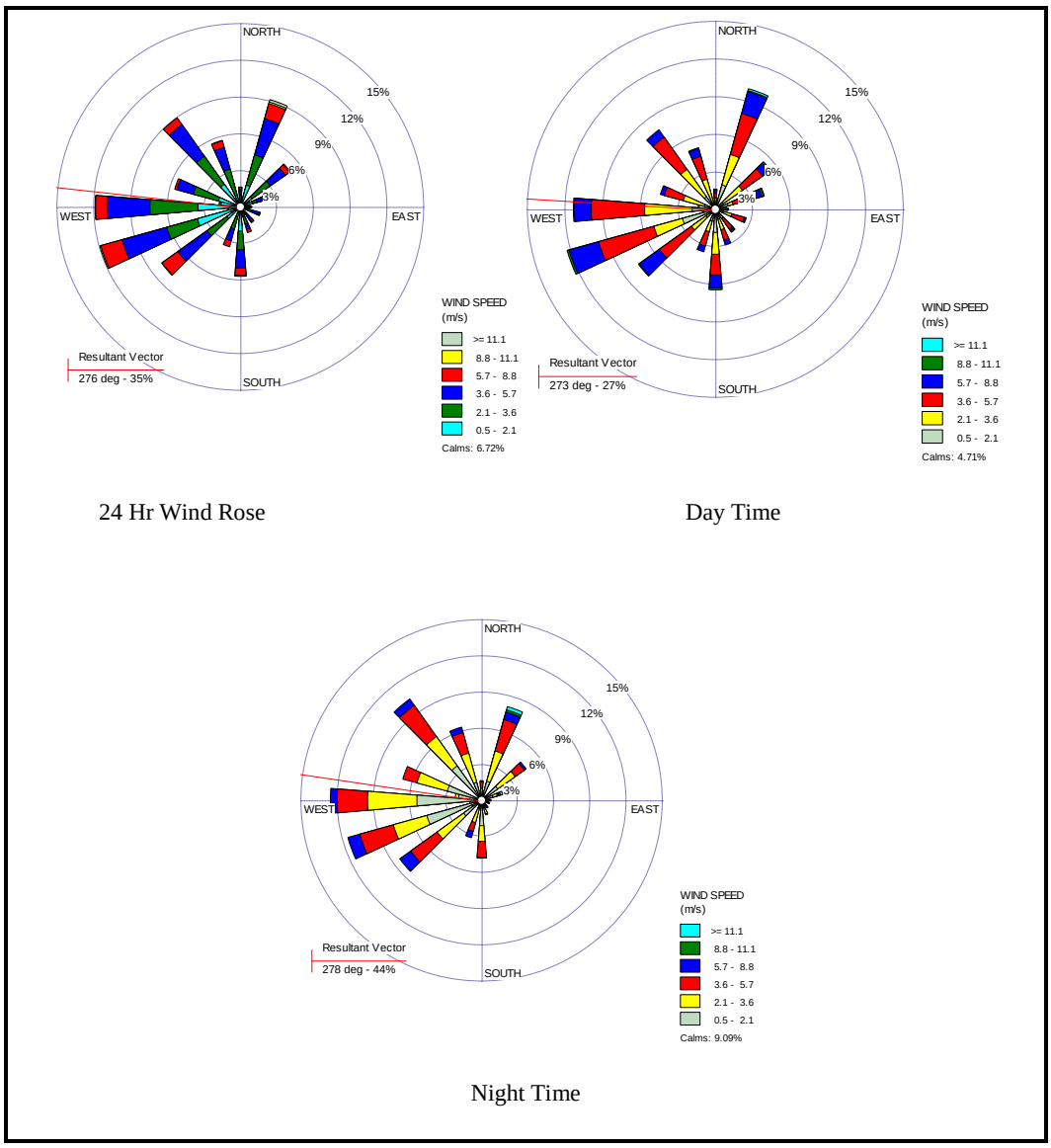
The hourly average meteorological data is presented below:

Table: Hourly Average Meteorological Monitoring Data

Hour	Ambient Air Temperature (°C)	Humidity (%)	Wind Speed (m/s)	Wind Direction (From)
1	30.6	34.3	2.6	SW
2	29.9	35.8	2.8	SSW
3	29.4	37.1	2.8	SW
4	28.7	38.8	2.8	SW
5	28.2	40.3	2.6	SSW
6	28.4	40.8	2.8	SW
7	32.7	34.5	2.7	SSW
8	35.1	31.3	2.9	SSW
9	35.2	30.7	3.2	SSW
10	36.9	27.2	3.5	SSE
11	38.7	23.8	3.7	S
12	39.7	21.3	3.7	SSW
13	40.3	19.6	3.8	SSW
14	40.7	18.0	3.9	SSW
15	40.6	17.9	3.8	SSW
16	40.1	18.4	4.0	SW
17	39.2	19.3	3.8	S
18	37.7	21.0	3.8	SSW
19	35.7	23.5	2.8	SSW
20	34.2	26.2	2.4	SSW
21	33.4	27.8	2.3	SW
22	32.6	29.3	2.3	SW
23	31.8	31.5	2.7	WSW
24	31.1	33.1	2.8	SW

*Source: Secondary data 2014 (developed by ERM)

Figure : Site Specific 24 Hours Wind rose (2014)



Source: Developed based on site specific meteorological data collected during March to June 2014

3.4.3 AMBIENT AIR QUALITY

The prime objective of the baseline air monitoring is to evaluate the existing air quality of the area. This will also be useful for assessing the conformity to standards of the ambient air quality during the operation of the mine.

This section describes the selection of sampling locations, methodology adopted for sampling, analytical techniques and frequency of sampling. The monitoring was carried out during pre-monsoon period (March-May'2016).

3.4.3.1 METHODOLOGY ADOPTED FOR AIR QUALITY SURVEY

A) SELECTION OF SAMPLING LOCATIONS

The baseline status of the air quality in the study area has been assessed though a scientifically designed ambient air quality monitoring network. The design of monitoring network in the air quality surveillance programme has been based on the following considerations:-

- Meteorological conditions on synoptic scale;
- Topography of the study area;
- Representatives of regional background air quality for obtaining baseline status; and
- Representatives of likely impact areas.

Ambient Air Quality Monitoring (AAQM) stations were set up at fifteen locations with due considerations to above mentioned points. Table 3.4.3.1 (a) gives the details of environmental setting around each monitoring stations and their distances with reference to the existing mining lease.

Table 3.4.3.1 (a) AMBIENT AIR QUALITY MONITORING STATIONS

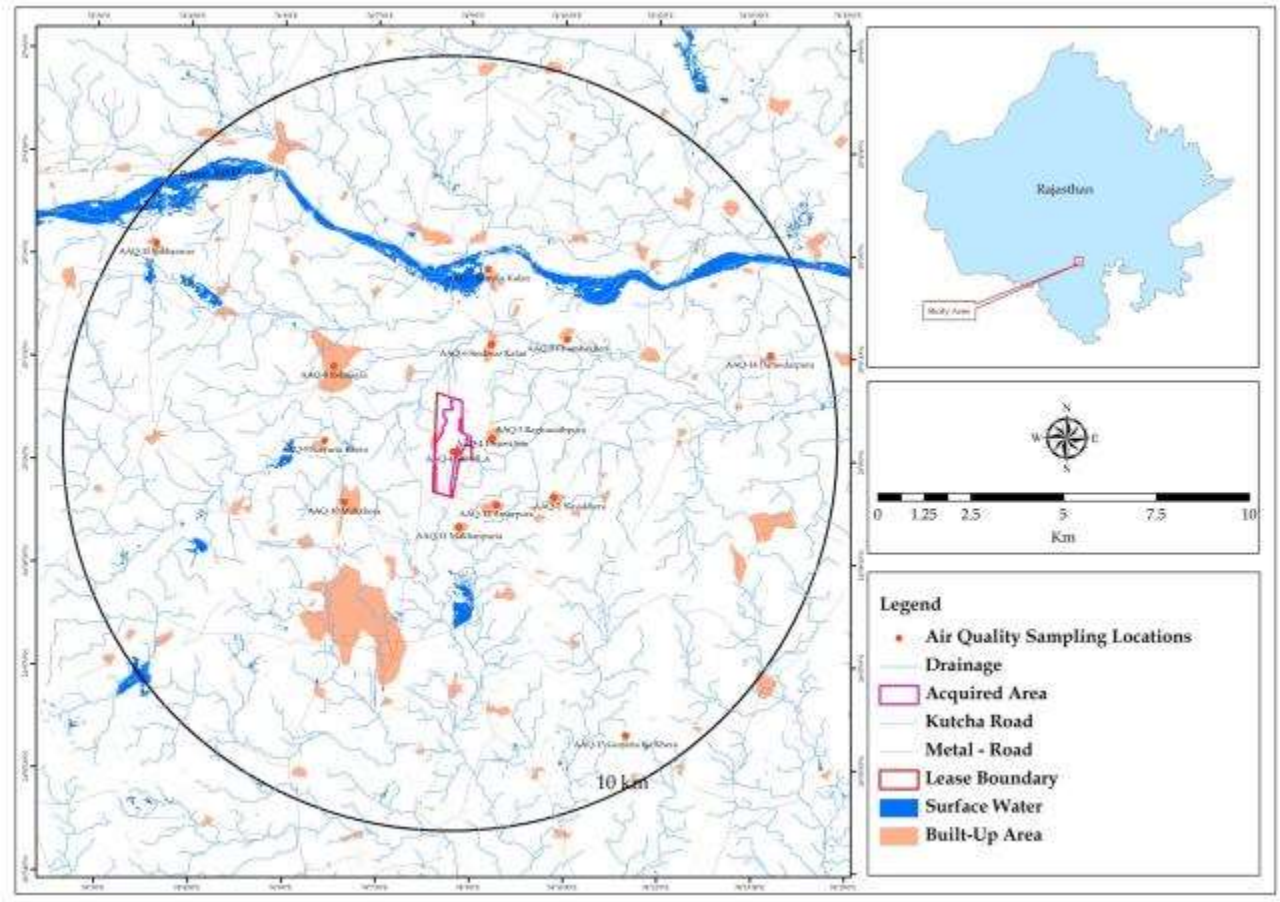
S.N	**Sampling Location**	**Station Code**	**Distance w.r.t mine lease area**	**Geographical Coordinates**	**Direction w.r.t mine lease area**	**Justification for the selection**
1	Mine lease area	AAQ1	-	25° 0'7.22"N 74° 8'42.68"E	within ML	Represent the Project site
2	Navakhera	AAQ2	2.7 km	24°59'27.91"N 74°10'19.80"E	E	• Downwind of the project site during summer and monsoon months • Baseline for residential location near the project site.

S.N	**Sampling Location**	**Station Code**	**Distance w.r.t mine lease area**	**Geographical Coordinates**	**Direction w.r.t mine lease area**	**Justification for the selection**
3	Raghunathpura	AAQ3	0.5 km	25° 0'18.24"N 74° 9'17.23"E	E	• Downwind of the project site during summer and monsoon months • Baseline for residential location in close vicinity to project site.
4	NE of mine lease	AAQ4	-	25° 0'8.82"N 74° 8'47.53"E	Within ML	Represent the Project site towards NE
5	Champakheri	AAQ5	3.3 km	25° 1'46.31"N 74°10'32.59"E	NE	• Downwind of the project site during summer and monsoon months (May to August) • Baseline for residential location near the project site.
6	Sindesar Kalan	AAQ6	1.7 km	25° 1'41.51"N 74° 9'18.93"E	N	As per IMD data, this station is 3rd predominant downwind of the project site during monsoon and post monsoon seasons (Jan to March, October to Dec) Further, this station's AAQ data captures the baseline for residential location located in within the vicinity from the project site.
7	Bamnia Kalan	AAQ7	3.6 km	25° 2'47.27"N 74° 9'15.70"E	NNE	As per IMD data, this station is 3rd predominant downwind of the project site during post monsoon seasons at evening hrs (January to March, October to Dec) Further, this station's AAQ data captures the baseline for residential location located in within the vicinity from the project site towards NNE
8	Relmagra	AAQ8	2.8 km	25° 1'21.75"N 74° 6'47.78"E	NW	As per IMD data, this station is 2nd predominant downwind of the project site during post monsoon seasons at morning hrs (October to Dec) Further, this station's AAQ data captures the baseline for residential location located in within the vicinity from the project site

S.N	**Sampling Location**	**Station Code**	**Distance w.r.t mine lease area**	**Geographical Coordinates**	**Direction w.r.t mine lease area**	**Justification for the selection**
9	Sarvariya Khera	AAQ9	2.8 km	25° 0'16.61"N 74° 6'39.54"E	W	As per IMD data, this station is downwind of the project site during summer and monsoon season (June–July) and upwind direction during post monsoon and winter season (Jan-Feb, November- Dec.) Further, this station's AAQ data captures the baseline for residential location located in within the vicinity from the project site
10	Malikhera	AAQ10	2.4 km	24°59'22.79"N 74° 6'58.53"E	WSW	As per IMD data, this station is upwind of the project site during summer and monsoon season (May – June , July – September) Further, this station's AAQ data captures the baseline for residential location located in within the vicinity from the project site
11	Makhanpuriya	AAQ11	0.9 km	24°59'1.56"N 74° 8'49.27"E	S	As per IMD data, this station is 3rd predominant upwind of the project site during monsoon and post monsoon seasons (Jan to June, October to Dec) Further, this station's AAQ data captures the baseline for residential location located in within the vicinity from the project site
12	Amarpura	AAQ12	1.5km	24°59'21.04"N 74° 9'24.75"E	SE	As per IMD data, this station is upwind of the project site during winter and Post monsoon seasons (Jan to March, October to Dec) Further, this station's AAQ data captures the baseline for residential location located in within the vicinity from the project site

S.N	**Sampling Location**	**Station Code**	**Distance w.r.t mine lease area**	**Geographical Coordinates**	**Direction w.r.t mine lease area**	**Justification for the selection**
13	Gujariya Ka Khera	AAQ13	7.9km	24°56'0.02"N 74°11'30.31"E	SE	As per IMD data, this station is upwind of the project site during winter and Post monsoon seasons (Jan to March, October to Dec) Further, this station's AAQ data captures the baseline for residential location located little away from the project site
14	Damodarpura	AAQ14	8.5km	25° 1'32.97"N 74°13'47.11"E	NE	As per IMD data, this station is located upwind of the project site during summer and monsoon seasons (May to June, July to Sep) Further, this station's AAQ data captures the baseline for residential location located little away from the project site
15	Sakhrawas	AAQ15	8.7 km	25° 3'8.87"N 74° 3'57.00"E	NW	As per IMD data, this station is located downwind of the project site during winter, summer and Post monsoon seasons (Jan to April, Oct to Dec.) Further, this station's AAQ data captures the baseline for residential location located little away from the project site

Map Showing Ambient Air Quality Sampling Locations in the Study Area



Source: Survey of India toposheet

B) FREQUENCY AND PARAMETERS FOR SAMPLING

The ambient air quality monitoring has been carried out with a frequency of two days per week at fifteen locations covering one complete season (Pre-Monsoon season). The ambient air quality along with their frequency of sampling is given below:-

Table 3.4.3.1 (b): Monitored Parameters, Code of Practise & Detection Limits

S.N	Parameter	Code of Practice	Detection Limit
1	Particulate matter (PM_{10}) ($\mu g/m^3$)	IS 5182 (Part 23):2006 & CPCB guidelines	4 $\mu g/m^3$

S.N	Parameter	Code of Practice	Detection Limit
2	Particulate matter ($PM_{2.5}$) ($\mu g/m^3$)	IS 5182 (Part 23):2006 & CPCB guidelines	4 $\mu g/m^3$
3	Sulphur dioxide ($\mu g/m^3$)	IS 5182 (Part 2): 2001 & CPCB guidelines	3 $\mu g/m^3$
4	Oxides of Nitrogen ($\mu g/m^3$)	IS 5182 (Part 6): 2006 & CPCB guidelines	3 $\mu g/m^3$
5	Carbon monoxide ($\mu g/m^3$)	IS: 5182 (Part-X) & CPCB guidelines	0.01 mg/m^3
6	Ozone ($\mu g/m^3$)	IS-5182 (Part-IX):1974 & CPCB Guidelines	1 $\mu g/m^3$
7	Ammonia (NH_3)	Indophenol Blue Method	10 $\mu g/m^3$
8	Benzene (C_6H_6)	IS : 5182 (P-09)1974 – 2009	1 $\mu g/m^3$
9	Banzo-a-pyrene (BAP)	IS : 5182 (P-11)- 2006	0.1 ng/m^3
10	Arsenic (As)	IS : 5182 (P-12)2004 – 2009	1 ng/m^3
11	Nickel (Ni)	IS : 5182 (P-22)2004 – 2009	1 ng/m^3
12	Lead (Pb)	IS : 5182 (P-22)2004 – 2009	0.01 $\mu g/m^3$
13	Free Silica		1 $\mu g/m^3$

3.4.3.2 BASELINE DATA

The ambient air quality data were collected to find the existing regional emissions. The data are stated in table no. 3.4.3.2 (a) to 3.4.3.2 (h).

Table 3.4.3.2 (i) Ambient Air Quality Status

S. No.	Pollutant	Locations	No. of observation	Minimum ($\mu g/m^3$)	Maximum ($\mu g/m^3$)	Average ($\mu g/m^3$)	98th Percentile	CPCB Standards
1.	**SO_2**	AAQ 1	24	10	18	13	17.572	**80.0**
		AAQ 2		5	13	8	11.534	
		AAQ 3		5	13	7	11.864	
		AAQ 4		6	15	9	14.74	
		AAQ 5		6	12	8	11.648	
		AAQ 6		6	14	9	13.572	
		AAQ 7		7	17	11	15.68	
		AAQ 8		10	21	16	20.6	
		AAQ 9		4	12	8	12.2	
		AAQ 10		5	13	7	11.58	
		AAQ 11		6	12	9	12.2	
		AAQ 12		5	13	8	12.616	
		AAQ 13		4	10	7	10.2	

		AAQ 14		6	15	10	14.908	
		AAQ 15		4	12	8	11.08	
2.	**NO_2**	AAQ 1	24	14	30	22	28.636	**80.0**
		AAQ 2		10	22	15	22.108	
		AAQ 3		9	20	14	19.188	
		AAQ 4		10	23	16	22.378	
		AAQ 5		12	22	15	21.172	
		AAQ 6		12	27	18	26.708	
		AAQ 7		12	30	21	30.354	
		AAQ 8		17	35	29	37.264	
		AAQ 9		10	28	16	26.62	
		AAQ 10		11	30	15	26.904	
		AAQ 11		11	27	17	26.6	
		AAQ 12		11	26	17	25.554	
		AAQ 13		10	23	15	21.78	
		AAQ 14		11	32	18	30.452	
		AAQ 15		10	27	15	24.024	
3.	**PM_{10}**	AAQ 1	24	78	99	88	98.594	**100.0**
		AAQ 2		44	90	66	88.16	
		AAQ 3		50	90	67	85.768	
		AAQ 4		66	94	80	92.744	
		AAQ 5		52	90	73	89.54	
		AAQ 6		65	98	80	94.32	
		AAQ 7		68	89	76	88.54	
		AAQ 8		69	96	83	96.216	
		AAQ 9		70	91	81	90.324	
		AAQ 10		58	90	73	90	
		AAQ 11		58	88	71	84.704	
		AAQ 12		52	83	64	81.58	
		AAQ 13		50	81	66	80.54	
		AAQ 14		50	80	65	80	
		AAQ 15		45	78	61	76.16	
4.	**$PM_{2.5}$**	AAQ 1	24	25	51	36	50.064	**60.0**
		AAQ 2		22	54	34	50.39	
		AAQ 3		26	52	34	48.32	
		AAQ 4		21	46	32	45.156	
		AAQ 5		26	47	36	45.566	
		AAQ 6		31	59	41	58.54	
		AAQ 7		30	50	40	49.584	
		AAQ 8		29	50	43	50.054	
		AAQ 9		27	54	41	53.388	
		AAQ 10		25	47	33	46.094	

		AAQ 11		24	42	32	41.594	
		AAQ 12		21	47	31	46.202	
		AAQ 13		20	45	31	42.776	
		AAQ 14		20	49	33	47.336	
		AAQ 15		18	40	30	40.016	
5.	**CO**	AAQ 1	24	115	518	254	517.5	**2000.0**
		AAQ 2		115	345	214	345	
		AAQ 3		115	575	212	512.9	
		AAQ 4		115	690	261	610.65	
		AAQ 5		230	138	230	230	
		AAQ 6		115	690	249	539.4	
		AAQ 7		115	345	176	308.2	
		AAQ 8		0	690	319	690	
		AAQ 9		115	230	158	230	
		AAQ 10		115	345	188	345	
		AAQ 11		115	230	161	230	
		AAQ 12		115	345	217	345	
		AAQ 13		115	345	177	317.4	
		AAQ 14		115	460	223	423.2	
		AAQ 15		115	345	182	345	
6.	**NH_3**	AAQ 1		12	30	18	28.12	**400**
		AAQ 2		9	18	12	17.28	
		AAQ 3		BDL	12	11	12.164	
		AAQ 4		BDL	20	13	19.44	
		AAQ 5		BDL	20	13	20	
		AAQ 6		10	22	14	21.56	
		AAQ 7		10	20	16	20	
		AAQ 8		10	32	19	31.4	
		AAQ 9		10	20	12	19.12	
		AAQ 10		12	14	13	13.92	
		AAQ 11		10	16	12	15.82	
		AAQ 12		10	17	13	16.41	
		AAQ 13		10	14	12	13.88	
		AAQ 14		10	20	14	20	
		AAQ 15		10	16	12	15.76	
7.	**O_3**	AAQ 1		10	22	16	21.08	**180**
		AAQ 2		6	160	17	94.036	
		AAQ 3		4.20	20.00	9.20	17.24	
		AAQ 4		8.50	28.00	13.66	26.62	
		AAQ 5		5	24	12	22.16	
		AAQ 6		9	26	14	24.376	
		AAQ 7		6	162	17	95.852	

		AAQ 8		7	23	11	22.702	
		AAQ 9		1	17	10	16.6	
		AAQ 10		5	14	9	14.4	
		AAQ 11		5	16	9	14.994	
		AAQ 12		6	19	10	18.27	
		AAQ 13		4	14	8	14.4	
		AAQ 14		6	19	9	16.66	
		AAQ 15		6	12	8	11.848	
8.	**Pb**	AAQ 1		BDL	0.40	0.18	0.4	**1000**
		AAQ 2		0.05	0.30	0.15	0.286	
		AAQ 3		BDL	0.23	0.11	0.22	
		AAQ 4		BDL	0.80	0.23	0.76	
		AAQ 5		BDL	1.20	0.16	0.98	
		AAQ 6		0.05	0.20	0.09	0.1888	
		AAQ 7		0.04	0.12	0.07	0.1168	
		AAQ 8		0.02	0.55	0.14	0.484	
		AAQ 9		0.02	0.08	0.04	0.0772	
		AAQ 10		0.02	0.05	0.03	0.0488	
		AAQ 11		0.02	0.04	0.03	0.04	
		AAQ 12		0.02	0.10	0.05	0.099522	
		AAQ 13		0	0	0	0.04171	
		AAQ 14		0.02	0.15	0.05	0.1374	
		AAQ 15		0.02	0.05	0.03	0.0476	
9.	**Ni**	AAQ 1		BDL	3	2	2.5	**20**
		AAQ 2		1	2	1	1.758	
		AAQ 3		1.20	2.20	1.77	2.20	
		AAQ 4		1.20	3.90	2.04	3.70	
		AAQ 5		BDL	3	2	2.728	
		AAQ 6		1	4	2	3.318	
		AAQ 7		0	4	2	3.52	
		AAQ 8		1	4	2	3.32	
		AAQ 9		1	3	2	3.074	
		AAQ 10		1	4	2	3.576	
		AAQ 11		1	4	2	3.5	
		AAQ 12		1	4	2	3.46	
		AAQ 13		1	3	2	3.144	
		AAQ 14		1	7	3	6.721672	
		AAQ 15		1	2	2	2.156	
10.	**As**	AAQ 1		BDL	BDL	BDL	BDL	**6**
		AAQ 2		BDL	BDL	BDL	BDL	
		AAQ 3		BDL	BDL	BDL	BDL	
		AAQ 4		BDL	BDL	BDL	BDL	

		AAQ 5		BDL	BDL	BDL	BDL	
		AAQ 6		BDL	BDL	BDL	BDL	
		AAQ 7		BDL	BDL	BDL	BDL	
		AAQ 8		BDL	BDL	BDL	BDL	
		AAQ 9		BDL	BDL	BDL	BDL	
		AAQ 10		BDL	BDL	BDL	BDL	
		AAQ 11		BDL	BDL	BDL	BDL	
		AAQ 12		BDL	BDL	BDL	BDL	
		AAQ 13		BDL	BDL	BDL	BDL	
		AAQ 14		BDL	BDL	BDL	BDL	
		AAQ 15		BDL	BDL	BDL	BDL	
11.	**C_6H_6**	AAQ 1		BDL	BDL	BDL	BDL	**5**
		AAQ 2		BDL	BDL	BDL	BDL	
		AAQ 3		BDL	BDL	BDL	BDL	
		AAQ 4		BDL	BDL	BDL	BDL	
		AAQ 5		BDL	BDL	BDL	BDL	
		AAQ 6		BDL	BDL	BDL	BDL	
		AAQ 7		BDL	BDL	BDL	BDL	
		AAQ 8		BDL	BDL	BDL	BDL	
		AAQ 9		BDL	BDL	BDL	BDL	
		AAQ 10		BDL	BDL	BDL	BDL	
		AAQ 11		BDL	BDL	BDL	BDL	
		AAQ 12		BDL	BDL	BDL	BDL	
		AAQ 13		BDL	BDL	BDL	BDL	
		AAQ 14		BDL	BDL	BDL	BDL	
		AAQ 15		BDL	BDL	BDL	BDL	
12.	**BAP**	AAQ 1		BDL	BDL	BDL	BDL	**1**
		AAQ 2		BDL	BDL	BDL	BDL	
		AAQ 3		BDL	BDL	BDL	BDL	
		AAQ 4		BDL	BDL	BDL	BDL	
		AAQ 5		BDL	BDL	BDL	BDL	
		AAQ 6		BDL	BDL	BDL	BDL	
		AAQ 7		BDL	BDL	BDL	BDL	
		AAQ 8		BDL	BDL	BDL	BDL	
		AAQ 9		BDL	BDL	BDL	BDL	
		AAQ 10		BDL	BDL	BDL	BDL	
		AAQ 11		BDL	BDL	BDL	BDL	
		AAQ 12		BDL	BDL	BDL	BDL	
		AAQ 13		BDL	BDL	BDL	BDL	
		AAQ 14		BDL	BDL	BDL	BDL	
		AAQ 15		BDL	BDL	BDL	BDL	
13.	**Free**	AAQ 1		BDL	BDL	BDL	BDL	

	Silica	AAQ 2		BDL	BDL	BDL	BDL	
		AAQ 3		BDL	BDL	BDL	BDL	
		AAQ 4		BDL	BDL	BDL	BDL	
		AAQ 5		BDL	BDL	BDL	BDL	
		AAQ 6		BDL	BDL	BDL	BDL	
		AAQ 7		BDL	BDL	BDL	BDL	
		AAQ 8		BDL	BDL	BDL	BDL	
		AAQ 9		BDL	BDL	BDL	BDL	
		AAQ 10		BDL	BDL	BDL	BDL	
		AAQ 11		BDL	BDL	BDL	BDL	
		AAQ 12		BDL	BDL	BDL	BDL	
		AAQ 13		BDL	BDL	BDL	BDL	
		AAQ 14		BDL	BDL	BDL	BDL	
		AAQ 15		BDL	BDL	BDL	BDL	

Presentation of Results:-

The analysis results for the study period are presented in above monitoring tables. Various statistical parameters like 98th percentile, average, maximum and minimum values have been computed from the observed raw data for all the AAQ monitoring stations. These are compared with the standards prescribed by Central Pollution Control Board (CPCB) for rural and residential zone.

3.4.3.3 AIR QUALITY INDEX

The Air Quality Index (AQI) is an indicator of air quality, based on air pollutants that have adverse effects on human health and the environment.

AQI to be calculated by using the pollutant concentration data, the following table, and the following equation (linear interpolation):

$$I_P = \frac{I_{Hi} - I_{lo}}{BP_{Hi} - BP_{Lo}} (C_p - BP_{Lo}) + I_{Lo}$$

Where,

I_p = the index for pollutant p

C_p = the rounded concentration of pollutant p

BP_{Hi} = the breakpoint that is greater than or equal to Cp

BP_{Lo} = the breakpoint that is less than or equal to Cp

BP_{Hi} = the breakpoint that is greater than or equal to Cp

I_{Hi} = the AQI value corresponding to BP_{Hi}

I_{Lo} = the AQI value corresponding to BP_{Lo}

AQI is divided into six categories

Air Quality index (AQI) values	Levels of health concern	Colors
When the AQI is in this range	Air quality conditions	Symbolized by this color
0 – 50	Good	Green
51 - 100	Moderate	Yellow
101 – 150	Unhealthy for sensitive Groups	Orange
151- 200	Unhealthy	Red
201 – 300	Very Unhealthy	Purple
301 - 500	Hazardous	Maroon

3.4.3.4 Existing Traffic Scenario

Traffic scenario at the existing access road and traffic after the proposed expansion, based on the anticipated increased traffic was compared with volume capacity ratio as per IRC 106-1990 for two lane paved shoulder road.

The same is given below in table

Table 3.4.3.4.1 Existing Traffic Scenario

Road	Peak hour traffic (volume PCU /hr)	Capacity (PCU/hr)	Existing V/C	Level of Service (LOS)
Current traffic				
SK Mine to Dariba	315	1500	0.196	A
Dariba to Fatehnagar	513	1500	0.32	B

Capacity as per IRC-106;1990 for guideline, for capacity ,for Urban roads page 11 table 2

V= Volume in PCU's/hr & C= Capacity in PCU's/ hr LOS = Level of Service

Table 3.4.3.4.2 Traffic Scenario Post expansion

Road (After expansion)	**Peak hour traffic (volume PCU/ hr) [V]**		**Capacity as per IRC 1990 Guidelines for Urban roads (PCU/hr) [C]**		**Proposed [V]/[C]**	**Level of Service (LOS)**
	Baseline	**Additional**	**Total**			
TS1: SK Mine to Dariba	315	10	325	1500	0.22	B
TS2: Dariba to Fatehnagar	513	3	516	1500	0.34	B

Capacity as per IRC-106;1990 for guideline, for capacity ,for Urban roads page 11 table 2

V= Volume in PCU's/hr & C= Capacity in PCU's/ hr LOS = Level of Service

Table 3.4.3.4.3 IRC V/C and performance class

V/C	**LOS**	**Performance**
0.0 - 0.2	A	Excellent
0.2 - 0.4	B	Very Good
0.4 - 0.6	C	Average
0.6 - 0.8	D	Poor

V/C	LOS	Performance
0.8 - 1.0	E	Very Poor
1.0 & above	F	Worst

As per the **Table** and **Table** the peak traffic level of existing road and after expansion for the both the access road was found to be in the category of excellent to very good due to current very low traffic. Post expansion will have minimal impact on the current traffic as most of the traffic will be restricted between SK mine and Dariba complex and to the tailing dam to some extent.

3.5 WATER ENVIRONMENT

The mining lease is situated in Railmagra Block of Rajsamand District, which is categorized as **"over-exploited"** block as per the CGWA classification. The mine working will intersect the groundwater table.

3.5.1 DRAINAGE:

The hydrology of the area has been studied in order to assess the impact of the mining activities on the water quantity and water quality of the Banas River and tributaries.

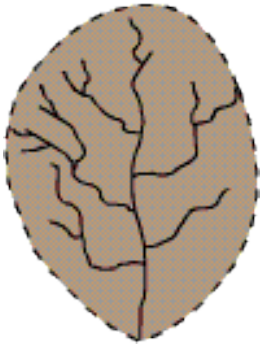
The study area is drained by Banas River and its tributaries towards North, North west, East and is drained by Berach River towards South of study area. The river as well as tributaries are ephemeral and flow only in response to heavy precipitation. The Banas rises in Aravalli Hills about 5 km from Kumbhalgarh Fort and flowing Southwards meets the Gogunda Plateau. It flows through Rajsamand and Relmagra Tehsils and crosses into Chittorgarh and Bhilwara Districts. The predominant drainage pattern in the Western hill ranges is rectangular to sub-rectangular and it is dendritic to sub-dendritic in rest of the area. Drainage pattern in the Western hill region is controlled by fractures & joints and in rest of the area by subsurface lineaments.

The lease area is devoid of any surface water body such as lake, dam or river. Banas River flows about 4.4km towards North of the lease. Numbers of dug wells exist within the study area with diameter varying from 1 m to 6 m and depth ranging from 5 m to 20 m.

Map showing drainage patterns within 10 km study area is detailed as under:

DENDRITIC DRAINAGE PATTERN:

A dendritic drainage pattern is the most common form and looks like the branching pattern of tree roots. It develops in regions underlain by homogeneous material. That is, the subsurface geology has a similar resistance to weathering so there is no apparent control over the direction the tributaries take. Tributaries joining larger streams at acute angle (less than 90 degrees).



The proposed study area is indicating the dendritic drainage pattern at site in 10 km radius, which is shows major directions of drainage, is east to west direction.

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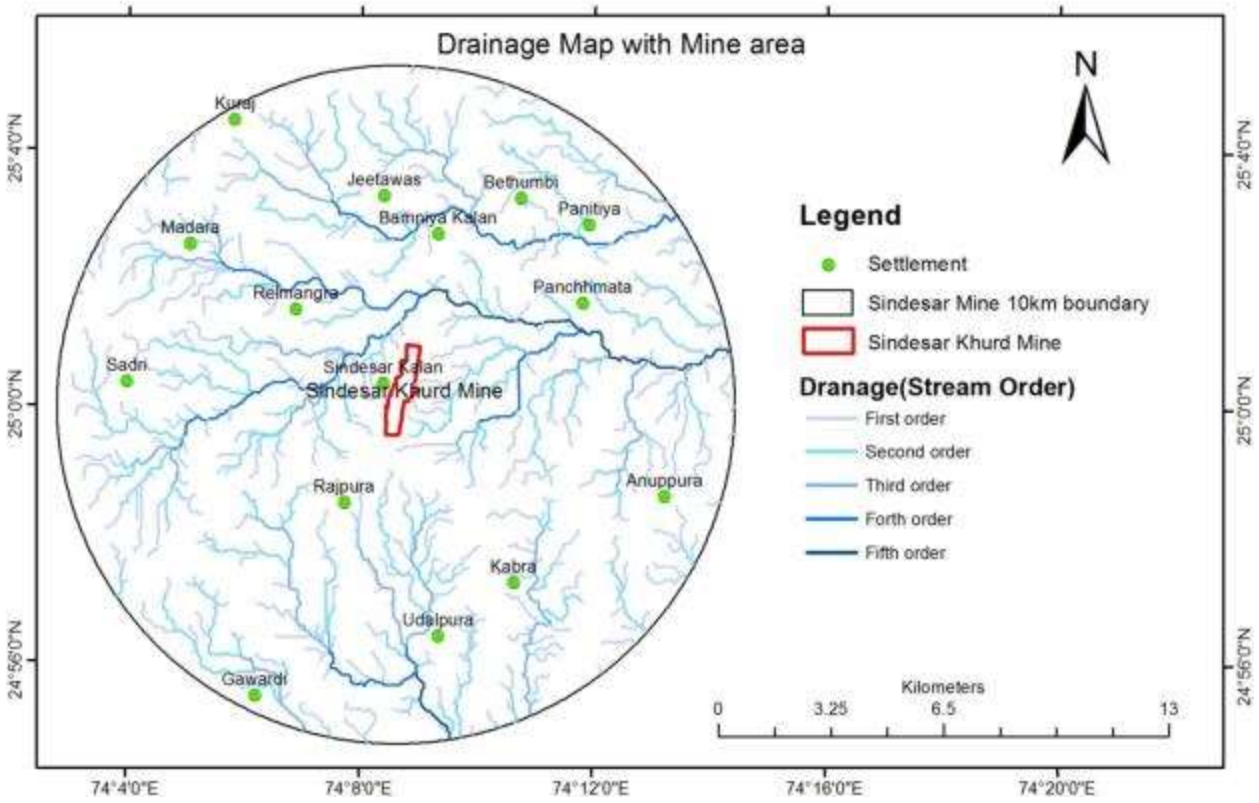


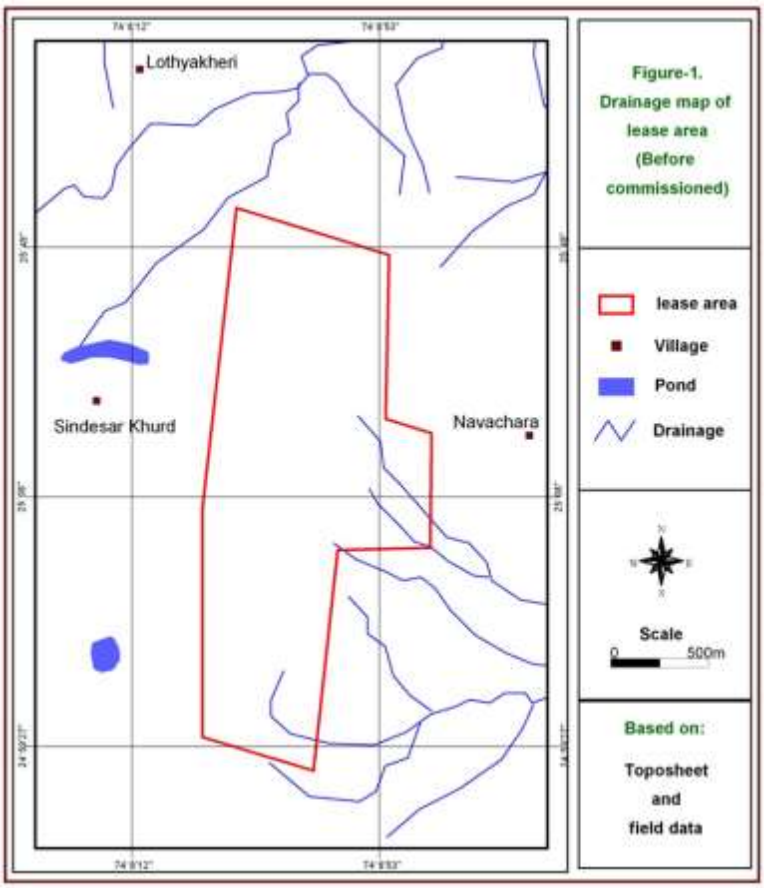
Fig. : Drainage map

3.5.1.1 Drainage pattern in lease area

The drainage pattern of the lease area is shown in

0Figure where four streams of first order originate near the Eastern border of the lease area. The catchment areas of these streams originating inside the lease area is small and these streams carry limited surface runoff during the rains. These first order streams will continue to flow uninterrupted as underground mining will be carried out and no surface activity is proposed on the Eastern slope of the hill.

0Figure: Drainage of Mine lease Area



Source: Hydrogeology Report, HZL

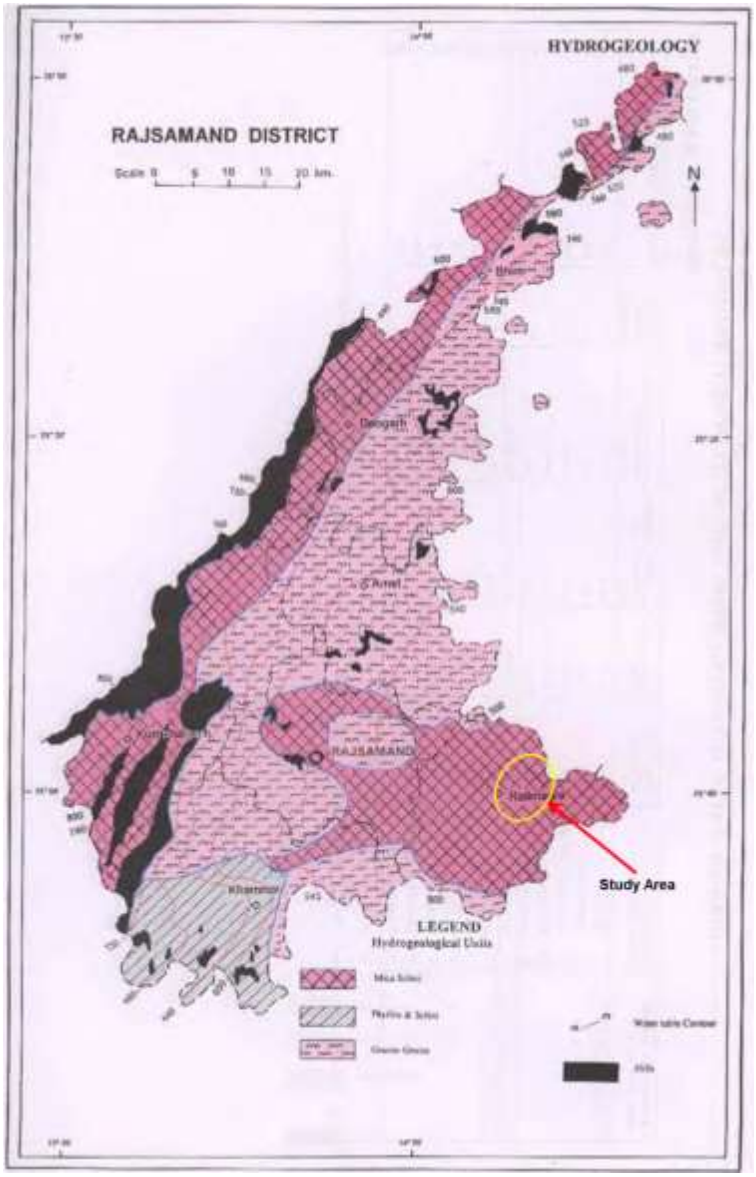
3.5.2 HYDROGEOLOGY:

The principal s0ource of water in the study area is groundwater. Ground water is the accumulation of water below the ground surface, caused by percolation of rainfall through pores and crevices. Percolated water accumulates when it reaches some impervious strata consisting of confined clay or confined rocks. Open wells and hand pumps are the major groundwater source of drinking water and are also used for limited irrigation. Tube wells in the villages wherever available are used mainly for irrigation purpose and to a limited extent for domestic purpose.

The occurrence of ground water in the study area is mainly controlled by the topographic and structural features present in the geological formations. The principal source of ground water is precipitation. Out of the total rainfall received, a major part of it is lost as run-off

and by evapo-transpiration through soil and vegetation. Only a small part of rainfall infiltrates down to reach ground water body. Groundwater occurs mainly under water table conditions in all formations. The important water bearing formation besides alluvium is the granite gneisses,0 schists, limestone and phyllites. In the hard rocks the occurrence and movement of ground water is controlled through the foliation/bedding planes, fissures, joints, solution cavities and other structural weak planes. The weathered mantle of the hard rocks yields good discharge of water. In alluvium, ground water occurs in the interstices of unconsolidated sand and gravel. Locally semi confined conditions are encountered both in hard rock and alluvium. The hydrogeology of Rajsamand district with study area marked is shown in Fig. (a).

0Fig (a): Hydrogeology of Rajsamand District



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3.5.2.1 GROUND WATER POTENTIAL

Ground water resources availability, utilization stage of development in Railmagra Block of Rajsamand District (as on 2009) is summarized as under:-

Table: Ground water potential

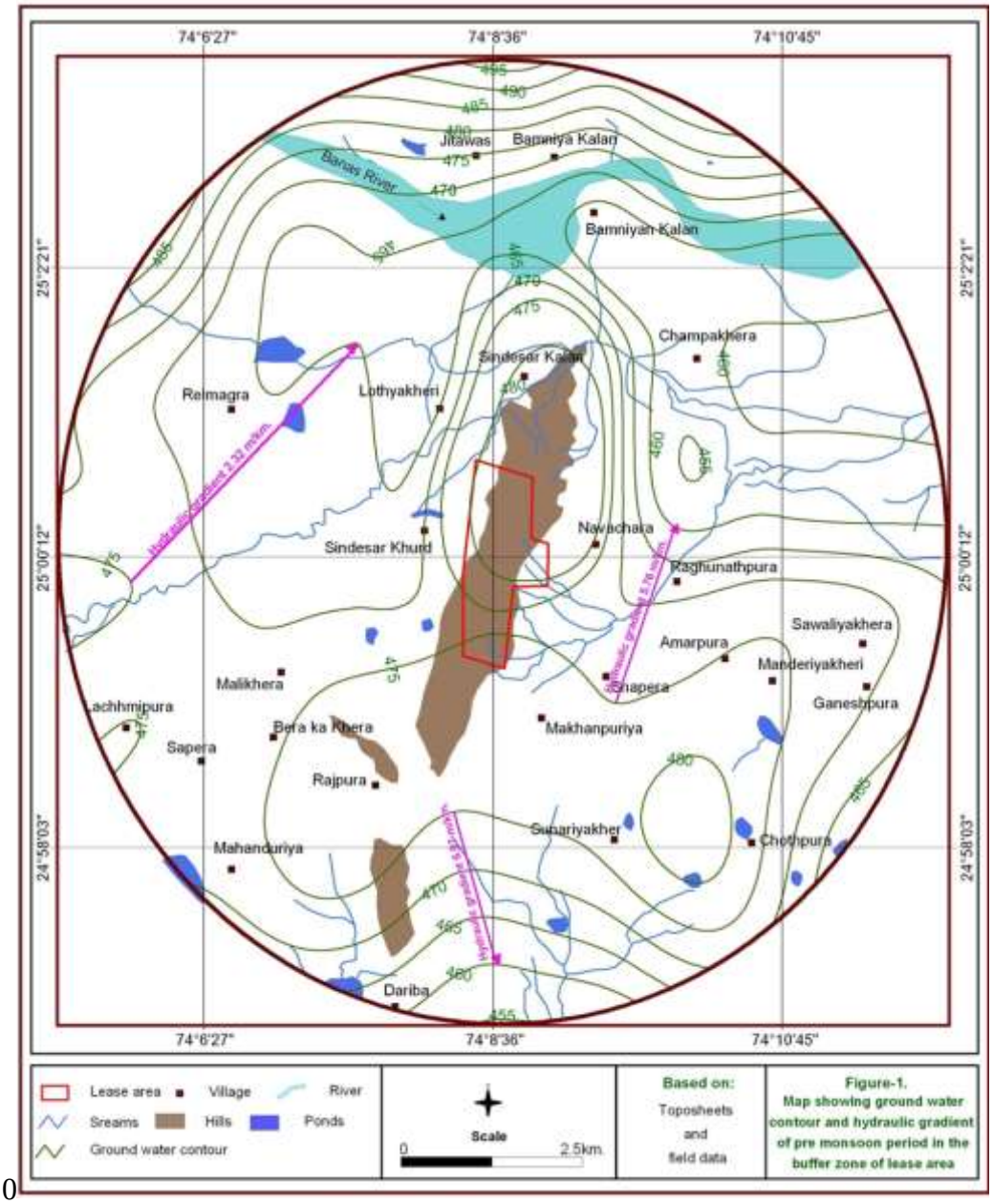
S. No.	Particulars	Details
1.	Net ground water availability	13.0862 MCM
2.	Annual ground water draft:	18.8620 MCM

a.	Irrigation	17.5206 MCM
b.	Domestic & Industrial use	1.3414 MCM
2.	**Total**	
3.	Stage of ground water development (%)	-144%
4.	Category	Over-exploited
(Source: CGWA Publication - 2013)		

3.5.2.2 GROUND WATER MOVEMENT:

A review of the topography and drainage pattern of the buffer zone reveals that there is a drainage divide passing in the central part of the buffer zone demarcating two water sheds, Banas river water shed forms a major part of the buffer zone covering northern part while a small area in the southern area of the buffer zone belongs to Berach river water. The ground water flow, which follows in general the surface topography has flow in two directions. The 0main ground water flow direction is towards the north east and towards Banas river while the southern part has ground water flow direction in southern direction as shown in Fig (a). The hydraulic gradient of ground water flow on the western side of the hill is towards Banas river with value of 2.32 m/km while in the eastern side is 5.76 m/km. The lower hydraulic gradient in the western part of Banas river water shed is due to ground water flow mainly through alluvial zone while in the eastern part, it is through mica schist which has lower hydraulic conductivity. The hydraulic gradient in the southern part is 6.97 m/km towards the south indicating ground water flow through metamorphic with very low hydraulic conductivity.

Fig: Groundwater level and Hydraulic Gradient in the study area



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3.5.3 WATER QUALITY:

The baseline water quality in the study area was analysed for ground and surface water samples. The sampling locations were selected based on reconnaissance survey with the considerations of:

- 0presence of water resource;
- access to water resource; and
- representative coverage of study area.

The quality of groundwater water was compared with IS: 10500 and surface water was compared with CPCB discharge standard for aquatic resources. Total of 8 groundwater locations and 2 surface water locations were identified. The details of the sampling locations identified in the study area for water quality monitoring are given in Table (a).

The water quality was assessed for physical, chemical and bacteriological parameters as per the Bureau of India Standards IS: 10500 specifications with additional parameters such as COD, BOD & DO etc.

Table (a) Analytical Protocol followed for Water Quality Monitoring and Analysis

S. N	Parameter	Protocol Followed	Detection Limit
1.	True Colour, Hazen Unit	IS:3025 (Part-4)	1
2.	Odour	IS:3025 (Part-5)	-
3.	Taste	IS:3025 (Part-7&8)	-
4.	Turbidity, NTU	IS:3025 (Part-10)	1
5.	pH	IS:3025 (Part-11)	2
6.	Total Hardness (as $CaCO_3$), mg/l	IS:3025 (Part-21)	6.6
7.	Iron (as Fe), mg/l	IS:3025 (Part-53)	0.3
8.	Chlorides (as Cl), mg/l	IS:3025 (Part-32)	1
9.	Fluoride (as F), mg/l	IS:3025 (Part-23)	0.1
10	Total Dissolved solids, mg/l	IS:3025 (Part-16)	25
11	Magnesi0um (as Mg), mg/l	IS:3025 (Part-46)	10
12	Calcium (as Ca), mg/l	IS:3025 (Part-40	1
13.	Copper (as Cu), mg/l	IS:3025 (Part-42)	0.01
14.	Manganese as Mn, mg/l	IS:3025 (Part-35)	0.01
15.	Sulphate (as SO4), mg/l	IS:3025 (Part-24)	1
16.	Nitrate (as NO3), mg/l	IS:3025 (Part-34)	1
17.	Phenolic Compounds (as C_6H_5OH), mg/l	IS:3025 (Part-43)	0.001
18.	Mercury (as Hg), mg/l	IS:3025 (Part-48) Mercury Analyzer	0.001
19.	Cadmium (as Cd), mg/l	IS:3025 (Part-41)	0.002
20	Selenium (as Se), mg/l	IS:3025 (Part-56)/IS 15303	0.01
21.	Arsenic (as As), mg/l	IS:3025 (Part-37)	0.01
22.	Cyanide (as CN), mg/l	IS:3025 (Part-27)	0.002

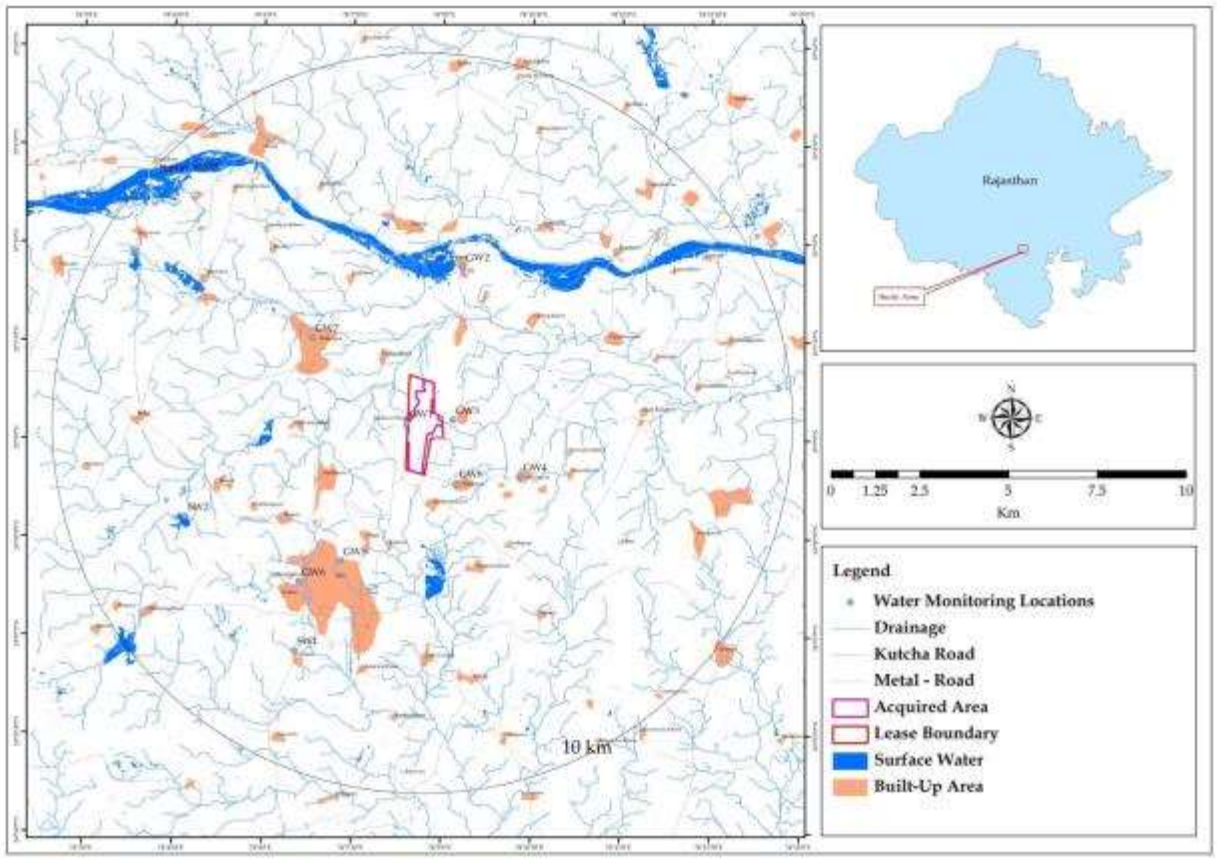
S. N	Parameter	Protocol Followed	Detection Limit
23.	Lead (as Pb), mg/l	IS:3025 (Part-47)	0.01
24.	Zinc (as Zn), mg/l	IS:3025 (Part-49)	0.2
25.	Anionic D0etergents (MBAS), mg/l	Annex. K , IS 13428	0.1
26.	Chromium (as Cr+6), mg/l	IS:3025 (Part-52)	0.01
27.	Mineral Oil, mg/l	APHA 5520 C & IS 3025 (Part 39)	0.1
28.	Alkalinity (as CaCO3), mg/l	IS:3025 (Part-23)	0.5
29.	Aluminium (as Al), mg/l	IS:3025 (Part-55)	0.01
30.	Boron (as B), mg/l	IS:3025 (Part-29)	0.01
31.	Barium	Annex. F, IS 13428 / IS 15302	0.01
32.	Molybdenum (as Mo)	APHA Method	0.01
33.	Sulphide (as H_2S)	IS:3025 (Part-29)	0.05
34.	Nickel (as Ni)	IS:3025 (Part-54)	0.01
35.	TPH	ASTM D3921-96-2011	1
37.	MPN Coliform/ 100 ml	IS : 1622, 1981 (2003)	2
38..	Tests for detection of E.Coli	IS : 1622, 1981 (2003)	2
39.	Dissolved Oxygen, mg/l	APHA 4500 O-C	0.1
40.	Salinity, parts per thousand	APHA 2520 B	0.0155
41.	Chemical Oxygen Demand, mg/l	APHA 5220 B	4
42	Biochemical Oxygen Demand (at 20°C for 5 days), mg/l	IS:3024 (Part-44)	0.1

Table (b): Water Sampling Locations in the study area

S.N.	Sampling Location	Station Code	Type of Sample	Distance w.r.t boundary of ML	Geographical Coordinates	Direction w.r.t lease area	Justification for the selection
Ground water sampling locations							
1	Sindesar Khurd	GW1	Ground Water	0.2 km	25° 0’14.86”N 74° 8’24.18”E	W	Representing groundwater quality for use in domestic services by village located in close vicinity to the project site.
2	Bamnia Kalan	GW2	Ground Water	3.6 km ;	25° 2’38.48”N 74° 9’20.09”E	NNE	Representing groundwater quality for use in domestic services by village located towards NNE the project site.

S.N.	Sampling Location	Station Code	Type of Sample	Distance w.r.t boundary of ML	Geographical Coordinates	Direction w.r.t lease area	Justification for the selection
3	Raghunathpura	GW3	Ground Water	0.3 km ;	25° 0’17.87”N 74° 9’10.62”E	E	Representing groundwater quality for use in domestic services by village located in close vicinity towards East of the project site.
4	Amarpura	GW4	Ground Water	2.7 km ;	24°59’26.27”N 74°10’19.11”E	SE	Representing groundwater quality for use in domestic services by village located towards SE of project site.
5	Rajpura	GW5	Ground Water	3.2 km ;	24°58’8.32”N 74° 7’18.39”E	SSW	Representing groundwater quality for use in domestic services by village located towards SSW of the project site.
6	Mahenduria	GW6	Ground Water	4.3 km ;	24°57’51.49”N 74° 6’40.54”E	SW	Representing groundwater quality for use in domestic services by village located towards SW of the project site.
7	Relmagra	GW7	Ground Water	3.7 km ;	25° 1’32.46”N 25° 1’32.46”N	NW	Representing groundwater quality for use in domestic services by village located towards NW of the project site.
8	Shivpura	GW8	Groundwater	1.08 km	24°59'19.71"N, 74° 9'14.71"E	SE	Representing groundwater quality for use in domestic services by village located close to the project site towards SE of the project site.
Surface water sampling locations							
9	Anjana tank	SW1	Surface Water	6.1 km ;	24°56’45.88”N 74° 6’32.47”E	SW	Representing surface water quality in SW portion of the study area. The pond is being used for irrigation and cattle drinking purposes.
10	Bharai dam	SW2	Surface Water	6.4 km ;	24°58’48.17”N 74° 4’41.94”E	WSW	Representing surface water quality in WSW portion of the study area. The dam is being used for irrigation and cattle drinking purposes.

Water Sampling locations in the Study Area



Source: Survey of India toposheet and DEM

Table (c): Primary Water Quality Criteria for Designated-Best-Use-Classes

Designated-Best-Use	Category	Criteria Description
Drinking Water Source without conventional treatment but after disinfection	A	Total Coliforms Organism MPN/100ml shall be 50 or less pH between 6.5 and 8.5 Dissolved Oxygen 6mg/l or more Biochemical Oxygen Demand 5 days 20^{o}C 2mg/l or less
Outdoor bathing (Organized)	B	Total Coliforms Organism MPN/100ml shall be 500 or less

		pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more Biochemical Oxygen Demand 5 days 20^{o}C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more Biochemical Oxygen Demand 5 days 20^{o}C 3mg/l or less
Propagation of Wild life and Fisheries	D	pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	pH between 6.0 to 8.5 Electrical Conductivity at 25^{o}C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/l
	Below-E	Not Meeting A, B, C, D & E Criteria

Source: CPCB

Table: Results of GW & SW analysis

		Sindesar Khurd (opposite S.K.Mines)	Bamnia Kalan	Raghunathpura	Amarpura	Rajpura	Mahenduria	Relmagra	Shivpura	Anjana talab	Bharai Dam
Parameters	**Unit**	**GW-01**	**GW-02**	**GW-03**	**GW-04**	**GW-05**	**GW-06**	**GW-07**	**GW-8**	**SW 1**	**SW 2**
pH value	-	6.62	7.65	7.05	7.55	7.18	7.09	7.28	7.35	7.85	7.22
Temperature	^{0}C	27.5	27	28	30	28	30	29	29	28.5	30.5
Turbidity	NTU	<1	<1	<1	2.8	3.2	2.2	3.6	2.6	<1	8
Total Hardness (as CaCO3)	mg/L	972	165	436	51	500	932	552	228	18	312

Total Alkalinity (as $CaCO_3$)	mg/L	245	295	412	278	355	372	1240	825	420	495
Chlorides (as Cl)	mg/L	388.20	110.50	128.80	220.90	240.60	560.60	810.60	180.40	77.20	255.50
Sulphate (as SO_4)	mg/L	180.4	78.4	30.2	78.2	210.2	250	210.6	40.4	8.8	80.4
Nitrite	mg/L	0.37	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Nitrate (as NO_3)	mg/L	0.084	0.55	0.62	0.98	0.65	0.38	0.55	0.23	2.22	3.46
Fluoride (as F)	mg/L	0.5	1.15	1.1	BDL	BDL	BDL	BDL	BDL	0.55	0.88
Sodium (Na)	mg/L	98.80	130.40	55.60	280.60	265.40	580.20	1008.00	1122.00	10.60	180.20
Potassium (K)	mg/L	7.77	3.56	3.89	8.55	2.45	5.55	6.78	4.43	2.20	5.10
Salinity	ppt	1.3882	0.482	0.541	0.9221	1.0425	2.2985	28992	0.8954	0.4587	0.7887
Total Nitrogen	mg/L	2.88	1.77	1.62	2.32	2.95	4.4	3.5	2.2	2.72	5.35
Total Phosphorus	mg/L	0.75	0.55	0.82	0.9	0.82	1.05	1.11	0.82	7.89	70.4
DO	mg/L	3.3	2.8	3	3.1	3.9	3.1	3.6	2.9	4.8	5.2
BOD	mg/L	0.6	0.4	0.6	0.4	0.8	1.4	0.2	1.4	6.8	16
COD	mg/L	14	6	12	10	12	16	10.6	17.8	44	160
Phenolic Compounds (as C_6H_5OH)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Lead (as Pb)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Iron (as Fe)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.41
Arsenic (as As)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium (as Cd)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total Chromium (as Cr)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chromium Hexavalnt (as $Cr+^{6}$)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury (as Hg)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Copper (as Cu)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc (as Zn)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Selenium (as Se)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Oil & grease	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total Coliform	mg/L	<2	<2	<2	21	<2	<2	10	22	<2	400
Faecal Coliform	mg/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Colour	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Odour	mg/L	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable

TDS	mg/L	1310	445	460	955	1028	2225	2802	955	85.5	852
RFC	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Boron	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sulphide	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cyanide	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Results & Discussions:

Physico-Chemical Parameters

Ground water

- pH of the groundwater samples were found in the range of 6.62 to 7.85 as against the drinking water norm of 6.5 to 8.5. Graphical representation of pH concentration in the groundwater samples are given in **Fig 1.**
- The level of dissolved solids in the groundwater samples varied from 445 mg/l to 2802 mg/l. GW-2 (Bamnia Kalan) and GW-3 (Raghunathpura) were observed to have TDS within acceptable limit, while GW-4 (Amarpura), GW-5(Rajpura),and GW-8(Shivpura) were observed to have TDS above the acceptable limit, however within the permissible limit of 2000 mg/l. Groundwater sample at GW-6 (Mahenduria) and GW-7(Relmagra) was found to have TDS above the permissible limit. Graphical representation of TDS concentration in the groundwater samples is given in **Fig 2.**
- Total hardness in the groundwater samples varied from 51mg/l to 972 mg/l. Groundwater at GW-2 (Bamnia Kalan) and GW-4 (Amarpura) site was observed to be within the acceptable limit of 200 mg/l, whereas groundwater samples, GW-3 (Raghunathpura), GW-5 (Rajpura), GW-7 (Relmagra) and GW-8 (Shivpura) observed to have total hardness above the acceptable

limit, however within permissible limit of 600 mg/l. Groundwater sample at GW-1 (Sindesar Khurd) and GW-6(Mahenduria)was found to have total hardness above the permissible limit. Graphical representation of TDS concentration in the groundwater samples is given in **Fig 3.**

- The chloride concentration ranged from 110.50 mg/l to 810.60 mg/l in the groundwater samples. Most of the groundwater samples had chloride concentration was found to be below the acceptable limits (250 mg/l) except GW-1 (Sindesar Khurd), GW-6 (Mahenduria) and GW-7(Relmagra), however these samples were found to have chloride within the permissible limit of 1000 mg/l.
- Alkalinity varied from 245 mg/l to 1240 mg/l in the groundwater samples. Total alkalinity was found to be exceeded the acceptable limit (200 mg/l) in all the water samples, however most of samples except GW-7 (Relmagra) and GW-8 (Shivpura), were observed to have alkalinity concentration within permissible limit of 600 mg/l. Graphical representation of alkalinity concentration in the groundwater samples is given in **Fig 4.**
- The fluoride level in the most of the groundwater samples was observed to be Below Detectable Limit of 1.14 mg/l. GW-1(Sindesar Khurd) have fluoride concentration below the acceptable limit, however, at GW-2 (Bamnia Kalan) and GW-3 (Raghunathpura) the fluoride concentration is found to have above the acceptable limit, but found within permissible limit of 1.5 mg/l.
- The Sulphate and nitrate concentrations in the groundwater samples was observed to be in the range of 30.2 mg/l to 250 mg/l (for Sulphate) and from 0.37 to BDL (for nitrate). Sulphate at most of the locations except GW-1 (Sindesar Khurd), GW-2 (Bamnia Kalan), GW-3 (Raghunathpura) and GW-4(Amarpura) were found to be within the acceptable concentration limit of 200 mg/l.
- Level of Phenolic compounds was observed to be BDL in all the groundwater samples.

Surface water

SW-1 Anjana Tank

The pond has limited use in terms of human consumption and is one of the surface water resources where water was observed during the summer season. During monsoon and post-

monsoon, when water body receives rain water and runoff, this water body can be utilised as outdoor bathing (Category B) and propagation of wildlife and fisheries (Category D). The monitoring result shows that pH value was 7.85. The DO and BOD level was 4.8mg/l and 6.8 mg/l respectively. The coliform was <2. The analyzed water quality of the Anjana Tank sample indicates water was not suitable for outdoor bathing, i.e. Class 'B', however, it is fit for propagation of wildlife and fisheries, i.e. Class 'D'

SW-2 Bharai Dam

The dam water is used for irrigation and cattle drinking and is one of the surface water resources where water was available during the summer season. The monitoring result shows that pH value was 7.22. The DO and BOD level was 5.2 mg/l and 16 mg/l respectively. The Coliform contents were observed to be 400 organisms/100ml. The Sodium and chloride content was 180.20 mg/l was 255.50 mg/l respectively. The analyzed water quality of the Bharai Dam sample indicates water was not suitable for irrigation purpose, i.e. Class 'E', however, it is fit for propagation of wildlife and fisheries, i.e. Class 'D'.

Figure 1: Graphical Representation of pH in Groundwater Samples

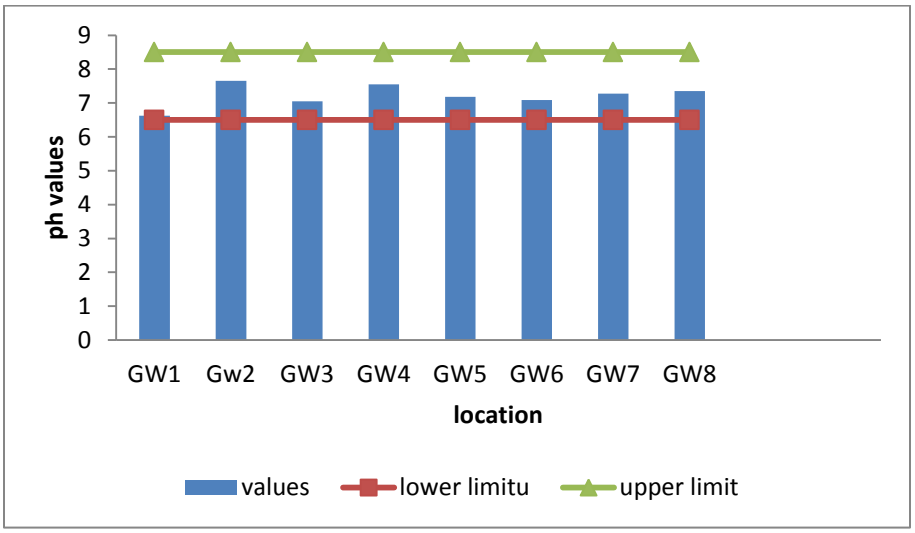


Figure:-2 Graphical Representation of TDS in Groundwater in the Study Area

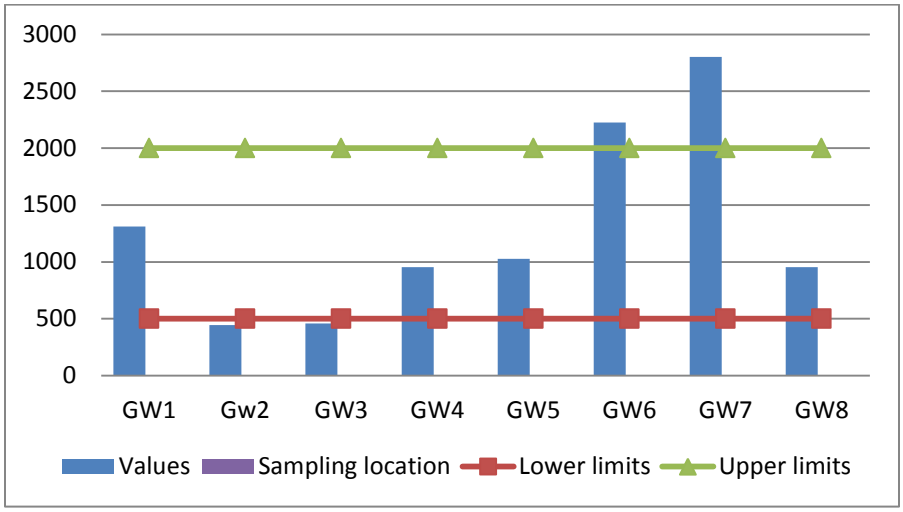


Figure 3: Graphical Representation of Total Hardness in the Study Area

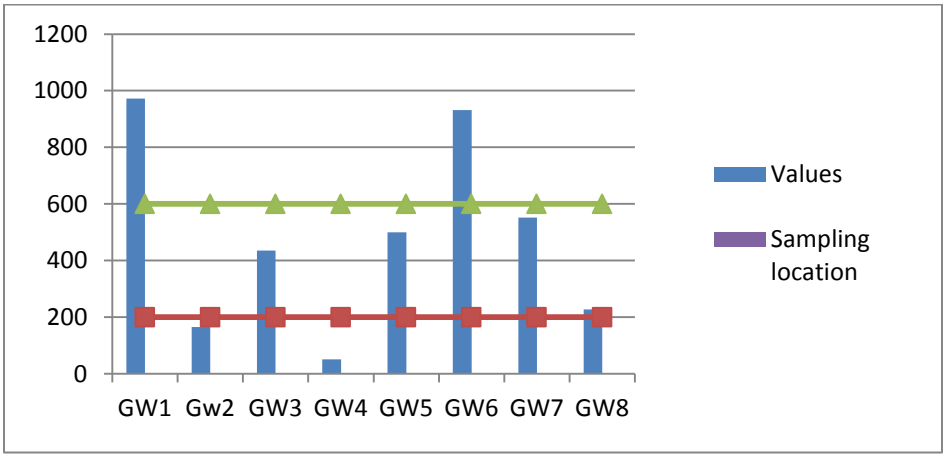
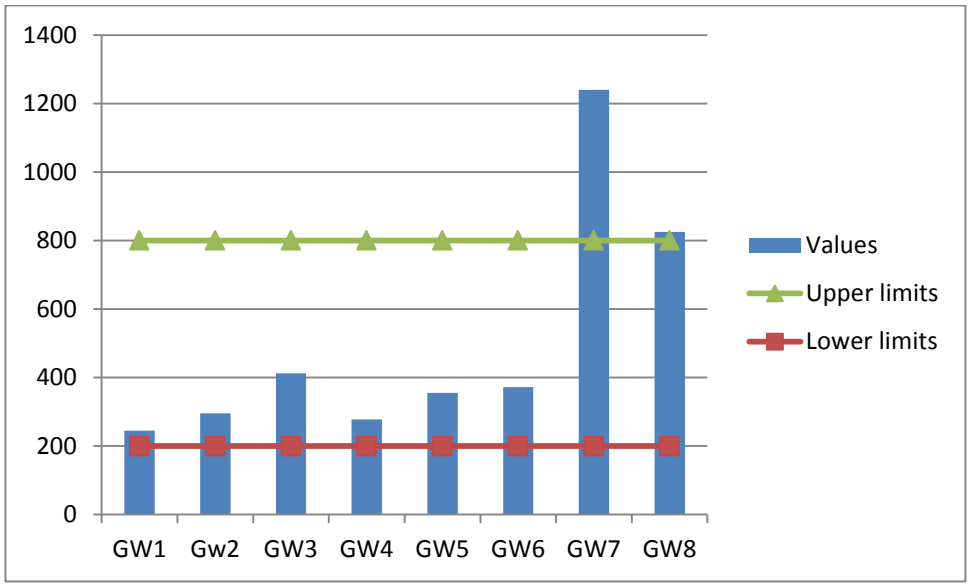


Figure 4: Graphical representation of Total Alkalinity in the Study Area



3.6 NOISE ENVIRONMENT

3.6.1 NOISE LEVEL SURVEY

The physical description of sound concerns its loudness as a function of frequency. Noise in general is sound, which is composed of many frequency components of various types of loudness distributed over the audible frequency range. The most common and universally accepted scale is the A weighted scale, which is measured as dB (A). This is more suitable for audible range of 20 to 20,000 Hz. The scale has been designed to weigh various components of noise according to the response of human ear. The environmental impact of noise can have several effects varying from Noise Induced Hearing Loss (NIHL) to annoyance depending on loudness of noise.

The main objective of noise monitoring in the study area is to establish the baseline noise level and assess the impact of the total noise expected to be generated during the project operations around the project site.

3.6.2 IDENTIFICATION OF SAMPLING LOCATIONS

A preliminary reconnaissance survey has been undertaken to identify the major noise generating sources in the area. Noise at different generating sources has been identified based on the residential, industrial and commercial activities in the area.

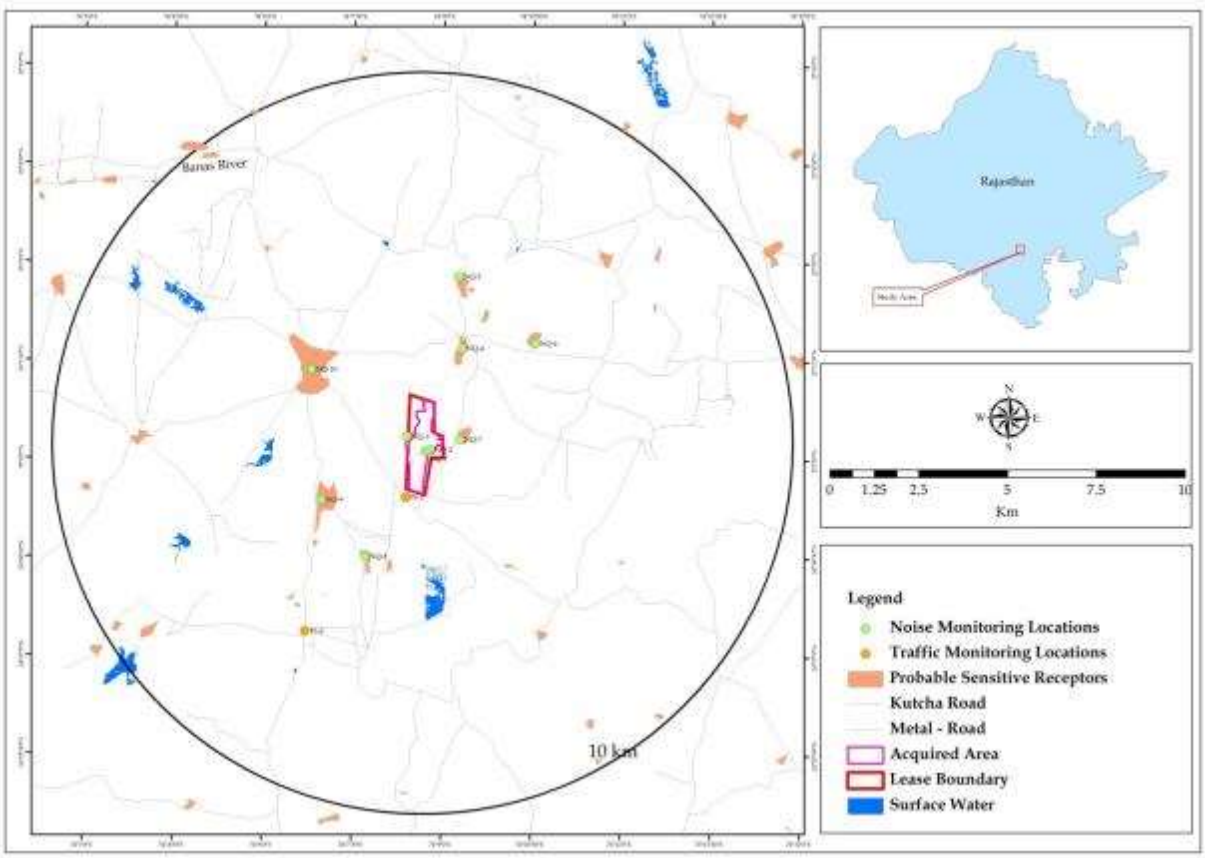
The noise monitoring has been conducted for determination of noise levels at ten locations covering both core and buffer zone in the study area. The noise levels at each location were recorded for 24-hrs. The environment setting of each noise monitoring location is given in Table.

Table: DETAILS OF NOISE MONITORING LOCATIONS

S N.	Sampling Location	Station Code	Type of Activity	Geographical Coordinates	Distance (km) w.r.t border of ML	Direction w.r.t ML	Remarks
1.	Mine Lease Area	NQ 1	Mining (Industrial)	25° 0’7.22”N	Within ML		Represent the Noise level within the Project site
2.	NE Mine Lease Area	NQ 2	Mining (Industrial)	74° 8’42.68”E	Within ML	NE	Represent the Noise level within the Project site
3.	Sindesar Khurd	NQ 3	Residential	25° 0’20.72”N 74° 8’24.38”E	0.70	NW	Represents residential area in North Western part of the study area and in close vicinity to the Project site.
4.	Sindesar Kalan	NQ 4	Residential	25° 1’41.51”N 74° 9’18.93”E	1.8 km	N	Represents residential area in Northern part of the study area and in close vicinity to the Project site.
5.	Bamnia Kalan	NQ 5	Residential	25° 2’47.27”N 74° 9’15.70”E	3.6 km	NNE	Represents residential area in NNE part of the study area and in close vicinity to the Project site.

S N.	Sampling Location	Station Code	Type of Activity	Geographical Coordinates	Distance (km) w.r.t border of ML	Direction w.r.t ML	Remarks
6.	Champa kheri	NQ 6	Residential	25° 1'46.31"N 74°10'32.59"E	3.5 km	NE	Represents residential area in North eastern part of the study area and in close vicinity to the Project site.
7	Raghunathpura	NQ 7	Residential	25° 0'18.24"N 74° 9'17.23"E	1.6 km	E	Represents residential area in eastern part of the study area and in close vicinity to the Project site.
8	Rajpura	NQ 8	Residential	24°58'30.79"N 74° 7'42.97"E	2.8 km	SSW	Represents residential area in SSW part of the study area and in close vicinity to the Project site.
9	Malikhera	NQ 9	Residential	24°59'22.79"N 74° 6'58.53"E	2.4 km ;	WSW	Represents residential area in WSW part of the study area and in close vicinity to the Project site.
10	Relmagra	NQ 10	Residential	25° 1'21.75"N 74° 6'47.78"E	2.5 km	NW	Represents residential area in North western part of the study area and in close vicinity to the Project site.

Map Showing Noise and Traffic Sampling Locations in the Study Area



Source: Survey of India Toposheet

3.6.3 METHOD OF MONITORING

Instant Sound Level Meter measurements were recorded at eight locations. The readings were taken for every hour for 24 hrs. The day noise levels have been monitored during 6 AM to 10 PM and night levels during 10 PM to 6 AM at all the locations covered in the study area.

The details of the instrument used for the sampling is mentioned below:-

Instrument	Make	Model No.	Instrument Identification	Detection Limit
Integrated Sound Level	Lutron	Sl-4001	SAL/ NOISE/ INT/ 01	Lo 30-80 dB

measurement Instrument Standard Accessories				Hi 80 – 130 dB

Testing Method to be followed

Particular		Testing Method to be followed
A	Noise level in dB(A) for continuous 24 hours at 1 hour interval	Operational manual of Noise Level Meter, Meter No. DT-805 issued by Mextech

Measured noise level displayed as a function of time provides a useful scheme for describing the acoustical climate of a community. Noise levels recorded at each station are computed for equivalent noise levels. Equivalent noise level is a single number descriptor for describing time varying noise levels. The equivalent noise level is defined as mathematically

$$10 \text{ Log} 1/ T \sum (10^{Ln/10})$$

Where L = Sound pressure level a function of time dB (A)

T = Time interval of observations

Noise levels during the night time generally drop, therefore to compute equivalent noise levels for the night time, noise levels are decreased by 10 dB(A) as the night time high noise levels are judged more annoying compared to the day time.

Noise levels at a particular station are represented as Day-Night equivalent (L_{dn}). Day –Night equivalent is the single number index designed to rate environmental noise on daily/ 24 hourly basis. Mathematically L_{dn} is given by

L_{eq} (day – night) = 10log {1/24 ($15x10^{(Ld/10)}$ + 9 x $10^{(Ln + 10)/10)}$}

Where :-

L_{eq} (day) = A weighed equivalent for day time period (6 am to 10 pm)

L_{eq} (night) = A weighed equivalent for night time period (10 pm to 6 am)

3.6.4 BASELINE DATA

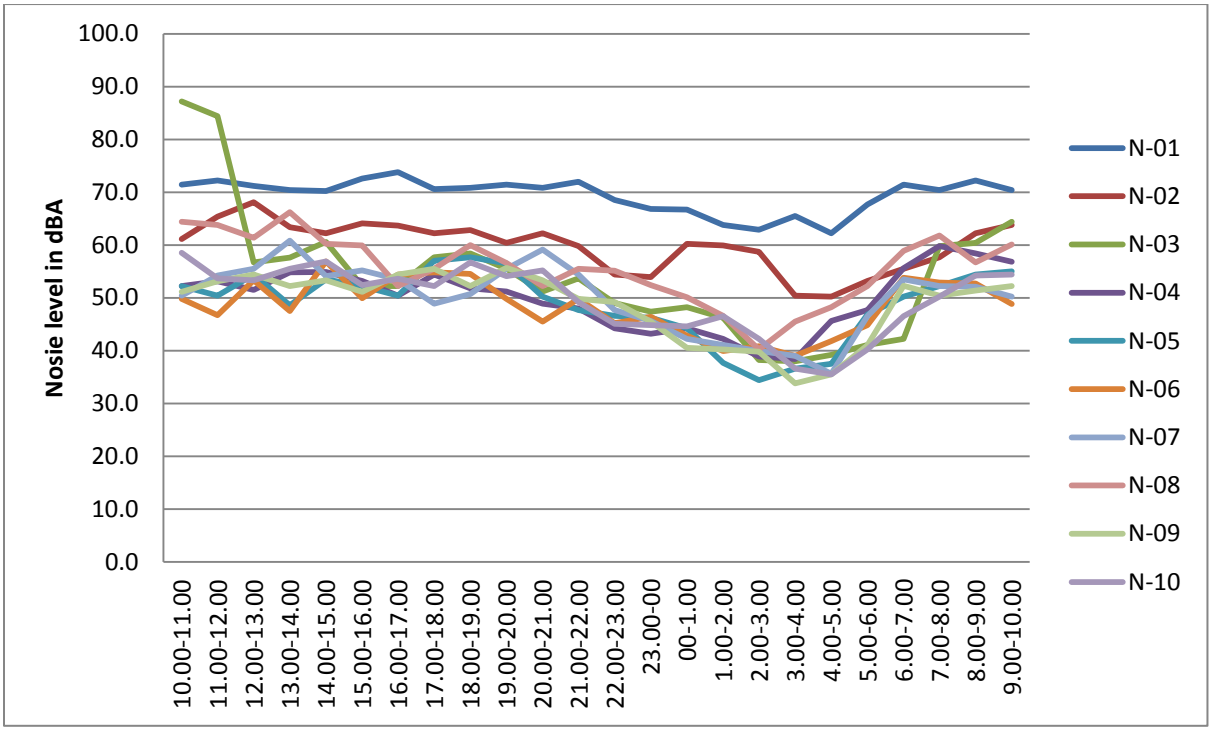
The statistical analysis is done for measured noise level at eight locations in the study area. The parameters are analyzed for L_{eq}(Day), L_{eq} (night) and L_{eq} (day-night). The statistical analysis results are given in table 3.5.4.

Table: Noise Levels in the Study Area during April 2016

Units – dB (A)

S. N.	Sampling Locations	Land use	Leq Day	Leq Night	Lmax	Lmin	CPCB Limits Leq (dBA)	
							Day	Night
1	N-01	Industrial	72.0	65.1	73.8	62.2	***75***	***70***
2	N-02	Industrial	62.8	54.1	68.1	50.2	***75***	***70***
3	N-03	Residential	54.5	43.8	87.2	38.0	***55***	***45***
4	N-04	Residential	53.2	43.7	59.8	38.4	***55***	***45***
5	N-05	Residential	53.7	42.2	57.7	34.4	***55***	***45***
6	N-06	Residential	51.7	42.9	54.8	39.9	***55***	***45***
7	N-07	Residential	53.8	43.4	60.8	35.06	***55***	***45***
8	N-08	Residential	52.1	42.6	66.2	40.2	***55***	***45***
9	N-09	Residential	54.5	42.4	55.7	33.8	***55***	***45***
10	N-10	Residential	53.8	43.4	58.5	36.6	***55***	***45***

Figure (a): Hourly Noise Levels in the Study Area during April 2016



1.1 BIOLOGICAL ENVIRONMENT

1.1.1 Introduction

The survey was undertaken by an ERM ecological expert to determine the sensitivities/activities in the core zone area (Sindesar Khurd Lead-Zinc Mine, ML No.7/95 area 199.8425 ha.) and buffer area of 10 km radius from the boundary of the mining lease area. The ecological survey was undertaken between 12th May 2014 to 17th May 2014. During the survey the study area was experienced peak summer with most of the shallow water bodies in the study area dried up or shallow. The ground herbaceous flora was completely parched or only available near the moist areas. The temperature ranged between a maximum of 39-34°C to a minimum of 28-26°C.

1.1.2 Objective of the Study

The study was undertaken with the following objectives

Floral Status

- Identify floral species within the mine lease and area in 10 km radial distances around the core mine area ;
- Assessment of conservation status of species in conformation of the Indian Wildlife Protection Act (1972) and its amendments, IUCN red-list (2014) and endemic status of the flora in the area along with their use by local communities;
- Identification of major vegetation types of the study area;
- Identification of impacts to the vegetation in the study area due to proposed expansion of lead and zinc mining and beneficiation plant;

Faunal Status

- Identification of all faunal species (wild, avian, terrestrial and aquatic) within 10 km radial distances around the core mine area;
- Classification of these fauna based on their conservation status as per IUCN red-list (2014) and Indian Wildlife Protection Act (IWPA), 1972 and its amendments along with their endemic status;
- Identification of impacts to faunal species due to proposed expansion (such as possibility of travel to, foraging in, or breeding in the core mine area by these animals (which may be disrupted by the mining activities), as well as other potential impacts on these fauna);
- Preparation of detailed mitigation measures required, for the identified impacts on flora and fauna within the study area due to proposed expansion of lead and zinc mining.

1.1.3 Approach and Methodology

The ecological survey was conducted to enumerate the floral and faunal status qualitatively and quantitatively.

Floral Status

A total of 10 sampling plots laid across different habitats were surveyed to enumerate the floral species in the study area. The location details of these sample plots are given in ***Table 3.6.1*** and ***Figure 3.6.1.***

Figure 3.6.1 Map Showing Study Area

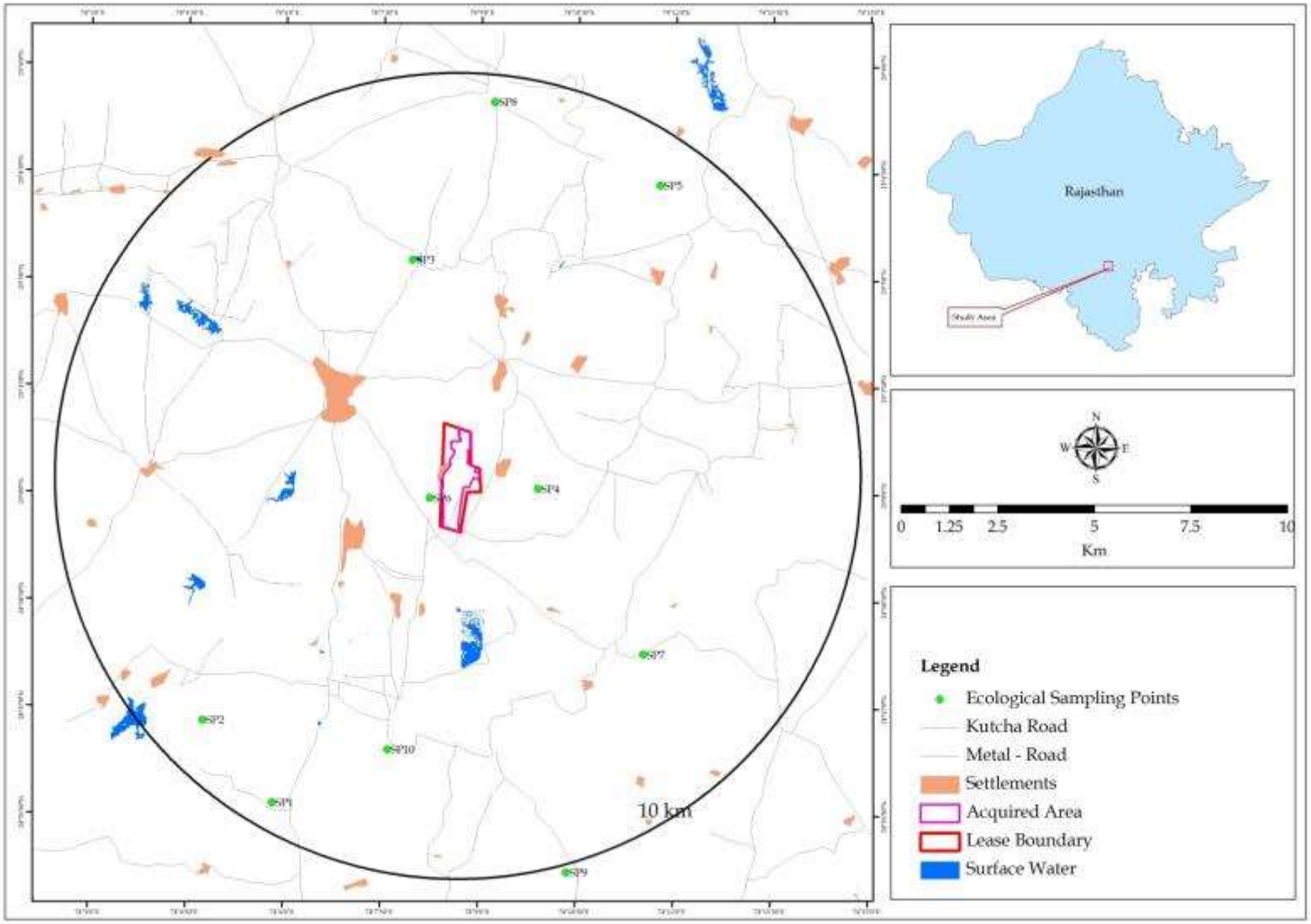
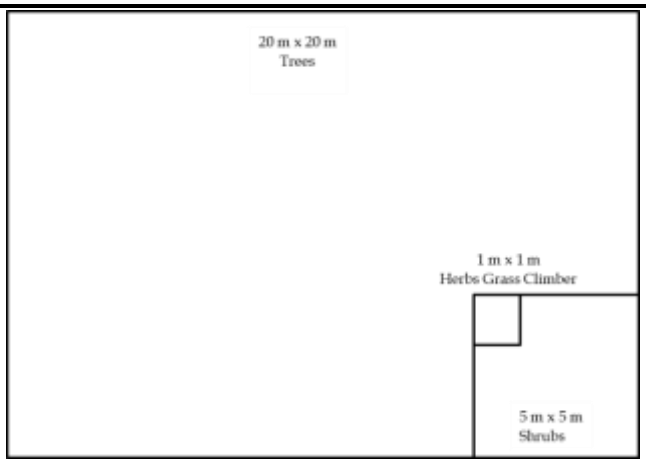


Table 3.6.1 Details of Surveyed Sampling Plots

Sampling Code	Sampling Location	Latitude	Longitude	Vegetation Types
SP1	Gawardi	24°55'39.17"N	74° 5'49.86"E	Scrub Vegetation
SP2	Ladpacha	24°56'48.34"N	74° 4'45.43"E	Agricultural Land
SP3	Jeetawas	25° 3'16.30"N	74° 7'57.07"E	Agricultural Land
SP4	Navakhera (Raghunathpura)	25° 0'4.09"N	74° 9'53.94"E	Scrub Vegetation
SP5	Manjhawas	25° 4'19.90"N	74°11'45.32"E	Scrub Vegetation
SP6	Sindesar Khurd	24°59'55.84"N	74° 8'14.11"E	Scrub Vegetation
SP7	Dhani	24°57'45.23"N	74°11'31.81"E	Scrub Vegetation
SP8	Junda	25° 5'29.32"N	74° 9'12.34"E	Scrub Vegetation
SP9	Lunera	24°54'41.72"N	74°10'21.82"E	Agricultural Land
SP10	Mataji Ka Khera	24°56'24.42"N	74° 7'36.33"E	Scrub Vegetation

Phytosociology of floral species was assessed in the representative habitat types; agricultural land, scrub land and water bodies existing within 10 km radius of the project boundary. Quantitative data was collected using standard quadrat methods of sample plot size 20 m x 20 m for trees, 5 m x 5 m for shrubs and 1 m x 1 m for herbs and grasses. Frequency, density, abundance and Importance Value Index (IVI) were calculated using standard methodologies [(1)]. Sample plot is described in ***Figure 3.6.2.***

Figure 3.6.2 Description of Sample Plot



(1) Misra, K.C., 1974, Manual of Plant Ecology, Oxford and IBH Publishing Co., New Delhi. p 376.

Species richness in the study area was determined by using Margalef's Index [1] and Menhinik's Index [2] and species diversity was calculated based on Simpson's diversity Index [3] and Shannon Weiner Index [4] for the trees, shrubs and herbs.

Faunal Status

Faunal status of different fauna groups was established by using standard methods as described below.

Herpetofauna

Intensive search was made along the hedges of representative aquatic habitats and open wells located in the study area, were checked to identify and list the amphibians.
Status of reptiles was assessed using Intensive Time Constrained Search Methods [5] [6] covering different micro habitats surveyed within the core and buffer zones of the study area.

Avifauna / Birds

Avifauna and aquatic birds were enumerated by different habitat (terrestrial as well as aquatic) surveys within the study area. Avian identification was carried out with standard field guides [7].

Mammals

Habitat survey for mammals was conducted. Direct sightings as well as indirect sightings such as presence of pug marks, scats, hairs, and spines were used for identification. Identification of the mammals followed standard literature. [8][9]

Secondary literature from published books and research publications were also consulted for the flora and fauna of the study area. Faunal were assessed using the IUCN Red list (2014) and the species listed in schedule 1-6 of IWPA, 1972 to confirm their conservation status. Consultation with the Forest Department was carried out to confirm the presence of possible wildlife species in the area.

1) Margalef DR 1958, Information theory in ecology. Gen. Sys. 3:36-71

(2) Menhinick EF 1964. A comparison of some species-individual diversity indices applied to samples of field insects. Ecology 45: 859-861

(3) Simpson EH 1949 Measurement of Diversity: Nature, 163:688

(4) Shannon CE & W Weaver 1949 The Mathematical Theory of Communication. University of Illionis Press. Urbana, IL USA.

(5) Welsh, H.H., jr. 1987. Monitoring herpetofauna in woodlands of north western California and south west Oregon: a comparative strategy. Pp. 203-213. In. Multiple – Use Management of Califirnia's hardwood resources. T.R. Plumb, N.H. Pillisbury (eds. Gen. Tech. Regional Environmental Planning. PSW – 100) US Department of Agriculture, Forest Service.

(6)Welsh, H.H. Jr. and Lind, A. 1991. The structure of the herpetofaunal assemblage in the Douglas-fir/hardwood forests of northwestern California and south western Oregon. Pp: 395-411. In: Wildlife and vegetation of unmanaged Douglas-fir forests. (Tech.Coords). L.F. Ruggiero, K.B. Aubry, A.B. Carey and M.H. Huff. Ge. Tech. Rep. PNW-GTR-285. Portland, OR: US. Department of Agriculture, Forest Service.

(7) Birds of India, Srilanka, Pakistan, Nepal, Bhutan, Bangladesh and Maldives. 2000. Krys Kazmeierczak and Ber Van `Perlo. Om Field Guides

(8) Prater. S. H. 2005. The Book of Indian Animals. Bombay Natural History Society and Oxford University press 12th Edn. pp. 316.

(9) Menon, V. 2003. A field guide to Indian Mammals. Dorling Kindersley (India) Ltd. New Delhi. 201 p.

1.1.4 Vegetation Analysis

Vegetation at Mine Lease Area (ML area or Core Zone)

The natural vegetation at project site is represented by small natural shrubs and herbs such as *Calatropis procera, Tridex procumbens, Solanum nigerum, Euphorbia hirta, Indigofera cordifolia, Parthenium hysterophorum* and *Sida acuta.* The naturally occurring tree species are *Butea monosperma* and *Prosopis juliflora*. As a part of the green belt development plan, many individuals of *Dalbergia sisso, Cassia siamea, Azadirachta indica* and *Leucaena leucocephala* have been planted. The plantation has been raised using drip irrigation as a part of water conservation measures. A view of the green belt plantation in ML area is given in ***Figure 3.6.3.***

Figure 3.6.3 Green Belt Plantation at Mining Lease Area

Source: ERM Ecological Survey 12th to 17th May 2014

Vegetation at Buffer Zone

The vegetation in the study area can be classified as Dry Deciduous and Thorn. The Dry Deciduous vegetation in the study area is represented by the tree species of *Anogeissus pendula, Lannea coromandelica, Boswellia serrata, Cassia fistula, Albizia odoratssima, Wrightia tinctoria, Mitragyna*

parviflora, Butea monosperma, Dalbergia sissoo and *Diospyros montana*. The throrn vegetation in the study area is represented by species of *Acacia senegal, Acacia luecophloea, Prosopis cineraria, Prosopis juliflora, Anogeissus pendula, Grewia tenax* and *Mimosa hamate.*

The various habitats in the buffer zone is given in **Error! Reference source not found.**

Figure 3.6.4 Habitats within the Buffer Area

Open Scrub

Open Scrub

Prosopis juliflora growth near Project Site

Dry deciduous vegetation (*Butea monosperma*)

Source: ERM Ecological Survey 12th to 17th May 2014

1.1.5 Floral Assessment

The phytosociology of trees, shrubs herbs and grasses observed/ reported in the study area are given below.

Phytosociology of Tree species

A total of 30 tree species were enumerated from the study area. The highest relative density and IVI is recorded for *Acacia nilotica* (RD-42.2/IVI-42.9). The details of tree species are provided in ***Table 3.6.2.***

Table 3.6.2 Phytosociology of Tree species

Tree Species	Relative Frequency	Relative Density	Relative Abundance	Important Value Index
Acacia catechu	0.5	19.3	0.03	19.8
Acacia nilotica	0.6	42.2	0.07	42.9
Adina cordifolia	0.6	32.1	0.05	32.8
Alangium salvifolium	0.5	22.0	0.04	22.5
Andina cordifolia	0.6	26.6	0.04	27.3
Anogeissus pendula	0.2	13.8	0.02	14.0
Azadirachta indica	0.5	13.8	0.02	14.3
Bauhenia racemosa	0.5	26.6	0.04	27.1
Bauhenia varigata	0.4	21.1	0.03	21.5
Bombax ceiba	0.2	10.1	0.02	10.3
Boswellia serrata	0.5	8.3	0.01	8.8
Butea monosperma	0.6	25.7	0.04	26.3
Cassia fistula	0.3	4.6	0.01	4.9
Cassia siamea	0.4	19.3	0.03	19.7
Commiphora glieadense	0.6	18.3	0.03	18.9
Cordia mixa	0.5	23.9	0.04	24.4
Dalbergia sisso	0.5	20.2	0.03	20.7
Ficus benghalensis	0.4	16.5	0.03	16.9
Ficus racemosa	0.6	31.2	0.05	31.9
Ficus religeosa	0.6	18.3	0.03	19.0
Lannea coromandelica	0.6	22.0	0.04	22.6
Leucaena leucocephala	0.6	22.0	0.04	22.6
Mangifera indica	0.5	19.3	0.03	19.8
Phoenix sylvestris	0.5	23.9	0.04	24.4
Polyalthia longifolia	0.6	26.6	0.04	27.3
Prosopis cineraria	0.5	22.9	0.04	23.5
Prosopis juliflora	0.3	10.1	0.02	10.4
Tamarindus indica	0.6	26.6	0.04	27.2
Wrightia arborea	0.6	30.3	0.05	31.0

Tree Species	Relative Frequency	Relative Density	Relative Abundance	Important Value Index
Wrightia tinctoria	0.2	8.3	0.01	8.5

Phytosociology of Shrubs Species

The shrub species in the study area were represented by 25 species. Highest Relative density was recorded for *Calotropis procera* (0.71). The details of shrub species are provided in ***Table 3.6.3***

Table 3.6.3 Phytosociology of Shrub species

Shrub Species	Relative Frequency	Relative Density	Relative Abundance
Adhatoda zeylanica	0.53	0.83	0.07
Annona squamosal	0.53	0.84	0.07
Argyreia strigose	0.30	0.64	0.05
Barleria cristata	0.41	0.55	0.05
Blepharis linariaefolia	0.47	0.43	0.04
Calotropis procera	0.47	0.71	0.06
Capparis decidua	0.36	0.49	0.04
Carissa spinarum	0.36	0.28	0.02
Cassia auriculata	0.30	0.19	0.02
Cassia spinarum	0.30	0.27	0.02
Elytraria acaulis	0.24	0.30	0.02
Euphorbia cauduefolia	0.41	0.52	0.04
Euphorbia nevulia	0.36	0.33	0.03
Holarrhena pubscens	0.36	0.34	0.03
Jatropha gossypifolia	0.36	0.37	0.03
Lantana camara	0.47	0.47	0.04
Lantana whitiana	0.36	0.41	0.03
Leea indica	0.41	0.59	0.05
Prosopis juliflora	0.47	0.59	0.05
Pupalia lappacea	0.47	0.62	0.05
Ricinus communis	0.47	0.67	0.06
Rungia repens	0.53	0.47	0.04
Thespia lampas	0.47	0.49	0.04

Shrub Species	Relative Frequency	Relative Density	Relative Abundance
Ziziphus mauritiana	0.36	0.40	0.03
Ziziphus nummularia	0.24	0.30	0.02

Phytosociology of Herbs and Grass species

Herbs and grasses in the study area were represented by 19 species. The highest relative density observed was for *Solanum nigerum (*0.105). A list of species observed from the study area are given in ***Table 3.6.4***

Table 3.6.4 Phytosociology of Herbs and Grass Species

Shrub Species	Relative Frequency	Relative Density	Relative Abundance
Achyranthes aspera	0.81	0.069	0.07
Ageratum conyzoides	0.51	0.038	0.04
Argemone Mexicana	0.71	0.079	0.08
Borreria pusilla	0.61	0.067	0.07
Cassia tora	0.61	0.046	0.05
Corchorus aestuans	0.71	0.062	0.06
Curcuma aromatic	0.40	0.044	0.04
Cynodon dactylon	0.51	0.067	0.07
Datura stramonium	0.20	0.022	0.02
Desmodium dichotomum	0.71	0.060	0.06
Euphorbia hirta	0.51	0.034	0.03
Grewia tiliifolia	0.40	0.032	0.03
Heteropogon contortus	0.61	0.052	0.05
Indigofera cordifolia	0.51	0.062	0.06
Physalis angulate	0.40	0.067	0.07
Solanum nigrum	0.51	0.105	0.11
Solanum suraentense	0.61	0.026	0.03
Themeda triandra	0.30	0.026	0.03
Tridex procumbens	0.40	0.044	0.04

Species Richness

The species richness in the study area was calculated based on total number of species, Margalef's Index and Menhinik's Index. The species richness observed in terms of number of species from the study area ranged from 40-49 species. Margalef's index calculated for different quadrates studied in the study area ranged from 7.5 to 9.2 while Menhinik's index calculated for different quadrats studied in the study area ranged from. 2.8 to 4.0. The species richness based on these three indicators suggests moderate species richness in the study area. The species richness across each quadrat sampled is given in ***Table 3.6.5.***

Table 3.6.5 Species Richness in the Study Area

Sample Plot	Total No. Species	Margalef's Index	Menhinik's Index
SP1	40	7.5	2.9
SP2	48	9.2	3.7
SP3	44	8.3	3.3
SP4	47	8.3	3.0
SP5	49	8.9	3.3
SP6	46	9.2	4.0
SP7	44	8.0	3.0
SP8	48	8.8	3.4
SP9	41	7.5	2.9
SP10	44	7.8	2.8

Species diversity

The species diversity is calculated based on Shannon Weiner Index (H'). The H' values calculated for tree species in *4.5*. H' values for shrub species were 2.71 and for herbs and grasses it was 4.1. These values show moderate diversity of species across the study area.

1.1.6 Aquatic Flora of the Study Area

The majority of water bodies have been dried up due to extreme summer conditions, however, perennial water bodies such as Jeetawas pond have aquatic flora such as *Eichornia crassipes, Typha augustata, Nelumbo nucifera and Ipomea species.*

1.1.7 Faunal Assessment

Faunal species from the study area were recorded based on direct sightings, and indirect evidence such as dung, droppings, scats, pugmarks, scratch signs, burrows, nests etc. and consultation with

Forest Department officials and local communities. During consultation with communities, pictorial representations of species in from field guides and other literature of the fauna of India were shown. The species occurring within the study area are discussed in the following sections:

Faunal Species at Project Site

The project site facility is an industrial facility with disturbance such as vehicular movement, industrial noise and movement of industrial labours. Due to these activities, the faunal species occurring at site are limited to a few reptiles, birds and smaller mammals. The common reptilian species observed from the project site are Garden Lizard (*Calotes versicolor and* Fan-throated lizard *(Sitana ponticeriana)*. The common avifaunal species observed at the project site are House Sparrow, Dusky-crag Martin, Rock Pigeon, Common Myna, Red-wattled Lapwing, Purple-rumped Sunbird, Grey Francolin and Small-green Bee-eater. Among the mammals, five striped squirrel was observed at site.

Faunal Species within Study Area

Faunal species observed/reported in the study area are given in the section below;

Herpetofauna

The Herpetofaunal (amphibian and reptilian) species found in the study area are discussed below and given in ***Figure 3.6.5***

Amphibians

A total of four (04) species belonging to 2 families were observed from the study area. None of the species have any conservational significance. The details of the species are given in ***Table 3.6.6.***

Table 3.6.6 Amphibians observed/recorded from the Study Area

Sn	Common Name	Zoological Name	Family	Occurrence	WPA Schedule / IUCN Status
1	Indian Skipper Frog	*Euphlyctis cyanophlyctis*	Dicroglossidae	Frequent	LC /Not Listed
2	Common Indian Toad	*Duttaphrynus melanostictus*	Bufonidae	Common	-/ LC
3	Indian Pond Frog	*Euphlyctis hexadactylus*	Dicroglossidae	Common	-/LC
4	Indian Bull Frog	*Hoplobatrachus tigerinus*	Dicroglossidae	Frequent	-/LC

Notes: LC-Least Concern,

Figure 3.6.5 Herpetofaunal species observed in Study Area

Indian Skipper Frog in Jeetawas Pond

Indian Flapshell Turtle in Jeetawas Pond

Source: ERM Ecological Survey 12th to 17th May 2014

Reptiles

A total of 11 species of 11 genera belonging to 9 families were observed from the study area. Monitor Lizard (*Varanus bengalensis*) and Indian Flapshell Turtle (*Lissemys punctata*) are listed as Schedule I species in the IWPA, 1972. None of the species are listed in the IUCN red-list (2014). A list of species observed/reported from the study area is given in ***Table 3.6.7.***

Table 3.6.7 List of Reptilian species observed/reported in Study Area

Sn	Common Name	Zoological Name	Family	Occurrence	WPA Schedule / IUCN Status
1	Northern house Gecko	*Hemidactylus frenatus*	Gekkonidae	Observed	-/-
2	Fan-throated lizard	*Sitana ponticeriana*	Gekkonidae	Observed	-/-
3	Indian Garden Lizard	*Calotes versicolor*	Agamidae	Observed	-/-
4	Keeled Grass Skink	*Eutropis carinata*	Scincidae	Observed	-/ LC
5	Monitor Lizard	*Varanus bengalensis*	Varanidae	Reported	I/LC
6	John's Earth Boa	*Eryx johnii*	Uropeltidae	Reported	IV/LC
7	Common Rat Snake	*Ptyas mucosa*	Colubridae	Observed	IV/LC
8	Saw-scaled viper	*Echis carinata*	Viperidae	Observed	IV/LC
9	Brahminy Worm Snake	*Ramphotyphlops braminus*	Tylopidae	Reported	IV/LC
10	Checkered Keelback	*Xenchrophis piscator*	Colubridae	Observed	II/ LC
11	Indian Flapshell Turtle	*Lissemys punctata*	Trionychidae	Observed	I/LC

Notes: LC-Least Concern, NT-Near Threatened

Avifauna

A total of 69 species from 42 families were observed within the Study area. Wooly-necked Stork (Ciconia episcopus) and Sarus Crane (Grus antigon) observed in the study area are listed as

Vulnerable (IUCN Ver. 3.1, 2012) Black headed Ibis (Threskiornis melanocephalus), River Tern (Sterna aurantia) and Great Thick-knee (Esacus recurvirostris) are listed as Near Threatened as per IUCN Ver.3.1,2012). Some of the species were observed in addition to species list provided by the Forest Department.

Indian Peafowl (Pavo cristatus), Indian Grey Hornbill (Ocyceros birostris), White eyed Buzzard (Butastur teesa) and Black-shouldered Kite (Elanus caeruleus) are listed as Schedule I species as per IWPA, 1972. Northern Shovler (Anas clypeata) was the sole migratory bird encountered.

Among the feeding groups of avifaunal species, 32 species were insectivores, 8 species were carnivores, 7 species were piscivores, 5 species were frugivores, 5 species were granivores and 3 species were herbivores. A list of species of avifaunal species observed from the study area are given in ***Table 3.6.8*** and presented in ***Figure 3.6.6.***

Table 3.6.8 Avifaunal species observed from the Study Area

Sn.	Common Name	Scientific Name	Migratory Status	IUCN Status	WPA Sch.	Foraging Guild	Habitats
1	**PHALACROCORACIDAE: Cormorants**						
1	Little Cormorant	*Phalacrocorax niger*	R	LC	IV	P	Freshwater wetland
2	**ARDEIDAE : Herons, Egrets**						
2	India Pond Heron	*Ardeola grayii*	R	LC	IV	I	Freshwater wetland
3	Cattle Egret	*Bubulcus ibis*	R	LC	IV	I	Freshwater wetland
4	Little Egret	*Egretta garzetta*	R	LC	IV	P	Freshwater wetland
5	Grey Heron	*Ardea cinerea*	R	LC	IV	P	Freshwater wetland
6	Intermediate Egret	*Mesophoyx intermedia*	R	LC	IV	P	Freshwater wetland
3	**CICONIIDAE : Storks**						
7	Wooly-necked Stork	*Ciconia episcopus*	R	VU	IV	P/I	Freshwater wetland
8	Painted Stork	*Mycteria leucocephala*	R	LC	IV	P	Freshwater wetland
4	**GRUIDAE : Cranes**						
9	Sarus Crane	*Grus antigone*	R	VU	IV	O	Freshwater wetland
5	**THRESKIORNITHIDAE : Ibises**						
10	Black headed Ibis	*Threskiornis melanocephalus*	R	NT	IV	I	Freshwater wetland
11	Red-napped Ibis	*Pseudibis papillosa*	R	LC	IV	I	Freshwater wetland
12	Eurasian spoonbills	*Platalea leucorodia*	R	LC	IV	P/I	Freshwater wetland

Sn.	Common Name	Scientific Name	Migratory Status	IUCN Status	WPA Sch.	Foraging Guild	Habitats
6	**STERNIDAE: TERNS**						
13	River Tern	*Sterna aurantia*	R	NT	IV	P/I	Large Inland Waters
7	**ANATIDAE : Ducks, Geese, Teals**						
14	Spot-billed Duck	*Anas poecilorhyncha*	R	LC	IV	H	Freshwater wetland
15	Northern Shovler	*Anas clypeata*	M	LC	IV	H	Freshwater wetland
16	Lesser-Whisling Teal	*Dendrocygna javanica*	R	LC	IV	O	Freshwater wetland
17	Knob-billed duck	*Sarkidiornis melanotos*	R	LC	IV	H	Freshwater wetland
8	**ACCIPITRIDAE : Hawks, Vultures, Eagles**						
18	Black-shouldered Kite	*Elanus caeruleus*	R	LC	I	C	Open Scrub
19	White eyed Buzzard	*Butastur teesa*	R	LC	I	C	Open Scrub
9	**CHARADRIIDAE : Plovers, Lapwings**						
20	Red-wattled Lapwing	*Vanellus indicus*	R	LC	IV	I	Freshwater wetland
21	Little Ringed Plover	*Charadrius dubius*	R	LC	IV	I	Freshwater wetland
10	**COLUMBIDAE : Pigeons, Doves**						
22	Laughing Dove	*Streptopelia senegalensis*	R	LC	IV	G	Open scrub
23	Eurasian collared Dove	*Streptopelia decaocto*	R	LC	IV	G	Open scrub
24	Blue Rock Pigeon	Columba livia	R	LC	IV		
11	**PSITTACIDAE : Parakeets**						
25	Rose-ringed Parakeet	*Psittacula krameri*	R	LC	IV	F	Open scrub
26	Plum headed Parakeet	*Psittacula cyanocephala*	R	LC	IV	F	Open Scrub (Endemic to India)
12	**CUCULIDAE : Cuckoos**						
27	Greater Coucal	*Centropus sinensis*	R	LC	IV	O	Open Scrub
13	**CISTICOLIDAE: Prinias**						
28	Ashy Prinia	*Prinia socialis*	R	LC	IV	I	Open Scrub

Sn.	Common Name	Scientific Name	Migratory Status	IUCN Status	WPA Sch.	Foraging Guild	Habitats
29	Zitting Citcola	*Cisticola juncidis*	R	LC	IV	I	Open Scrub
14	**RAMPHASTIDAE: BARBETS**						
30	Coppersmith Barbet	*Megalaima haemacephala*	R	LC	IV	F	Arboreal
15	**BUCEROTIDAE: HORNBILLS**						
31	Indian Grey Hornbill	*Ocyceros birostris*	R	LC	I	F/I	Arboreal
16	**APODIDAE : Swifts**						
32	House Swift	*Apus affinis*	R	LC	IV	I	Open scrub
17	**MEROPIDAE : Bee-eaters**						
33	Green Bee-eater	*Merops orientalis*	R	LC	IV	I	Open scrub
18	**CORACIIDAE : Rollers**						
34	Indian Roller	*Coracias benghalensis*	R	LC	IV	I	Open Scrub/Agricultural land
19	**ALAUDIDAE : Larks**						
35	Ashy-crowned Sparrow-Lark	*Eremopterix grisea*	R	LC	IV	I	Open Scrub/Agricultural land
36	Indian Bushlark	*Mirafra erythroptera*	R	LC	IV	I	Open Scrub/Agricultural land
37	Crested Lark	*Galerida cristata*	R	LC	IV	I	Open Scrub
20	**HIRUNDINIDAE : Swallows**						
38	Dusky Crag – Martin	*Hirundo concolor*	R	LC	IV	I	Open Scrub
21	**ORIOLIDAE : Orioles**						
39	Indian Golden Oriole	*Oriolus kundoo*	SV	LC	IV	I	Open Scrub
22	**DICRURIDAE : Drongos**						
40	Black Drongo	*Dicrurus macrocercus*	R	LC	IV	I	Open Scrub/ Agricultural land
23	**STURNIDAE : Mynas**						
41	Brahminy Starling	*Sturnus pagodarum*	R	LC	IV	O	Open Scrub
42	Common Myna	*Acriotheres tristis*	R	LC	IV	O	Open scrub
43	Bank Myna	*Acridotheres ginginanus*	R	LC	IV	O	Agricultural Land

Sn.	Common Name	Scientific Name	Migratory Status	IUCN Status	WPA Sch.	Foraging Guild	Habitats
44	Rosy Pastor	*Pastor roseus*	PV	LC			Agricultural Land
24	**STRIGIDAE: OWLETS**						
45	Spotted Owlet	*Athena brama*	R	LC	IV	C	Around Habitation and Cultivation
25	**CORVIDAE : Crows, Magpies**						
46	House Crow	*Corvus splendens*	R	LC	V	O	Open Scrub and Agricultural Land
47	Rufous Treepie	*Dendrocitta vagabunda*	R	LC	IV	O	Open Scrub/ Agricultural Land
26	**CAMPEPHAGIDAE: Cuckoo-Shrikes, Minivets**						
48	Small Minivet	*Pericrocotus cinnamomeus*	R	LC	IV	I	Open Scrub
27	**PYCNONOTIDAE : Bulbuls**						
49	Red-whiskered Bulbul	*Pycnonotus jocosus*	R	LC	IV	O	Open Scrub/agricultural land
50	Red-vented Bulbul	*Pycnonotus cafer*	R	LC	IV	O	Open Scrub/agricultural land
28	**MUSCICAPIDAE : Flycatchers and Babblers**						
51	Large Grey Babbler	*Turdoides malcolmi*	R	LC	IV	I	Open Scrub/agricultural land
29	**MOTACILLIDAE : Pipits, Wagtails**						
52	Paddyfield pipit	*Anthus rufulus*	R	LC	IV	I	Open Scrub
30	**NECTARINIDAE : Sunbirds**						
53	Purple Sunbird	*Nectarinia asiatica*	R	LC	IV	N	Open Scrub
31	**PLOCEIDAE : Sparrows**						
54	House Sparrow	*Passer domesticus*	R	LC	IV	G	Open Scrub/Agricultural Land
32	**EMBERIZIDAE : Buntings**						
55	Crested Bunting	*Melophus lathami*	R	LC	IV	G	Open Scrub/Agricultural Land
33	**CERILYDAE: KINGFISHERS**						
56	White-throated Kingfisher	*Halcyon smyrnnsis*	R	LC	IV	P/C	Cultivation/Freshwater
57	Pied Kingfisher [a]	*Ceryle rudis*	R	LC	IV	P/C	Still Freshwater, slow-moving River

Sn.	Common Name	Scientific Name	Migratory Status	IUCN Status	WPA Sch.	Foraging Guild	Habitats
34	**TURDINAE : Thrushes Chats**						
58	Oriental Magpie Robin	*Copsychus saularis*	R	LC	IV	I	Open Scrub/agricultural land/
59	Indian Robin	*Saxicoloides fulicata*	R	LC	IV	I	Open Scrub/agricultural land
35	**RHIPIDURIDAE: Fantails**						
60	White-browed Fantail	*Rhipidura aureola*	R	LC	IV	I	Agricultural Land
36	**PICIDAE: WOODPECKERS**						
61	Lesser Goldenback Woodpecker	*Dinopium benghalense*	R	LC	IV	I	Plantations
37	**RECURVIROSTRIDAE: STILTS**						
62	Black-winged Stilt	*Himantopus himantopus*	R	LC	IV	P/C	Freshwater wetland
38	**PHOENICOPTERIDAE: Flamingoes**						
63	Greater Flamingo	*Phoenicopterus roseus*	OV	LC	IV	P/C	Freshwater wetland
39	**PHASIANIDAE: Pheasants**						
64	Indian Peafowl	*Pavo cristatus*	R	LC	I	F/I	Near Habitation
65	Grey Francolin	*Francolinus pondicerianus*	R	LC	IV	O	
40	**RALLIDAE-Coots**						
66	Common Coot	*Fulica atra*	R	LC	IV	O	Freshwater wetland
67	White brested WaterHen	*Amaurornis phoenicurus*	R	LC	IV	O	Freshwater wetland
41	**ROSTRATUIDAE: Snipes**						
68	Greater Painted Snipe	*Rostratula benghalensis*	R	LC	IV	I/G	Freshwater wetland
42	**BURHINIDAE: Thick Knees**						
69	Great Thick-knee	*Esacus recurvirostris*	R	NT	IV	I/C	Freshwater wetland

Notes: IUCN Status: LC-Least Concern, NT-Near Threatened Foraging Guild: C-Carnivore, F-Frugivore, G-Granivores, I-Insectivores, N-Nectarivores, O-Omnivores P-Piscivores, Migratory Status (MS): R-Resident, M- Migratory, SV- Summer Visitor, OV-Occasional Visitor, PV-Partial Visitor

Figure 3.6.6 Avifaunal and Aquatic Species observed in Study Area

Red-vented Bulbul

Indian Robin

Coppersmith Barbet

Laughing Dove

Source: ERM Ecological Survey 12th to 17th May 2014

Mammals

A total of 10 species of 10 genera belonging to 9 families were observed/ reported from the study area. One (01) species Indian Pangolin (*Manis crassicaudata)* is categorized as Near Threatened (IUCN 2014).

A list of species observed/ reported from the study area are given in ***Table 3.6.9*** and represented in ***Figure 3.6.7***.

Table 3.6.9 Details of Mammals observed/ reported from the Study area

Sn.	English Name	Scientific Name	Family	Occurrence	WPA Schedule / IUCN Status
1	Jackal	*Canis aureus*	Canidae	Observed	II/LC
2	Common Fox	*Vulpes bengalensis*	Canidae	Observed	II/LC
3	Southern plains Gray Langur	*Semnopithecus dussumieri*	Cercopithecidae	Observed	II/LC
4	Blue Bull	*Boselaphus tragocamelus*	Bovidae	Observed	III/LC
5	Indian Grey Mongoose	*Herpestes edwardsii*	Herpestidae	Observed	II/LC
6	Jungle Cat	*Felis chaus*	Felidae	Reported	II/LC
7	Five Striped Squirrel	*Funambulus pennantii*	Sciuridae	Observed	IV/LC
8	Bandicoot rat	*Bandicota indica*	Muridae	Observed	V/LC
9	Indian Flying Fox	*Pteropus giganteus*	Pteropodidae	Observed	V/LC
10	Indian Hare	*Lepus nigricollis*	Leporidae	Observed	IV /LC

Notes: IUCN-International Union for Conservation of Nature, WPA-Wildlife Protection Act, 1972, LC-Least Concern

Figure 3.6.7 Mammalian Species observed within the Study Area

Southern Plain Grey Langur near Bamaniya Kalan

Blue Bull near Bharari reservoir

Source: ERM Ecological Survey 12th to 17th May 2014

The authenticated list of flora and faunal species present in the region was collected from the State Forest Department and the same is provided in ***Annex H1.***

1.1.8 Protected Areas in Study Area

The study area of 10 km radius from the mining lease boundary does not have any protected areas such as National Parks or Wildlife Sanctuaries.

The authenticated list of flora and faunal species present in the region was collected from the State Forest Department and the same is provided in ***Annex H1***.

1.2 SOCIO-ECONOMIC BASELINE ENVIRONMENT

This Social Impact Assessment (SIA) section assesses the socio-economic impacts as a part of the EIA study for expansion of SK Mines operation from 2 Mtpa ore mining to 3.75 Mtpa and ore beneficiation plant capacity from 2 Mtpa to 4.25 Mtpa

Scope for the social impact assessment is listed down below which is inclusive of the social component of the Terms of Reference (ToR) issued by MoEF&CC for the EIA study and these are:

- Understand demographic profile of the study area for this project;
- Understand existing physical and social infrastructure of the study area;
- Assess likely impact in surrounding communities of the project in view of expansion of SK Mines operation;
- It may be clearly brought out whether the village located in the mine lease area will be shifted or not. The issues relating to shifting of village including details of the land for any Waste Dumps outside the mine lease, such as extent of land area, distance from mine lease, its land use, R&R issues, if any, should be given.
- R&R Plan/compensation details for the Project Affected People (PAP) should be furnished. While preparing the R&R Plan, the relevant State/National Rehabilitation & Resettlement Policy should be kept in view.
- Implementation status of recognition of forest rights under the Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 should be indicated.
- In respect of SCs /STs and other weaker sections of the society in the study area, a need based sample survey, family-wise, should be undertaken to assess their requirements, and action programmes prepared and submitted accordingly, integrating the sectoral programmes of line departments of the State Government.
- Public health implications of the Project and related activities for the population in the impact zone should be systematically evaluated and the proposed remedial measures should be detailed along with budgetary allocations.
- Occupational Health impacts of the Project should be anticipated and the proposed preventive measures spelt out in detail. Details of pre-placement medical examination and periodical medical examination schedules should be incorporated in the EMP.

- Measures of socio economic significance and influence to the local community proposed to be provided by the Project Proponent should be indicated. As far as Possible, quantitative dimensions may be given with time frames for implementation.
- Details of litigation pending against the project, if any, with direction /order passed by any Court of Law against the project should be given.

1.2.1 Project background

The proposed expansion project lies in Rajsamand District of Rajasthan. The proposed area falls within Sindesar Khurd village in Railmagra Block and tehsil of Rajsamand district.

1.2.2 Context of the social assessment

HZL has been granted 199.8425 ha mining lease area at Sindesar Khurd village in Rajsamand district of Rajasthan. Existing SK Mines operation of HZL is spread across 125.52 ha land which is located within the mining lease area. Expansion of SK Mines operation requires additional 23.32 ha land within the Mining lease area.

Land use profile of existing and additional required land indicates that these lands are barren lands and it is not under use of community in any manner. Therefore additional land requirement for expansion of SK Mines will not result in any physical or economic displacement. However HZL is considering resettlement of families of Sindesar Khurd village in view of perceived impact on village structures due to blasting operation (*Refer social impact assessment section for detail*) as requested during the public hearing in 2008. HZL has requested Rajsamand District Administration for approving decision of resettlement of the village along with identification alternative land for resettlement, which is under consideration of district administratioin. Preparation of R&R plan would start after getting approval from District Administration for resettlement of the village.

The project location falls under Sindesar Khurd gram panchayat. As per census 2011 data, there is no ST population in Sindesar Khurd village. District Rajsamand as a whole also doesn't fall under Schedule V area. Therefore the requirements of Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, is not applicable for this project.

HZL has a dedicated CSR department in place for carrying out development activities in surrounding villages of the project location. HZL has adopted a systemic approach for its CSR programs. HZL had initiated a pilot project in 12 poverty stricken Gram Panchayats of Railmagra and Khamnore Panchayat

Samitis of Rajsamand district, Rajasthan in collaboration with the District Administration, Rajsamand, Techpeople Management Services Pvt. Ltd. and Vishvas Sansthan. Integrated Panchayat

Development Plan (IPDP) in form of a detailed project report was prepared in 2012 for the 12 Gram Panchayats. The purpose is to establish public private partnership for the holistic development of 12 poverty stricken villages in the Railmagra and Khamnore Panchayat Samitis of Rajsamand district, Rajasthan aligned with Millennium Development Goals (MDGs) for improving the quality of lives of the poor in these selected villages through multi-stakeholders engagement and convergence of various flagship schemes/programmes of the State and Central Government especially under the Ministry of Rural Development and Panchayati Raj, Government of India (GoI) to create a self-sustaining and replicable model to be implemented in other districts of Rajasthan.Presentation of this social assessment report is aligned with the above mentioned project contexts.

The approach and methodology adopted for SIA is based on its understanding of the type, range/extent of impacts and the stakeholder sensitivities associated with the project and its activities.

1.2.3 Approach

For the purpose of establishing the social baseline and undertaking the social impact assessment of the project, a participatory approach was adopted. Through this approach, an attempt was made to integrate the local understanding and perspective into the impact assessment process and identification of the mitigation measures. The approach for writing this social baseline is also guided by Terms of Reference (TOR) issued by MoEF&CC to *HZL* for undertaking EIA study on account of seeking Environment Clearance from MoEF&CC for expansion of SK Mine. The purpose of such an approach was to allow for:

- The triangulation of the information available from secondary sources and through the qualitative information made available by the local community;
- Formulation of the socio-economic baseline on the basis of a combination of primary and secondary qualitative and quantitative data;
- An understanding to be developed of the community's perception towards industries, the past interaction with the industries in the area and the experiences of the same;
- An understanding to be developed of the local community's perception of the project and its activities and the possible impacts from the same and the desirable mitigation measures;

1.2.4 Methodology

The following sub section provides the methodology adopted for undertaking the baseline data collection and environmental and social impact assessment stages of the project.

Preliminary Discussions with the client

ERM team undertook preliminary discussions with the Client in order to gauge the status of the existing project, plans for proposed expansion and the activities which the expansion will entail. In addition, the team also had discussions with the CSR team in order to understand the nature of existing community engagement, developmental activities being undertaken and the proposed plans.

Sharing of Information request list with the client

After a preliminary discussion, ERM team shared an information request list with the Client in order to gather specific data pertaining to land requirement for project expansion, community development activities, impact on adjoining Sindesar Khurd village in view of existing SK Mines operation, community perception and demands, monitoring reports, pending litigations, nature of liasoning with various District and Government officials etc.

Review of secondary literature

A desk based review and assessment of the available primary and secondary data and information for the project area, the administrative block, the district and the state has been done. Some of the documents and literature that were reviewed includes but not limited to:

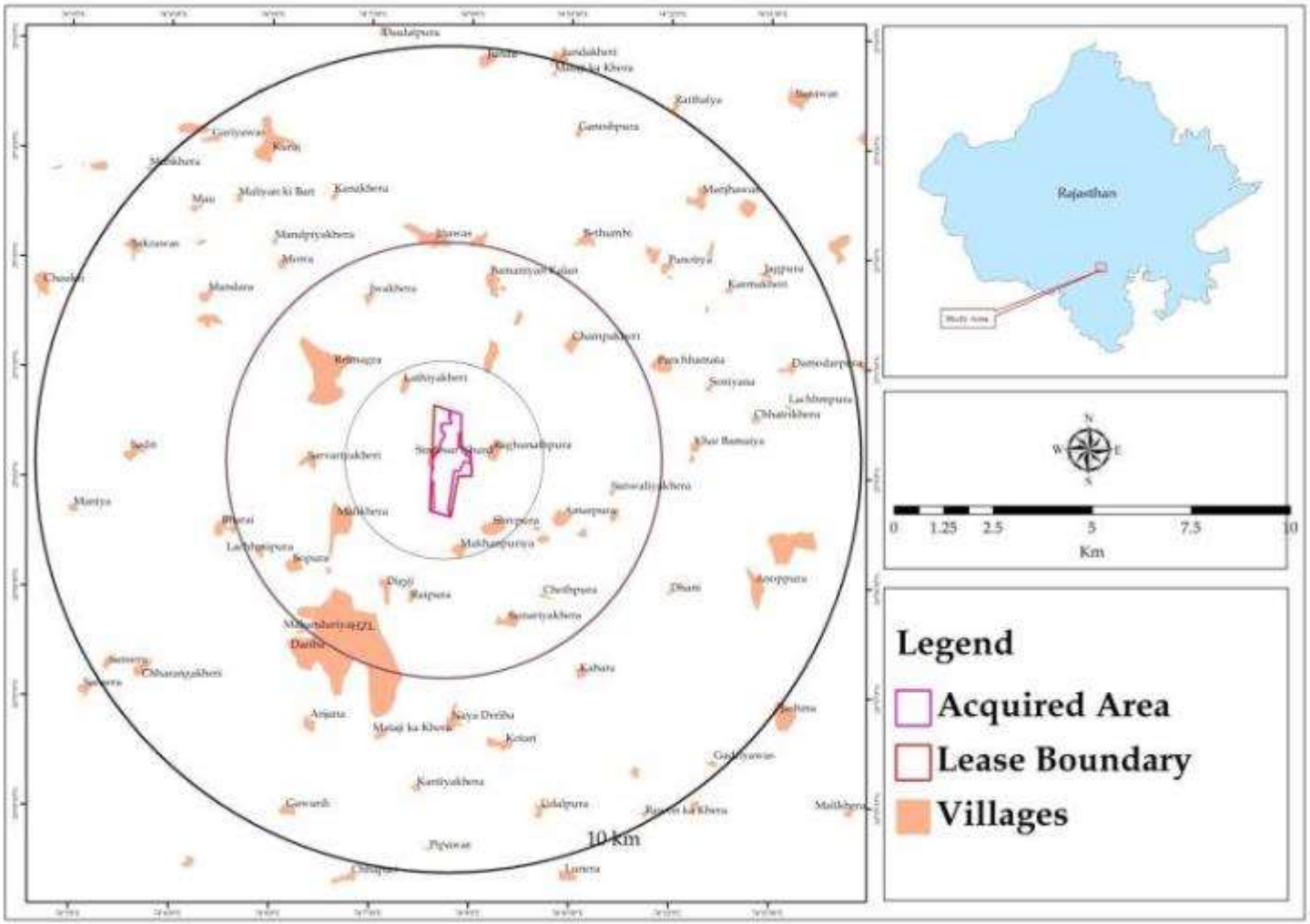
- Primary Census Abstract (PCA) India 2011 data;
- Village Directory (VD), Census of India 2001;
- Integrated People Development Programme (IPDP) Report covering 12 poverty stricken Gram Panchayats of Railmagra and Khamnore Panchayat Samitis;
- Documents on ongoing CSR activities by HZL around the local area;
- Published research papers, articles and other information available in public domain on aspects such as Mining impact on local communities, occupational structure, land reform, local governance anddecentralisation, civil society and NGOs as well as economic policies and regional development plans the state is pursuing.

This was an ongoing process and secondary data was also collected during the site visit.

Scoping and Defining the Study area

This section outlines the socio-economic baseline of the study area identified as the area within 10km radius zone from the mining lease boundary area. It is expected that the social impacts will not exceed beyond this geographical area. The study area is further divided into core zone and buffer zone. The core zone for this study has been considered as the ML area, where most of the consultations have been conducted and the buffer zone stretches from beyond ML are to 10 km from the site. The figure below illustrates the study area including the core and buffer zone.

Figure 3.6.8 Villages falling under the study Area



Tool Development

The methods and tools employed to undertake this study have been presented in the following table:

Table 3.6.10 Description of tools employed for the study

Tools	Description of the Methods/Tools
Focus group discussions (FGD)	• Semi-structured meetings with community members and specific groups including village elders, women group etc. to understand issues faced by relevant groups; including vulnerability and perceptions of the project and needs in the area; • FGD helps in capturing the needs and expectations of diverse groups; hence an effective method to cross-validate data gathered and to also make it representative for a larger population;
Key informant interviews (KIIs)	• Interviews with individuals who are informed members of the community such as Panchayat member, community leader etc.; • These also included school teachers, healthcare professionals, NGOs etc.; • Perceptions of the project through these interviews were also gauged; • KII method helps in undertaking focused and in-depth analysis and hence effective as a tool to gather specific concerns etc.
Surveys	▪ Sample Surveys were undertaken in core zone of the project study area to understand their livelihood patterns, to understand how they perceive the impact of mining operation on their day to day living, to understand how they perceive community development activities by HZL, among others; ▪ The questions were of the nature of semi-structured and mostly open-ended in order to generate qualitative information.
Village mapping	▪ Village Resource Mapping and identifying settlement and livelihood patterns and existing facilities (education, health, infrastructure etc.) and changes in the recent years; ▪ Community consultations at village level (e.g. Sindesar Khurd) to understand how the village perceived impacts from the project; ▪ Gauging further community needs of villages in the study area;

Site Visit and Data Collection

ERM undertook a site visit in the study area and undertook consultations with the youths, panchayat members, village elders, and women group members, other community members and government representatives.

The team developed a field visit plan on the basis of the number of stakeholders to be consulted in different villages, the time taken to travel to and from the villages, distance between villages, availability of the government representatives, community members and the project affected families etc.

Kick off meeting with the Project Management at site

The ERM team held a detailed discussion with the project proponents before the commencement of field visit and community consultation to obtain a detailed understanding of the project, the project area, the type/range of ongoing and planned activities, resources available etc. General discussions with respect to the administrative set-up, land ownership, land use, livelihoods, dependence and

related issues were also held. The issues and concerns raised by different stakeholder groups, NGOs, Civil society groups and other action forums were also covered in these consultations.

Consultation with communities in core zone of study area

Focused group discussion with select communities around the SK Mine, particularly with communities closer to the Mines location was carried out with the objective of getting community feedback over mining operation as well as to understand existing socio-economic conditions of the community, particularly of the vulnerable group such as backward caste of the villages, BPL groups, elderly groups, women groups etc. Another important objective of the community consultation was to get first hand visual reconnaissance of mining operation impact over nearby communities.

Box.1 Community Consultation in nearby villages of SK Mines

Stakeholder Consultations: Interviews with key informants

Under this stage of work, mapping of key stakeholders of the project was done based on discussion with project proponent at site and honest attempt was made to have discussion with key stakeholder in person. This process was also used as an opportunity to collect relevant primary data for strengthening socio-economic baseline of the project study area.

Detail discussion with CSR team of the project was carried out in order to understand the key areas of intervention and coverage area under CSR programme. Various tehsil level departments of Railmagra tehsil like Revenue department, health department etc were consulted in order to capture their perception on project impact on local community as well as for collecting necessary primary data/information for the socio-economic baseline condition of the project study area.

1.2.5 Overview of the Study Area

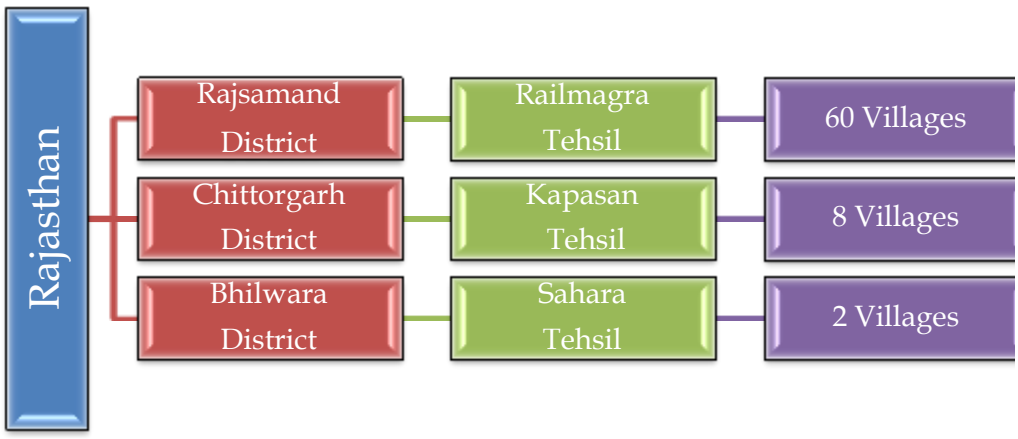
SK Mines is located near at Railmagra tehsil in Rajsamand district of Rajasthan. This baseline report provides socio-economic baseline conditions of the project study area which is defined as 10 km radius boundary from mining concession area and also tries to provide comparative assessment by classifying the study area into three zones i.e. a) villages within 2 km radius area from concession boundary, b) villages located between 2 to 5 km radius area from concession boundary, and c) villages located between 5 to 10 km radius area from concession boundary.

Villages within 2 km radius boundary includes 5 villages that could be considered as core zone for this project as they are likely to experience relatively more impacts on account of operation of mining expansion from 2 Mtpa to 3.75 Mtpa. Villages falling under 2 to 10 km radius area are considered as buffer zone and it is further classified into 2 to 5 km (which includes 17 villages) and 5 to 10 km radius area (which includes 43 villages) from concession boundary in order to present overall comparative assessment of socio economic features of entire study area. As per census records, total 70 villages are located within 10 km radius area. Out of which 60 villages are located in Railmagra tehsil, 8 villages are under Kapasan tehsil and remaining 2 are in Sahara tehsil.

1.2.6 Administrative Pattern

Core zone of the study area is administratively located under Railmagra tehsil of Rajsamand District of Rajasthan. Villages within 2 to 5 km radius area majorly located in Railmagra tehsil of Rajsamand district except one village i.e. Chautpura which is under Kapasan tehsil of Chittorgarh District. Villages within 5 to 10 km radius area, are located in three different tehsil of three district which includes tehsil Railmagra, tehsil Kapasan and tehsil Sahara of the district Rajsamand, Chittorgarh and Bhilwara respectively. Administrative pattern of the villages under study area, is captured in the **Figure. 3.6.9** provided below which clearly shows that majority of the villages under study area, are located in Railmagra tehsil of the Rajsamand district.

Figure. 3.6.9 Administrative Profile of the Study Area



Entire study area is scattered across three tehsils of three different districts of Rajasthan as shown in above mentioned figure. Socio-economic data for these three tehsils and districts have been captured in this report through secondary sources and is considered as reference point for assessing existing socio economic status of the study area.

1.2.7 Demographic Profile of the Study Area

Railmagra tehsil population constitute 11.5% of the district population. Sex ratio of this tehsil is 989 female per thousand male which is almost equal to that of district level sex ratio and it is also much better than state level sex ratio which stands at 928 female per thousand male populations. Among the study region, Sahara tehsil has highest sex ratio with 1021 female per thousand male population. Key demographic indicators of the study region as per 2011 census data are captured in the ***Table.3.6.11.*** Detailed data is provided in ***Annex J.***

Table.3.6.11 Regional demographic profile of the project study area

Study area region	Population	Sex ratio	Population Density	SC%	ST%
Rajasthan	68548437	928	200	17.8	13.5
Rajsamand district	1156597	990	248	12.8	13.9
Railmagra tehsil	131800	989	217	16.9	10.0
Chittorgarh District	1544338	972	197	16.2	13.1
Kapasan tehsil	199340	991		17.3	11.5
Bhilwara District	2408523	973	230	16.9	9.5
Sahara tehsil	135086	1021	207	18.2	7.0

Source: Census 2011 data

Key demographic profiling of the villages within 10 km radius study area of the project is captured in ***Table.3.6.12.*** The table provides village wise data for core zone of the project and data for buffer zone of study i.e. 2 to 10 km radius area which is grouped in two parts for better assessment of the demographic profile of the study area.

Table.3.6.12 Demography of the study area villages

Study area villages	Households	Population	Population Density	Sex ratio	SC%	ST%
Sindesar Kalan village	497	2280	213	1021	27.7	6.2
Sindesar khurd village	203	1038	129	1055	29.3	0.0
Lathiya Kheri village	134	656	242	982	5.2	25.8
Makanpuriya village	77	409	292	938	21.3	13.2
Shivpura village	92	423	155	863	23.2	76.8

Study area villages	Households	Population	Population Density	Sex ratio	SC%	ST%
Villages within 2 km radius area	1003	4806	188	1001	24.0	14.4
Villages within 2 to 5 km radius area	5205	24615	320	989	19.6	6.5
Villages within 5 to 10 km radius area	13854	66947	223	974	15.1	10.8

Source: Census 2011 data

Sindesar kalan is the most populous village in immediate vicinity of the SK mines Mining Lease (ML) area. The nearest village from the ML boundary is Sindesar Khurd that is populated with more than thousand number of persons. Scheduled caste population is also relatively more in these villages. Shivpura was observed to be most backward village during site reconnaissance visit as mostly houses were found to be kutcha house. Shivpura village is also habited with only SC & ST population.

Large number of migrant population including floating population was observed near village Rajpura and Dariba. One important factor for this migrant population is that there exists HZL employee housing colony near these villages wherein migrant employees of HZL lives. Secondly number of migrant workers, trucks drivers etc resides on rented houses in this area. These factors are gradually changing demographic pattern of these two villages. Other local persons are also attracted towards market of these villages because of the various business opportunities arising out of existence of large number of migrant population.

Literacy Profile

Literacy profile of the study region is captured in the **Table .3.6.13.** It appears from this table that literacy rate for Railmagra tehsil is 60.1% which is less than the literacy rate of Rajsamand district as well as of Rajasthan. One common feature in literacy profile study region is that there is wide gap between male and female literacy rate. All the three districts and tehsils in the study region have recorded less than 50% female literacy rate whereas male literacy rate is above 70% in all of these areas.

Table .3.6.13 Literacy Profile of study area

Study region/area	Literacy rate	Male literacy rate	Female Literacy rate
Rajasthan	66.1	79.2	52.1
Rajsamand district	63.1	78.4	48.0
Railmagra tehsil	60.1	76.5	43.8

Study region/area	Literacy rate	Male literacy rate	Female Literacy rate
Chittorgarh District	61.7	76.6	46.5
Kapasan tehsil	55.3	71.9	38.7
Bhilwara District	61.4	75.3	47.2
Sahara tehsil	59.8	75.2	45.0

Source: Census 2011 data

Literacy profile of the study area villages is captured in the **Table.3.6.14.** Overall literacy rate of village within 2 km radius is 55.4 % which is lower than literacy rate of corresponding tehsil and district literacy rate. Village Sindesar Khurd is most literate village with 60.7% literacy among the close by villages, ironically this village also records widest gender gap in literacy rate.

Table.3.6.14 Literacy Profile of the study area villages

Study area villages	Literacy rate	Male literacy rate	Female Literacy rate
Sindesar Kalan village	58.2	75.3	41.8
Sindesar khurd village	60.7	80.4	42.4
Lathiya Kheri village	53.4	71.9	35.5
Makanpuriya village	47.4	59.6	35.3
Shivpura village	36.7	54.3	17.6
Villages within 2 km radius area	55.4	72.8	38.6
Villages within 2 to 5 km radius area	66.8	81.6	52.0
Villages within 5 to 10 km radius area	59.2	75.9	42.2

Source: Census 2011 data

Villages located between 2 to 5 km radius area records highest literacy compare to other two cluster of the study area because of the existence of better educational institution in this area.

1.2.8 Land Profile

Land requirement for the Project

Expansion of the underground mining from 2 Mtpa to 3.75 Mtpa as discussed in project background section, is planned in the existing 199.84 ha mining lease are for which surface right is already transferred in the HZL from the government. No additional land is required for expansion of mining and any associated activities.

Land use of the Study Area

For land use analysis of the study area villages, data from Census 2001 Village Directory was collected. Summary of those analyses is presented in the **Table.3.6.15**.

Table.3.6.15 Land use profile of the study area villages

Study area villages	Area (In Ha)	(% of total land)	Irrigated land (% of total land)	Unirrigated land (% of total land)	Culturable waste land (including gauchar and groves) (% of total land)	Area not available for cultivation (% of total land)
Sindesar Kalan village	1069	0.0	28.3	14.8	30.2	26.7
Sindesar khurd village	804	0.0	5.8	26.9	45.1	22.1
Lathiya Kheri village	271	0.0	57.2	1.8	10.3	30.6
Makanpuriya village	140	0.0	33.6	42.1	14.3	10.0
Shivpura village	273	0.0	12.1	33.7	39.9	14.3
Villages within 2 km radius area	2557	0.0	22.9	20.7	33.0	23.4
Villages within 2 to 5 km radius area	7772.28	0.0	21.5	33.4	26.1	19.0
Villages within 5 to 10 km radius area	29984.7	0.05	11.22	37.16	32.60	18.96

Source: Village directory, Census 2001 Data.

Analysis of the data presented above reflects that large portion of land is falling under either unirrigated or culturable waste land category. In core zone of the study area, only 22.9% land is irrigated land. Maximum portion of the core zone is under culturable waste land category that includes grazing field. Similar observation was witnessed during the site visit. Some of the land use pictures in core zone of the study is presented below in the ***Figure.3.6.10***

There is no forest land in the study area except for village Deoron ka Khera which is located in 5 to 10 km radius distance from ML Boundary and administratively falls under Kapasan tehsil of Chittorgarh district.

Figure.3.6.10 Land use pictures around the SK mines area

1.2.9 Occupation & Livelihoods

Workers Participation Rate (WPR) depicts the engagement of main and marginal workers in different occupations at household, commercial or agricultural level. WPR is calculated as the ratio of working population (both main and marginal workers) to the total population (working and non- working population) of the town/village. It also indirectly indicates the employment opportunities in informal sectors like household industries, industrial and commercial activities etc. the higher the WPR, the more active local population in terms of employment, which could be due to the commercial activities in the vicinity.

The distribution of occupational pattern of the people in Railmagra tehsil reflects that 51.5% of working population is cultivators which are higher than corresponding district and state level figure. WPR of Railmagra tehsil is also better than WPR of Rajsamand district and state level WPR.

Table.3.6.16 Distribution of occupational pattern of the population in study area

Study region/villages	Main Workers %	Marginal Workers %	Non Workers %	CL %	AL %	HH %	OT %	WPR
Regional Information								
Rajasthan	30.7	12.9	56.4	45.6	16.5	2.4	35.5	43.6
Rajsamand district	31.3	16.3	52.4	37.7	19.4	2.5	40.5	47.6
Railmagra tehsil	39.1	11.4	49.5	51.5	17.2	2.7	28.6	50.5
Chittorgarh District	42.5	9.4	48.0	56.5	15.4	1.9	26.2	52.0
Kapasan tehsil	40.4	12.5	47.1	58.0	17.7	2.3	21.9	52.9

Study region/villages	Main Workers %	Marginal Workers %	Non Workers %	CL %	AL %	HH %	OT %	WPR
Bhilwara District	36.7	11.0	52.3	48.4	14.2	2.6	34.8	47.7
Sahara tehsil	34.9	16.7	48.4	50.8	17.4	3.8	27.9	51.6
Study area villages								
Sindesar Kalan village	35.7	16.8	47.4	53.1	12.8	1.8	32.3	52.6
Sindesar khurd village	43.0	4.2	52.8	51.0	7.3	6.3	35.3	47.2
Lathiya Kheri village	61.1	2.0	36.9	64.3	1.7	7.0	27.1	63.1
Makanpuriya village	58.2	2.2	39.6	66.4	5.7	0.0	27.9	60.4
Shivpura village	35.5	19.4	45.2	47.8	28.9	0.0	23.3	54.8
Villages in 2 km radius area	42.7	11.1	46.3	55.3	10.7	3.2	30.8	53.7
Villages in 2 to 5 km radius area	38.6	8.5	52.9	45.6	12.4	2.3	39.7	47.1
Villages in 5 to 10 km radius area	42.3	8.5	49.3	57.1	13.9	2.9	26.0	50.7

Source: Census 2011 data

The distribution of the occupational pattern in core zone of the study reflects that proportion of Other Workers in Sindesar Khurd and Sindesar Kalan village is relatively higher than other villages of the core zone which indicates these two villages have relatively more access to the employment opportunities generated in the operation of SK Mines.

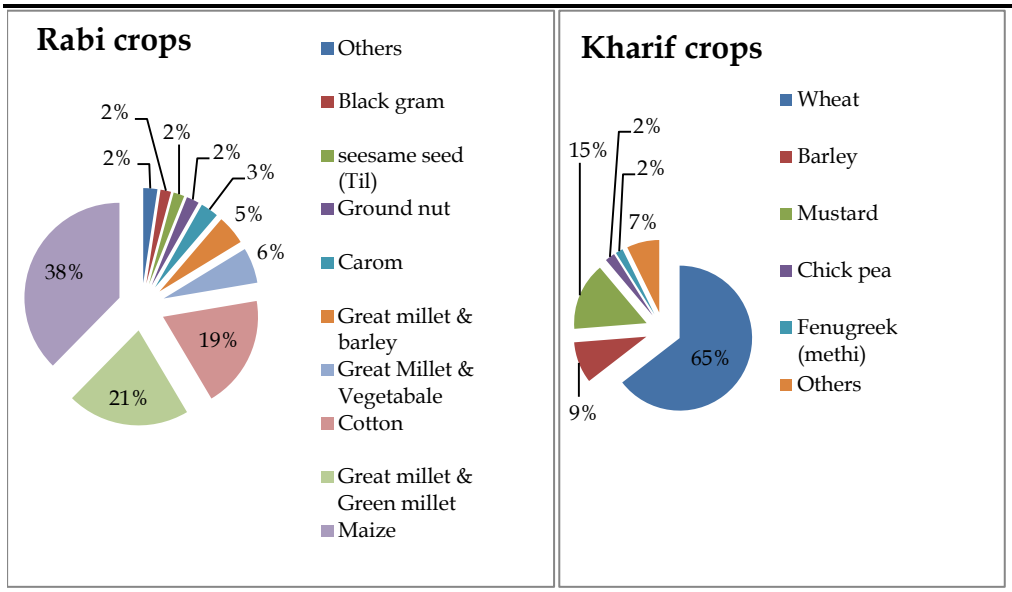
Overall WPR for the villages within 2 to 5 km radius is less than 50%, however proportion of Other Worker is 39.7% which is better than other two clusters of study area. This phenomenon can be attributed to the employment opportunities arising out of existence of HZL Dariba Mines in this area. SK Mine operation has created petty business opportunism for the nearby villagers like shops, vehicle hiring, renting etc.

Figure.3.6.11 Petty shops around the SK Mines area

1.2.10 Cropping pattern

Mostly crops are cultivated in Rabi season in the study area villages. Key crops during Rabi season are maize, wheat, great millet, cotton, barley, mustard etc. Other crops and vegetables are also cultivated but relatively in less proportion. Data on total area cultivated during Rabi and Kharif season was collected during discussion at Railmagra tehsil office. Analysis of the data is presented in below mentioned **Figure.3.6.12.**

Figure.3.6.12 Cropping pattern in Railmgara tehsil



Source: Discussion with Railmagra tehsil office

Note: Data presented here is intended to reflect degree of intensity for various crops and it may not be exhaustive in terms of data accuracy.

Total area cultivated during the Rabi season in Railmagra Tehsil was reported to be 22706 ha in the year 2013-14. In which, maize was cultivated in 38% area followed by great millet, cotton and others. Others cultivated crops of Rabi season were black gram, til, ground nut, barley, vegetables, spiked

millet, sugarcane etc. In Kharif season, total cultivated area was reported to be 10906 ha and proportion of wheat cultivation was reported to be maximum with 65% of total Rabi crops cultivation area. Other crops grown in Rabi season were barley, mustard, chick pea, seesame seed, cumin, carom etc.

1.2.11 Physical & Social Infrastructure and Amenities

Education Infrastructure

An overview of census 2001 data reveals that mostly villages in the study area have a primary school within their periphery. Enrolment of children up to primary level schooling was also observed to be good in community consultation. Distance to middle school, high school and colleges for mostly villages in study area is beyond 5 km. This is one of factor observed as a cause of higher drop-out rate among the children after primary level education, particularly among the girls. Dropout rate was also observed to be more in socially backward class of the villages like SC and ST groups.

There are some private schools as well in in industrial area like village Dariba and Panchayat Samiti headquarters like Railmagra. There are higher education institutions like senior secondary schools, Degree Colleges, technical institution etc in Railmagra. Villages close to these areas, thus also have better access to education facility compare to other villages of the study area. Based on stakeholder consultation, it was also observed that people prefer to send their children to private school depending upon their financial capability.

Health Infrastructure and Services

Railmagra tehsil houses 60 villages out of the total 70 villages located within study area of the project. There are two CHCs, 6 PHCs and 34 SCs in Railmagra tehsil. Most of these government health centres are located within the project study area**. Table.3.6.17** provides listing of these health centres captures location of these health centres.

Table.3.6.17 Health infrastructure of Railmagra tehsil

Type of health care unit	Total number	Location	Location under study area
Community Health Centre (CHC)	2	Railmagra, Dariba	• Railmagra • Dariba

Type of health care unit	Total number	Location	Location under study area
Primary Health Centre (PHC)	6	Kuraj, Kotadi, Pipli Ahiran, Gilund, banedia, Dhaneria	• Kuraj,
Sub-Centre (SC)	34	Madara, Mora, Sakrawas, Chokadi, oda, Adkiya , Sindeshar Kalla, Lathiyakhedi, Sadri, Khandel, Lapsiya, Jitawas, Junda, Bamaniya Kalla, Mehnduriya, Sansera, Rajpura, Khadbamniya kalla, Kabra, Gawardi, Ladpacha, Anjana, Gogathalla, Kundiya, Pachamta, Bethumbi, Jagpura, Jawasia, Panotiya, Pipli, Dodiyan, Meniya, Fukiya, Charana, Khatukada	• Madara, • Mora, • Sakrawas, • Sindeshar Kalla, • Lathiyakhedi, • Sadri, • Jitawas, • Junda, • Bamaniya Kalla, • Mehnduriya, • Sansera, • Rajpura, • Khadbamniya kalla, • Kabra, • Gawardi, • Ladpacha, • Anjana • Pachamta, • Bethumbi, • Jagpura • Panotiya • Meniya,

Source: CHC, Railmagra

Common ailments

Railmagra CHC provides services for mostly villages of the study area. Assessment of the diagnosis record of the total outdoor and indoor patient enrolled in this Railmagra CHC for the year 2013 is presented in the ***Table.3.6.18*** given below which shows that patients diagnosed with disease of respiratory system were as much as 22% out of the total number of outdoor and indoor patient which is maximum. Next major disease diagnosed among the enrolled patient was intestinal infectious disease like cholera, typhoid, amoebiasis etc.

Table.3.6.18 Proportion of various diseases diagnosed in Railmagra CHC in the year 2013

S. No	Disease	Percentage
1	Disease of the respiratory System	21.9%
2	Intestinal Infectious Diseases	11.4%
3	Hypertensive heart disease	5.6%
4	Ulcer of stomach and other diseases of digestive system	7.6%
5	Diseases of Blood and Blood Forming organs (Anaemias)	4.1%
6	Motor vehicle traffic accidents	3.1%
7	Open wounds and injuries to Blood vessels	2.8%
8	Disease of urinary system	2.0%
9	Diabetes mellitus	1.6%
10	Nutritional Deficiencies	1.6%
11	Other disease	29.6%

Source: Railmagra tehsil CHC, Rajsamand District.

During consultation with community, polluted ground water and air pollution emerged as major concern for community health & safety. These two reasons can also be attributed to one of the factors for higher rate of respiratory disease and intestinal infectious disease prevailing in the community.

During consultation with Chief Medical Officer of Railmagra tehsil, another bottleneck in the way of access to medical facilities appeared to be a cultural barrier, particularly among the rural women. He informed that large number of local people believe in approaching local deities/priest over medical centres in case of any medical exigency for the recovery of the patient. There have been many instances where patients have lost their life because of this cultural barrier.

Water Supply

Review of 2001 census data reveals that hand pump and well have been the primary source of drinking water supply in mostly village of study area. It was also observed that source of drinking water is gradually shifting to piped water supply provided by government. CSR programme of the HZL is also providing piped water supply scheme in some villages in the study area.

During community consultation, it was reported that ground water level has gone down over the period of last two decades resulting in drying of wells, bearing higher cost for digging and installing personal hand pump. Villagers also reported that water is contaminated with acid in wells and tube wells. Hence safe drinking water is a major issue reported by community.

Figure.3.6.13 Sample pictures of drinking water sources in study area villages

Sanitation

Sanitation is also observed to be very poor in mostly villages of the study area. Open defecation is very common. The *Integrated People Development Programme (IPDP) study report* carried out on behalf of HZL in 2012 also highlights that level of awareness for use of toilet is very low in the mostly villages of study area. Percentage of households using toilet is very low. This IPDP report also highlights that many toilets constructed under Total Sanitation Campaign (TSC) fund for the BPL families are actually being

used as store room. Therefore there is need for intensive awareness campaign on use of toilet in the villages with lower rate of sanitation practice.

Electricity

Review of Village directory 2001 for villages under study area reveals that power supply for domestic and agriculture use is available for all the villages under study area. Issues around power cut were raised in community consultation process.

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CHAPTER - 4

ANTICIPATED ENVIRONMENTAL IMPACT AND MITIGATION MEASURES

4.1 GENERAL

Environmental impacts both direct and indirect on various environmental attributes due to existing as well as proposed mining activity will be created in the surrounding environment, during the pre-operational, operational and post–operational phase.

The impacts due to mining operations commence from the exploration activities, extend through extraction and processing of minerals, may continue up to post closure of the operation, with the nature and extent of impacts varying throughout the stages of project development.

Identification of possible impacts specific to an activity is an important task since this helps in focusing attention upon relevant environmental parameters and relating them with the activities involved. The following parameters are of significance in the Environmental Impact Assessment and are being discussed in detail.

1. Land Environment
2. Water Environment
3. Air Environment
4. Noise Environment
5. Solid waste
6. Biological Environment
7. Socio-Economic

4.2 LAND ENVIRONMENT

Parameter	Impact	Management
Topography and drainage	The mining activities in the mine will have very limited impact on topography of the mine lease area due to underground workings and hence alteration of the surface topography is not expected. The areas affected on the surface will be only the entry points to the underground mine, facilities at surface and the dump area created for the disposal of waste generated from drivages of underground drifts/ inclines in rock. As there will not be any expansion work at the existing establishment, change in topography is not envisaged.	Precautions will be taken by partial extraction, if required, to protect them from any damage from subsidence. Suitable drainage will be made to avoid and water logging in the center of subsidence. During extraction of panels, the ground subsidence will be monitored over at least one panel each in forestland to know the actual impact by an external agency. The facilities and entry points will be fenced and free access prevented for both man and animal. No adverse impact of the streamlets is

	Drainage There is no perennial source of water like pond, river, stream or nallah running through the lease area. Four first order streams which originate within the lease area on the Eastern and Southern slopes of the hill will continue to flow without being disturbed by the underground mining or any surface activity. The area is drained by Banas River, an ephemeral river, which flows at distance of 3 km north of the northern boundary of the lease area. The hydraulic conductivity is very low. The depth of productive hydraulic conductivity has been observed up to maximum depth of 110m in the metamorphic, beyond which there are hardly any secondary openings making the metamorphic completely barren for ground water. No major impact is envisaged as the proposed expansion will be achieved by increasing the efficiency of the existing infrastructure of the mine.	anticipated as the peak flow will be of low magnitude and for very short duration under natural gradient. As underground mining is being carried out, any streams will not be affected and will continue to flow undisturbed by the mining. So, no diversion is required and there will not be any impact on the surface drainage system and surface water resources of the lease area and on any existing users
Land	Out of the acquired area, currently 77.2 ha land under use, it is proposed to bring additional 51.8 hectares in to use for proposed expansion is considered for allied infrastructure on surface and site for construction of proposed beneficiation plant and waste dump in surface. As all the activities related to the project will be restricted to the core zone, the impact on buffer zone will be negligible.	This is an underground mining project, will cause merger land degradation as the limited area disturbed will be due to surface facilities only. The post expansion mining land use of the core zone shows that out of total disturbed area, 50.0 ha. area will be planted in post mine closure.
Soil	Since, Hindustan Zinc Limited is an underground mine, there will be no net loss of soil during the operation of mine. Contamination of soil quality, to some extent, is possible in the core zone near	The topography of the lease area is hilly and it is an underground mine. Hence, top soil will not be disturbed but at the places of dumps etc if it is encountered, it will be stacked and

	workshop and beneficiation pant for which adequate mitigating measures have been taken. In spite of these, no significant impact on soil quality has been observed.	will be used for plantation purpose.

4.3 WATER ENVIRONMENT

Water plays a very important role in preserving life. It is also vital for the growth of flora, fauna and agriculture. Aquatic life fully depends on the quality and quantity of water. Rain cycle is an important activity of nature which fully depends on water, plantation, air, hills and other features. The mining activity in general is considered as creating negative impacts on this system. However, all mitigation measures have been envisaged to nullify these negative impacts, in this project, as detailed below:-

4.3.1 IMPACT ON WATER ENVIRONMENT

4.3.1.1 Impact due to Mining

It is an underground mine. The ground water table has already been intersected, but there is no negative impact anticipated on ground or surface water. Several measures have also been undertaken for water conservation and augmentation of ground water resources which are as given below:-

S. No.	Anticipated Impacts	Mitigation/ Conservation Measures
1	Domestic wastewater and industrial waste water	➢ Septic tank followed by soak pit is already provided for the treatment of domestic waste water. ➢ Waste water from beneficiation plant is sent to a lagoon for settling. ➢ Garland drains around dumps, and sumps are constructed to channelize rainwater. ➢ Wastewater generated from beneficiation mill plant will be pumped to tailing dam, where it will be allowed to settle; the clear water will be reclaimed on continuous basis and pumped to the water reservoir for re-use in the process. ➢ No water will be allowed to discharge outside the tailing dam to maintain zero discharge, as the suitable garland drain has been constructed around the waste dump to collect the run-off water from the dump and to prevent contamination of land, surface and

		groundwater of the surrounding area. Thewater collected will be pumped and reused in beneficiation plant.
2	Ground Water (i) Mine dewatering Pump test conducted in nearby area having mica schist revealed low hydraulic conductivity of 0.2 m/day and estimated total inflow from the mining opening will be 95.93 m3/day post expansion has against the current inflow of 32 m3/day. The abstraction of ground water will have influence of around 150 -200 m radius area and there are no villages present within 150-200 m radius of the Project, hence the impact on groundwater is limited to mine lease area. (ii) Water quality Groundwater in the region is likely to provide flow to the nearby River Banas in the North and Berach River in extreme South and therefore with a potentially reduced water table this additional volume of water would	➢ Development of ground water recharge management system around the ML area; ➢ Implementation of recharge measures proposed in the hydrological and hydrogeological study; ➢ Tailing dam has been provided with HDPE liner systm and the same will be adopted during the operation phases; ➢ Monitoring of groundwater level and quality around Tailing dam area shall be carried out regularly to ensure no groundwater contamination and seepage; ➢ Construction of garland drains of suitable size around waste dump and tailing dam with proper gradients to prevent rain water descent into ML area and other surface activity area; ➢ Also for the extension of existing dump along with new proposed waste dump site, suitable garland drain similar to the existing dump will be provided. Garland drains will be connected to siltation tank of appropriate size and will be desilted at regular intervals. The water collected will be utilized for watering the mine area, roads, green belt development etc; ➢ Labour deputed onsite will be instructed for optimal use of water; ➢ Minimum use of water in cleaning/washing of equipment's and vehicles; ➢ Garland drains (size, gradient and length) and sump capacity will be designed keeping 50% safety margin over and above the peak sudden rainfall and maximum discharge in the area adjoining the mine site; ➢ Settling ponds capacity will provide adequate retention period to allow proper settling of silt material;

	not be available. A reduction in flow can have impacts on water quality as well as availability in pre-monsoon conditions. Based on the above information, the potential impacts on aquifer water quality due to underground mining operations will be minor.	➢ Use of silt/sediment traps to reduce the sediment load from the disturbed area to the natural drainage; ➢ The waste dump will be provided with garland drains. The dump tops and sides of inactive areas will be progressively reclaimed with grasses and shrubs to prevent erosion.

4.4 AIR ENVIRONMENT

The proposed expansion of underground mining occurs in horizontal tunnels with access to the surface via large vertical shafts. The main activities carried out at underground ore mines that could lead to emissions to air, are as follows:

- Earthmoving associated with the development of the surface facilities
- Shaft/decline access and ventilation development
- Extracting, transporting, and dumping ore
- Crushing ore (including primary, secondary and tertiary crushing)
- Floatation and thickening
- Ore beneficiation
- Power plant operations. (DG Sets)

4.4.1 AIR QUALITY IMPACT PREDICTIONS (AQIP)

The major sources of air pollution due to the proposed mine is dust generation due to loading and transportation of mineral, wind erosion of exposed material. In this present study, United States Environmental Protection Agency (USEPA – 42 series) approved mathematical equations have been used to predict concentrations for different operations in mining including the mineral transportation.

4.4.1.1 DETAIL OF EMISSIONS

Table 19 Area source emission details

Source	Activity	Emission Factor		
		PM10	PM2.5	Nox
Fugitive Dust	From loading and Unloading of ores	0.25 kg/ha/hr	0.03 kg/ha/hr	--
Transportation	From Transporting Road	27.2 g/VKT	6.6 g/VKT	--
Beneficiation	From Crusher	100 mg/Nm3	--	--

Table 20: STACK (Point source) EMISSION DETAILS

Source	Source ID	Release Height	Gas Exit Velocity (m/s)	Gas Exit Temperature (K)	Stack Inside Diameter	PM_{10} (emission in g/s)	$PM_{2.5}$ (emission in g/s)	Nox (emission in g/s)
Crusher	STCK 1	30 m	15	300	0.5	0.3	-	-
Course Ore Stock	STCK 2	30 m	7.5	300	0.8	0.4	-	-
DG set	STCK 3	30 m	20	573	1.2	0.1	0.04	1.81

4.4.2 AIR QUALITY MODELLING

The ISCST-3 model developed by US Environmental Protection Agency (EPA) is used to compute the ground level concentrations of the pollutant. This model has the capability to handle polar or Cartesians co-ordinates, simulate point, area and volume sources, considers wet and dry deposition, makes terrain adjustments, considers building downwash. The ISCST-3 model for continuous elevated point sources uses the steady-state Gaussian plume equation. The ISCST-3 model employs Briggs formulae to compute plume rise, Pasquill-Gifford curves for parameterising the horizontal and vertical dispersion parameters for rural background and empirical relations for urban background and it includes buoyancy-induced dispersion. This model has an option to use rural or urban background. Wind profile law is used to estimate the wind speed at stack height.

Meteorological Data:

Meteorological data recorded during baseline monitoring (1 March to 31 May 2014) was used for the modelling exercise. The wind rose diagram of the study period has been presented in Figure 1. The predominant wind direction is E to NE.

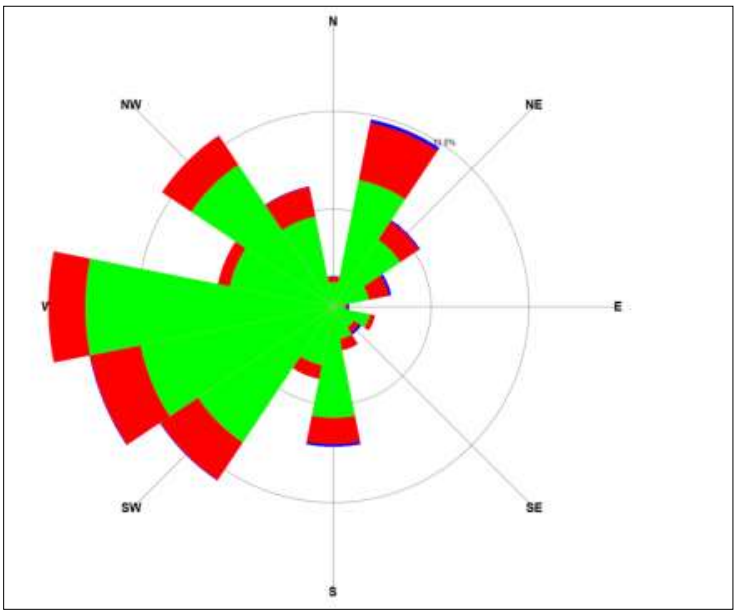

Figure :1 Wind rose of the meteorological station in the study domain for the Summer Season

Receptors:

The receptor grid, defines the locations of predicted air concentrations used to assess compliance with the relevant standards or guidelines. Receptors are selected in this study are those which are used for the monitoring purpose. Total 15 receptors are selected for the study which is shown in Figure 2. Receptors with coordinate also described in Table 3.

Table 21: Receptors selected for the study

Monitoring Station/ Receptor	Station Code	Co-ordinate(m)		Distance from ML in Km	Direction
		Easting	Northing		
Project Site	AAQ1	12076	11435		Within ML
Navakhera	AAQ2	13636	11859	2.7	E
Raghunathpura	AAQ3	14733	11335	0.5	E
Project Site	AAQ4	13024	10850		Within ML
Chambakheri	AAQ5	15581	14433	3.3	NE
Sindesar Kalan	AAQ6	12282	14170	1.7	N
Bamnia Kalan	AAQ7	13566	15945	3.6	NNE

Relmagra	AAQ8	8272	14041	2.8	NW
Sarvaria Khera	AAQ9	8500	11403	2.8	WSW
Malikhera	AAQ10	9569	10022	2.4	WSW
Makhanpuria	AAQ11	12869	9283	0.9	SE
Amarpura	AAQ12	15325	10292	1.5	SE
Gurjaria Ka Khera	AAQ13	16239	3869	7.9	SE
Damodarpura	AAQ14	20855	14208	8.5	NE
Sakhrawas	AAQ15	4815	17114	8.7	NW

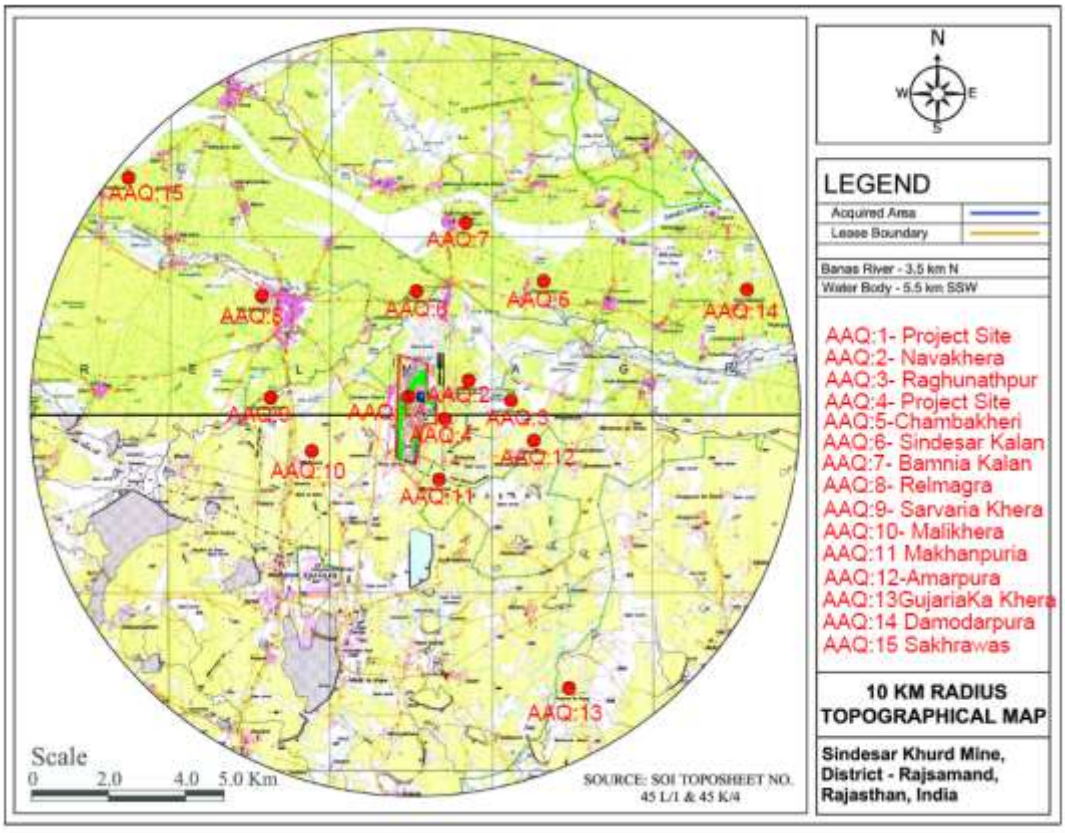

Figure 2: Location of receptors used in this study

Projected Emission for Proposed Expansion Project:

It can be seen from table 4 that highest incremental values which are coming as a modelling result are within mining lease area or near to mining lease area. As distance increases from core zone the predicted values fall drastically. It is can be seen from Table 4 that maximum 24 hourly concentrations (when predicted incremental concentrations at each receptor added with the average recorded concentrations during the study period) of PM10, PM2.5 and NOx concentrations will be within the stipulated standards except at one site i.e project site. It has

further been noted from Table 5 that the incremental ground level concentrations of PM10 at the receptors outside the project boundary are varying from 0.45 to 5.32 µg/m3, whereas PM2.5 levels are varying from 0.26 to 1.5 µg/m3. This clearly reflects that the impact will be confined within and close to the project boundary and transportation route/s. NOx concentration of baseline as well as predicted were observed well within the applicable standards. Incremental ground level concentrations at all the receptors were observed between 0.1 to 2.7 µg/m3.

Table 22: Predicted incremental concentration

Monitoring Station	Station Code	Predicted 24 hourly Maximum Concentration (µg/m3)		
		PM10	PM2.5	Nox
Project Site	AAQ1	14.21	3.2	2.7
Navakhera	AAQ2	3.25	0.89	1.2
Raghunathpura	AAQ3	5.32	1.5	1.9
Project Site	AAQ4	8.25	2.01	1.92
Chambakheri	AAQ5	2.52	0.45	1.1
Sindesar Kalan	AAQ6	2.69	0.54	0.45
Bamnia Kalan	AAQ7	3.11	0.79	0.86
Relmagra	AAQ8	1	0.24	0.36
Sarvaria Khera	AAQ9	1.1	0.22	0.3
Malikhera	AAQ10	1.98	0.51	0.38
Makhanpuria	AAQ11	4.3	0.89	0.56
Amarpura	AAQ12	1.9	0.85	1.3
Gurjaria Ka Khera	AAQ13	0.87	0.26	0.47
Damodarpura	AAQ14	2.6	0.56	0.85
Sakhrawas	AAQ15	0.45	0.12	0.1

Table 23 General Scenario – 24 Hourly Maximum (Baseline + Predicted) Ground Level Concentrations

Monitoring Station	Station Code	Predicted 24 hourly Maximum Concentration (µg/m3)			Baseline 24 hourly Average Concentration (µg/m3)			24 hourly Maximum Concentration (µg/m3) (Predicted + Baseline)		
		PM10	PM2.5	Nox	PM10	PM2.5	Nox	PM10	PM2.5	Nox
Project Site	AAQ1	14.21	3.2	2.7	88	36	22	102.21	39.2	24.7
Navakhera	AAQ2	3.25	0.89	1.2	66	34	15	69.25	34.89	16.2

Raghunathpura	AAQ3	5.32	1.5	1.9	67	34	14	72.32	35.5	15.9
Project Site	AAQ4	8.25	2.01	1.92	80	32	16	88.25	34.01	17.92
Chambakheri	AAQ5	2.52	0.45	1.1	73	36	15	75.52	36.45	16.1
Sindesar Kalan	AAQ6	2.69	0.54	0.45	80	41	18	82.69	41.54	18.45
Bamnia Kalan	AAQ7	3.11	0.79	0.86	76	40	21	79.11	40.79	21.86
Relmagra	AAQ8	1	0.24	0.36	83	43	29	84	43.24	29.36
Sarvaria Khera	AAQ9	1.1	0.22	0.3	81	41	16	82.1	41.22	16.3
Malikhera	AAQ10	1.98	0.51	0.38	73	33	15	74.98	33.51	15.38
Makhanpuria	AAQ11	4.3	0.89	0.56	71	32	17	75.3	32.89	17.56
Amarpura	AAQ12	1.9	0.85	1.3	64	31	17	65.9	31.85	18.3
Gurjaria Ka Khera	AAQ13	0.87	0.26	0.47	66	31	15	66.87	31.26	15.47
Damodarpura	AAQ14	2.6	0.56	0.85	65	33	18	67.6	33.56	18.85
Sakhrawas	AAQ15	0.45	0.12	0.1	61	30	15	61.45	30.12	15.1

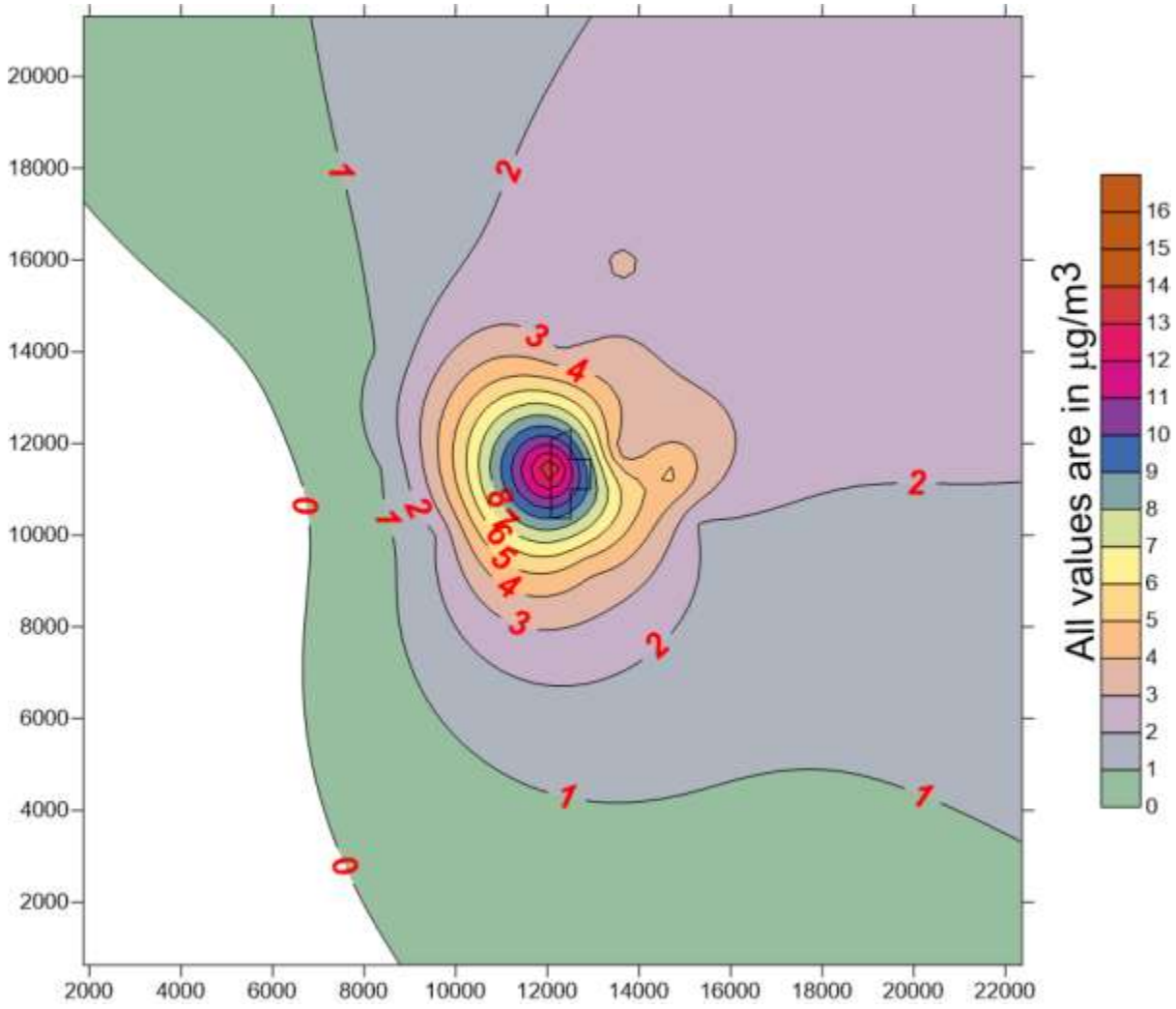

Figure2: Isopleths Showing Maximum Incremental Ground Level Concentrations of PM_{10}

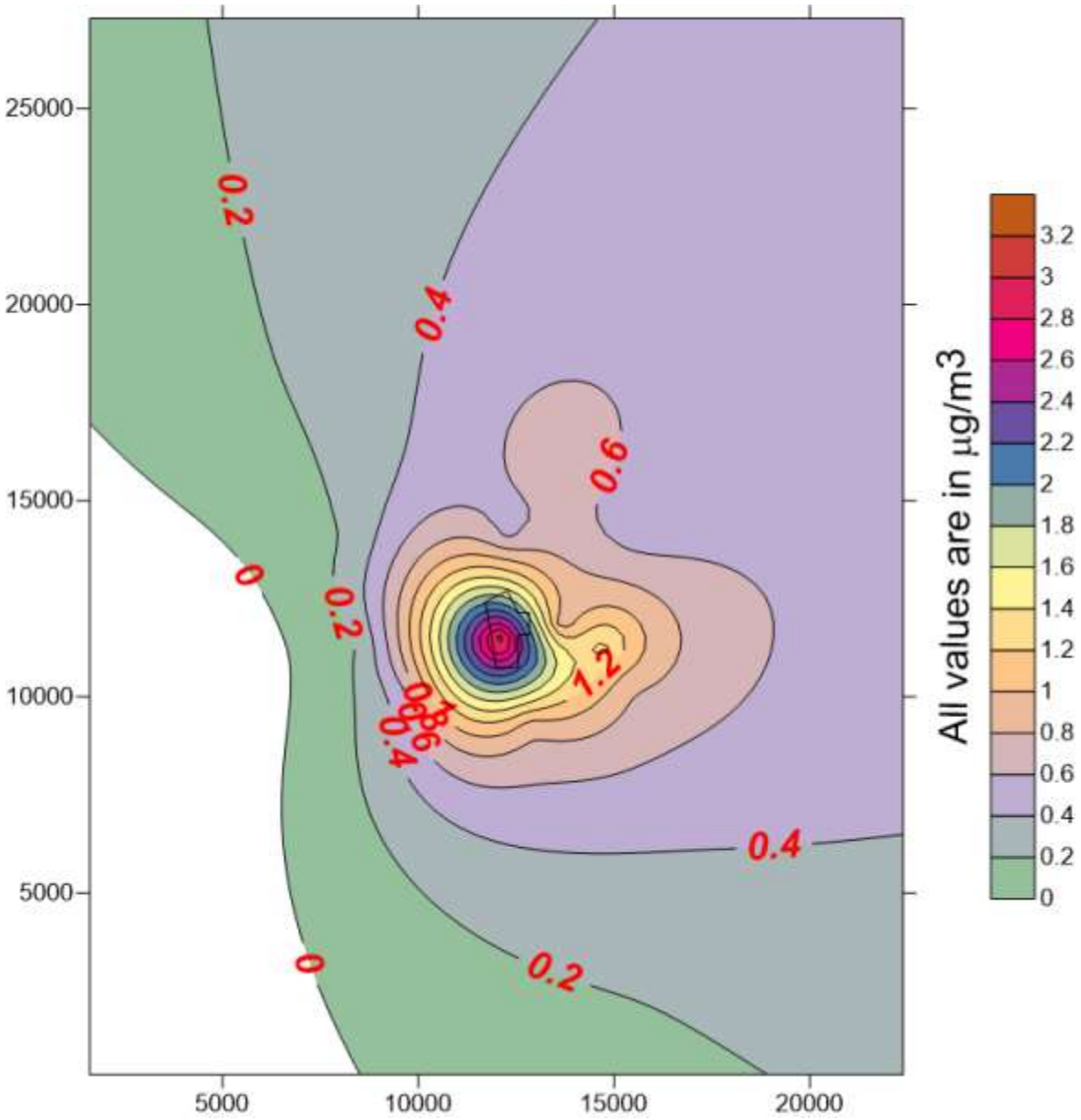

Figure:2 Isopleths Showing Maximum Incremental Ground Level Concentrations of $PM_{2.5}$

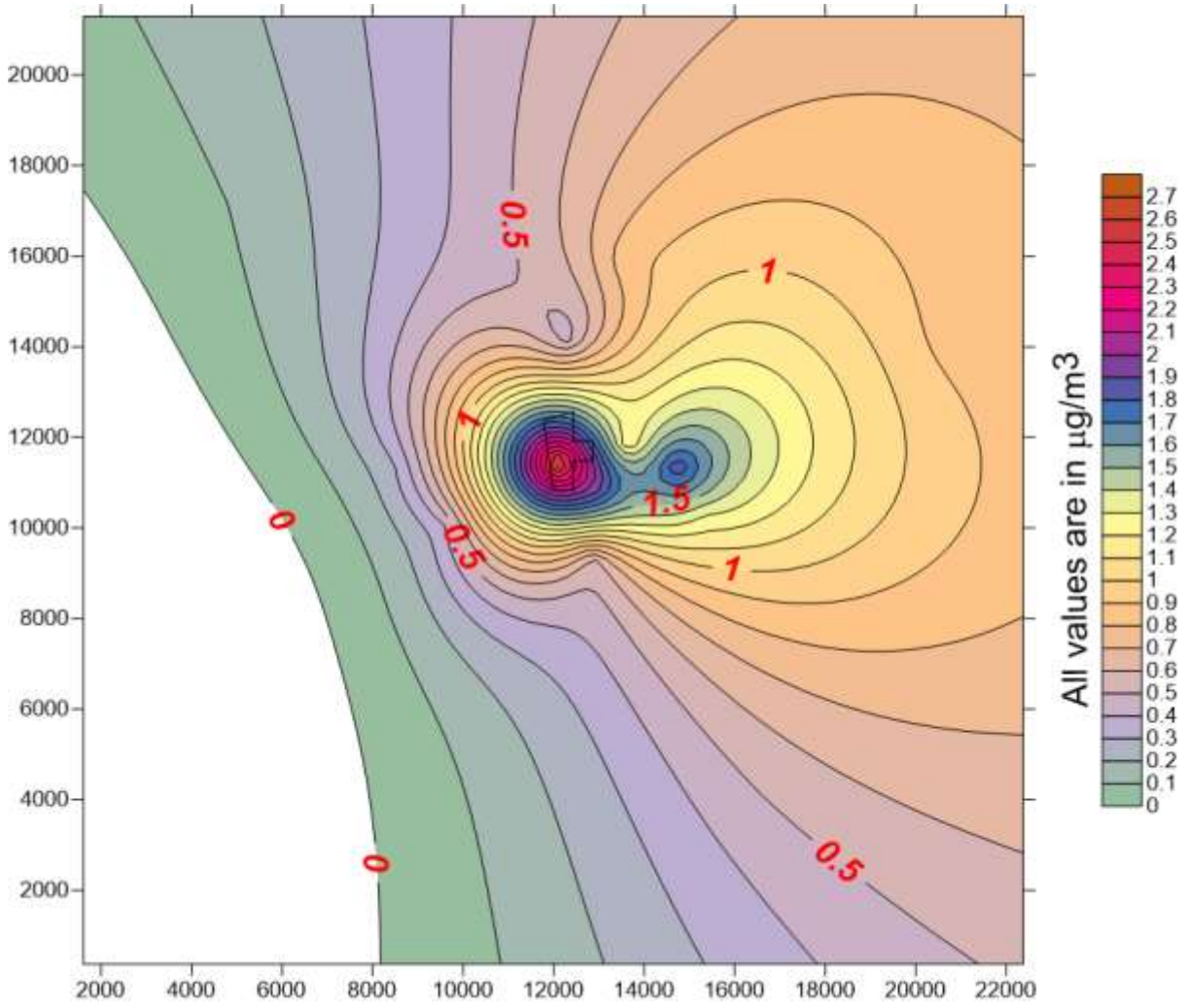

Figure:3 Isopleths Showing Maximum Incremental Ground Level Concentrations of NOx

Source Apportionmate study:

Receptor-oriented source apportionment models have often been used to identify sources of ambient air pollutants and to estimate source contributions to air pollutant concentrations. The most widely used models are the chemical mass balance (CMB), principal component analysis (PCA)/absolute principal component scores (APCS). Among multivariate techniques, principal component analysis (PCA) is often used as an exploratory tool to identify the major sources of air pollutant emissions and to select statistically independent source tracers.

Principal Component Analysis:

The statistical analysis on the collected data was performed by using SPSS statistical software packages (SPSS Inc, USA). Factor analysis attempts to identify underlying variables, or factors, that explain the pattern of correlations within a set of observed variables. PCA is often used in data reduction to identify a small number of factors that explain most of the variance observed in a much larger number of manifest variables. In this study, PCA was carried out on selected 15 monitoring stations for a summer season since they were the most abundant trace compounds in the air for the whole year. The next step was to rotate the initial factor matrix. The rotation phase of factor analysis attempt to transform the initial matrix into one that is easier to interpret. The varimax rotation of the matrix was selected which attempts to minimize the number of parameters that have high loadings on a factor. This enhanced the interpretability of the factors. Only the principal components that explained more than 5% of total variance of the data set were used as factors. Factor loadings determined the more representative parameters in each factor.

Table 24 PCA analysis of NMHCs at TW site

Rotated Component Matrix[a]			
	Component		
	1	2	3
PM_{10}	**.877**	.230	.148
$PM_{2.5}$	**.864**	.273	.149
SO_2	.241	**.919**	.050
NO_X	.275	**.906**	-.065
CO	**.699**	.041	-.234
NH_3	.505	.276	.053
O_3	.456	.215	.045
Pb	.226	.103	**.852**
Ni	.371	.315	-.463

The results of PCA are incorporated in table 6. Three principal components come out from this study. First factor describe PM_{10}, $PM_{2.5}$ and CO. Second Factor shows high loading on SO_2 and NO_x and Third component shows high loading on Pb. From this we can derive that first factor is loading and unloading activity which gives rise to fugitive dust. While second factor is Vehicle transportation as SOx and NOx is due to Vehicular movements only. The Third factor is Beneficiation where due to crushing some of Pb is mixing air. So from this study we can identify different pollution source from different mine activity.

4.4.4 IMPACT AND MANAGEMENT OF AIR ENVIRONMENT

Impact	Management
This is an underground mine, dust producing activities are only a few. Ore from mine is to be loaded to conveyor and Granby cars. Material transfer points will be source of dust pollution. Material handling by heavy equipment as well as ore handling plant will release considerable amount of dust if no action is taken for suppressing it at source, while the immediate effects will be poor visibility and intake of dust through inhalation can have health impacts. The incremental values are 14.21 µg/ m^3 for PM_{10}, 3.2 µg/ m^3 for $PM_{2.5}$, 2.7 µg/ m^3 for NO_X at mine site. Point source emissions considered through two stacks will be consisting of mainly PM, SO_2 and NO_X. The three most predominant wind directions observed during the study period towards E, NNE and NE directions for with average wind speed during this period (March, April & May 2016) is 0.45m/s.	The mine site has mechanical ventilator. Emanation of dust during working will be minimized by adoption of dust suppression systems (like water spraying) at working faces before and after blasting and during loading. Wet drilling will be adopted in drill machines. Transport of material will be done by covered conveyor belt of km length to minimize the dust generation. The transfer points will be provided with sufficient water sprinkling system. Dust generation will also be reduced by using sharp drill bits for drilling holes with flushing system. To mitigate the NOx generation beyond necessity, quantity of explosives will be used. Greenbelt will be developed in and around the facilities. Dust masks will e provided as safety measure to the workers, engaged at dust generation points like drills, loading/ unloading points, material handling etc. Transfer points of ore will be provided with appropriate hoods/ chutes to prevent fugitive dust emissions.

4.5 NOISE ENVIRONMENT

Sources	Impact	Management
➢ Drilling and Blasting ➢ Operation of Machinery	**Physical structure** Vibration can cause varying degrees of damage in buildings and affect vibration sensitive machinery or equipment **Human** Effects on the body, psychological reactions, attitude, interference with communication and concentration, sleeping disturbance and inspiring fear. **Animals** Adversely affect wildlife by interfering with communication, masking the sounds of	➢ Particle velocities of less than 51mm./s (2.0 in./s) show little probability of causing structural damage ➢ If there is at least 8 ms. (millisecond) separation between detonations, the vibration effects of individual explosions are not cumulative. Particle velocity is still the best single ground motion description ➢ Controlled blasting is a technique for the purpose to reduce the amount of overbreak and to control the ground

	predators and prey, cause "stress" and result in temporary or permanent hearing damage. Exposure to noise impulses throughout the night-time sleep period resulted in poorer daytime task performance by animals *(Fletcher & Busnel, 1978).*	vibrations. ➢ In the management of noise and blast emissions is to implement a monitoring and audit program. ➢ Additional sound proof enclosures of fixed and mobile plant and mine ventilation fans. ➢ Acoustic enclosures around process plant and optimising mine layout to shield noise generating plant and haul roads. ➢ Providing bund walls for acoustical screening and acoustic treatment of dwellings. ➢ Altering the blast drilling pattern and delay layout. ➢ Using alternative rock breaking techniques. ➢ Blasting at times that suit local conditions. ➢ Conduct blasts at a set time or use a pre-warning system.

4.6 BIOLOGICAL ENVIRONMENT

Potential or likely impacts due to the proposed mining activity may be, Loss of adjacent forest habitats and biodiversity, Loss of vegetation cover and biodiversity, Loss of aquatic ecosystem and biodiversity, Effects of heavy transportation on habitats and faunal groups, Impact on water and land components, Changes in ambient air quality and degradation of vegetation, Impact of Noise on faunal groups, Accidental mortality of faunal groups, Impact to threatened floral species, Impact to threatened faunal species, Impact on Animal movement. Keeping all this in mind the following mitigations have been suggested under environmental management plan.

With the above understanding of the role of plant species as bio-filter to control air pollution, appropriate plant species (mainly tree species) have been suggested conceding the area/site requirements and needed performance of specific species.

Impact	Evaluation	Mitigation
Loss of adjacent forest habitats and biodiversity	The expansion is coming up in the same lease area. The increase in the production capacity may affect the surrounding habitats & biodiversity.	As the expansion is coming in the same mine lease area (core zone) is not consists of any critical / unique habitat or designated forest land vulnerable to the fragmentation or isolation. Therefore the proposed expansion project activities will not have any impacts like loss of true forest habitat, floral species and associated faunal diversity. However 33% area of the existing mine site is already covered under the green belt.

Impact	Evaluation	Mitigation
Loss of vegetation cover and biodiversity (core zone)	The expansion is coming up in the same lease area. So there will no impact on associated biodiversity of the core zone area.	There is no any clearing of existing sparse vegetation within the lease area so no major impact on floral composition and associated faunal species at local level. Now it was suggested that approx 800 trees (Local trees species like: *Cassia fistula, Delbergia sissoo, Delonix regia, Polyalthia longifolia etc*) will be planted in the mine area and nearby villages, to reduce the impact of expansion activities in the surroundings of the existing mine site.

Table 7

List of plant species suggested to plant and improve green belt in and around the existing mine

S. No.	Species Name	Local Name	Species

			Characters
1.	*Acacia nilotica*	Desi Babul	*WT, ST*
2.	*Albizzia lebbek*	Shiris	*WT*
3.	*Annona squamosa*.	Sitafal	*CT, FT, ST*
4.	*Azadirachta indica*	Neem	*CT, MT*
5.	*Dalbergia sissoo*	Sisam	*WT, ST*
6.	*Pongamia pinnata*	Karanj	*MT, CT*
7.	*Emblica officinalis*	Ambla	*CT, ST, FT*
8.	*Ficus bengalensis*	Bad or Vad	*CT, LT, FT*
9.	*Ficus religiosa*	Piplal	*CT, LT, FT*
10.	*Holoptelea integrifolia*	Churel	*WT, LT*
11.	*Lawsonia inermis*	Mehndhi	*Sh*
12.	*Mangifera indica*	Aam	*CT, LT, FT*
13.	*Pithecellobium dulce*	Jungal Jalebi	*CT, MT*
14.	*Syzygium cumini*	Jamun	*WT, FT*
15.	*Tamarindus indica*	Emli	*CT,MT, FT*
16.	*Terminalia arjuna*	Arjun	*WT, LT*
Species Characters: SH=Shrub; WT sp= Wild Tree species; CT sp= Common Tree species; FT = Fruit Tre ST = Small Tree; LT = Large Tree and MT = Medium Tree.			

Overall 16 plants species have been suggested to grow in and around the mine lease area.

Impact	Evaluation	Mitigation
Changes in ambient air quality (dust & gases) and degradation of vegetation	Due to the proposed mining project transportation of material with the movement vehicles will increase and Dust concentration is expected to increase because of Heavy	Greenbelt development program with specific plant species which can act as bio-filters can further reduce the level of pollutant concentration and also will improve the overall ambient air quality in and around the project environment. Provision of spraying water can help to reduce dust emission on roads. Moreover, the following tabulated plant species suggested includes few shrubs and trees species of wild, common and species of ornamental values for

	vehicle movements in the area.	effective dust control. The level of dust control efficiency of these species ranges from minimum of 6.12% by *Acacia nilotica* to maximum of 35.39% by *Holoptelea integrifolia*. The area of plantation suggested mainly focused along the road side where the vehicle pressure is likely to increase during the mining activities especially during sand transportation. In each location, a wider range plant species are suggested to maintain the floral diversity and improve the survival rate. Therefore, the species list includes predominately wild and few common tree species with high rate of dust control efficiency *(Cassia fistula-23.03%, Azadirachta indica -25.54. Polyalthia longifolia- 29.84%, Terminalia arjuna-30.54% and Holoptelea integrifolia 35.39%).* The location 2 includes the stretches of all the roads passing through the village area which are under the influences of project related activities mainly vehicle pressure due to transporting sand. A list of 11 species has been recommended to develop avenue plantation along the road sides. This list includes mainly common species of aesthetic values with colorful flowers and also fruit trees to attracts birds

Table 8

List of Plant Species to Control Dust (Particulate matter) in and around the mine area

S. No.	Scientific Name	Common & Local Name	%of DC	Location		
				1	2	3
1.	*Annona squamosa*	Sitafal	12.09	*	*	
2.	*Magifera indica*	Aam	12.25			*
3.	*Thevetia peruviana (sh)*	Peeli Kaner	12.56	*	*	*
4.	*Ipomea carnea (sh)*	Beshram/Behaya	14.87	*	*	*
5.	*Hibiscus rosa- sinensis(Sh)*	Gurhal, Jasund,	21.09	*	*	

6.	*Bougainvilliea glavra(St)*	--	21.35			
7.	*Ficus religiosa*	Peepal	12.94	*	*	*
8.	*Syzygium cumini*	Jamun	14.39			*
9.	*Citrus limon*	Nimboo	15.96			
10.	*Delbergia sissoo*	Shesham	17.02	*	*	
11.	*Delonix regia*	Gulmohar	18.05			*
12.	*Moringa olieifera*	Sahajan	18.79			*
13.	*Aegle marmelos*	Bel	18.9	*	*	
14.	*Pithecolobium dule*	Jungle Jalebi	19.21	*	*	
15.	*Cassia fistula*	Amaltas	23.03	*	*	*
16.	*Butea monosperma*	Palas, Dhak	24.44	*	*	*
17.	*Azardirachta indica*	Neem	25.54	*	*	*
18.	*Polyalthia longifolia*	Ashoka	29.84	*	*	*
19.	*Terminalia catappa*	Desi Badam	30.12			*
20.	*Terminalia arjuna*	Arjun	30.54	*	*	

Locations: 1- both sides of the mining area, 2- Roads connecting mine lease, 3- Roa passing through nearest villages. Sh- shrub, St – Straggler. %DC – Percent Dust Control efficiency

Impact	Evaluation	Mitigation
Impact of Noise on faunal groups: **Increase in noise level in the project area may affect the faunal groups in term of their normal behaviors like; feeding, resting**	The main sources of noise in the mining activities will be of mining equipment and vehicular movement associated. The standard prescribed by the Occupational Safety and Health Administration	1.Some of the plants species listed in above different table also perform vital role in control noise pollution due to their thick and fleshy leaves and vibrating nature (Sexena 1991). A total of seven species were identified as species which are able to absorb So_2 emission also. 2.Therefore those species listed below are suggested to grow in and around the villages and other public places like schools, hospitals, health Centre and temples of nearby villages. 3.In addition, following the afforestation programs

and breeding/nesting (especially avifauna).	(OSHA) is 90 db not more than 8 hrs. Exposures for the worker However, no such conditions and any standard limitations have been available for any animal group. However, intensive afforestation program with appropriate plant species can take care of this localized and short term disturbance in the long run.	suggested above in different locations in and around the mining sites, road sides, village and other area in different phases will further minimize the noise level and also provide habitat for many avifauna & other faunal groups and improve the overall faunal diversity of the surrounding area.

Table 9

List of plant species to control Noise pollution and absorb gas (SO_2 emission)

S. No.	Scientific Name	Common & Local Name	Performance		Location	
			CN	OGE	1	2
1.	*Aegle marmelos*	Bel	*			*
2.	*Azardirachta indica*	Neem	*	+	*+	*+
3.	*Diospyros melanoxylon*	Tendu	*		*	
4.	*Ficus bengalensis*	Banyan, Vad	*		*	*
5.	*Ficus religiosa*	Peepal	*	+	*+	*+
6.	*Polyalthia longifolia*	Ashoka	*	+	+	*+
7.	*Terminalia catappa*	Desi Badam	*		*	*

8.	*Terminalia arjuna*	Arjun	*	+	*+	+
*** CN –Control Noise level, OGE – Absorb Gas emission (+ So_2), Locations: 1- roads crossing villages, 2 – Public places (schools, hospitals, health centre and temple**						

4.7 Biological Conservation Plan -

A detailed biological study of the study area [core zone and buffer zone (10 km radius of the periphery of the mine lease) was carried out by M/s ERM, Gurgaon and details are placed in chapter 3 of EIA-EMP report

Forest Resources

No forest land in the ML area and study area

Floral Diversity

The natural vegetation at ML area is represented by small natural shrubs and herbs such as Calatropis procera, Tridex procumbens, Solanum nigerum, Euphorbia hirta, Indigofera cordifolia, Parthenium hysterophorum andSida acuta.

- **Wildlife Habitat**
  - No ecologically sensitive habitat like National Park, Wildlife Sanctuary, Elephant Reserve, Tiger Reserve in the study area (10 km around the ML)
- **Fauna**
  - Core Area
  - Reptilian: Garden Lizard (*Calotes versicolor*), Fan-throated lizard (*Sitana ponticeriana*).
  - Avifaunal: House Sparrow, Dusky-crag Martin, Rock Pigeon, Common Myna, Red-wattled Lapwing, Purple-rumped Sunbird, Grey Francolin and Small-green Bee-eater.
  - Mammals: Five striped squirrel.
- **Buffer Area**
  - Amphibians: 4 species
  - Reptile: 11 species
  - Avifauna: 69 species
- Authenticated list from Forest department for flora and fauna is placed in EIA report as Annexure No 5.

- Schedule-I species, Indian Peafowl (*Pavo cristatus*), Indian Grey Hornbill (*Ocyceros birostris*), White eyed Buzzard (*Butastur teesa*), Black-shouldered Kite (*Elanus caeruleus*), Monitor Lizard (*Varanus bengalensis*) and Indian Flapshell Turtle (*Lissemys punctata*) were recorded in the study.
- Conservation plan for Schedule-I species reported in the study area is given in Annex 6
- Conservation plan for Schedule-I species has been submitted to Forest Department, Rajsamand for the approval from Chief Conservator of Forest, Jaipur.
- A total of Rs. 2 cr. has been earmarked for capital cost for conservation and in addition to that a recurring cost 40 Lakhs has been allotted for a period of 5 years in various activities with average of Rs. 8 Lakhs of expenditure annually.

4.8 Rehabilitation and Resettlement (R&R) Plan

R&R is proposed for shifting of Sindesar Khurd Village. There is provision of Rs. 60 crore towards R&R plan. It is proposed for utilization of the land for Green belt post shifting of village. Details of R&R is given below-

S. No.	Particulars	Amount (in Lacs)	Total Amount (in Lacs)	Status
1	Cost of Land for village shifting (120 Bigha @ Rs. 5.0 lacs/ bhigha)	600	600	72 Bigha already acquired and for remaining land, acquisition is in process
2	Compensation to Inhabitants	723.1	1590.2	The valuation of all dwelling units of SK Mine except has been completed by independent valuer which is now given for cross verification and certification to PWD as same is nodal agency nominated by District Collector .
	Land (83Bigha*Occupancy 50%)*(132*132)*Rs.100/Sq ft	867.1		
	Property (120% of Land Cost)			
3	Compensation as per LARR Act:-	105.2	2026.65	No movement depends on point 1 &2.
	Displace allowance: (195*Rs.36000+70*Rs.50000)	132.5		
	Resettlement allowance: (265*Rs.50000)	132.5		
	Transportation allowance:	66.25		

	(265*Rs 50000)			
	Cattle Shed allowance: (265*Rs25000)	1590.2		
	Solatium on Property			
4	Development of Rehabilitation site e.g. Construction of Roads, community Centre, School, Hospital and other Infrastructure (Lumpsum) and Compensation	2000	2000	
5	Allotment of existing village land	400	400	
Total Broad Financial Implication			**6616.85**	

4.9 SOCIO ECONOMIC IMPACT

Impact on Community Demographics

S. No.	Existing variables/situations of Socio-economic Issues	Predict (adverse/ favorable) impacts (reasons for variations & bias of representative data).	Mitigation measures. In numbers.
1	Habitation in the Core Zone There is no habitation in the core zone.	**Zero (0)** Loss of habitation. No displacent due to the proposed mine expansion project.	The nearest habitation is 200 m away from the mine and all necessary measures are being taken to ensure safety.

PUBLIC HEALTH IMPLICATION

S. No.	Existing variables/situations of Socio-economic Issues :	Predict (adverse/ favorable) impacts (reasons for variations & bias of representative data).	Mitigation measures. In numbers.
2.	Loss/ gain of health & fitness in short term (>1) or long term (<1)	The deterioration in health & fitness of the habitation will be negligble. The nearest habitation in the South Direction may be	Regular health camps to trace the develeopments and control any ill-consequences due to any mining

		effected with the long term impact of the mining activities in the long run.	pollution.
3.	The unit has provided following health facilities in the study area: • Installed 5 Nos. 500 LPH RO plants at Gawardi, Kotri, Mehanduria, Dariba and SunariaKhera villages and 10 mini RO plants in nearby schools. • 161 Medical & other camps at village level benefitted 15000 people. • Eye screening of all school going children of Railmagra block and 12 Cataract camps benefitting 22000 persons.	The proposed project is an underground expansion mine and air pollution control measures will be as per standards. The unit has spent on improving the health facilities.	The PP proposes to continue further expenditure on health care facilities and adoption of various health facilities in government run Primary Health Centre and Community health centers.
4.	Health impacts – on mental, physical, and social well being.	The proposed expansion project will not adversely impact the mental, physical and social well being.	Expectations in Fair pay, employee care, social responsibility commitments etc. will be timely met. Greivance redressal mechanism is made to handle complaints from the study area.
5	Loss/gain of self esteem Less developed areas like The local residents have high self esteem due to the Hindustan zinc mine and associated economic growth in the region.	A rise in the self esteem due to incresing rate of economic growth in the region. Higher degree of self satisfation and contentment.	--
6.	Loss/gain of view by study area inhabitants	The project concerned is an underground mine.	Plantation will be done, Cleanliness will be maintained in and around the mine premises.

7.	Loss/gain of culture and religion: It is clearly stated in as per the Human Rights, that the obligation of States is to promote universal respect for, and observance of, culture & religion.	The proposed project is a PSU and will follow universal respect for, and observance and protection of, human rights and fundamental freedoms for all.	The proposed project expansion will promote neither selective, nor relative, but universal respect through contribution in various festivities, equal observance and protection among employees and societies at large in all CSR activities.

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Chapter- 5

Analysis of Alternatives

5.1.1 Analysis of alternative site

The Sindesar Khurd deposit is located 6 km NNE of Rajpura Dariba Mines in Relmagra Tehsil of Dist Rajsamand, Rajasthan. Sindesar Khurd deposit extends over a lease area of 199.8425ha with estimated in-situ ore Reserves &Resources of 106.88 million tons with grades of 4.52% Zinc and 2.70% Lead. The present proposal is for expansion of Lead – Zinc underground mine from 3.75 million TPA to 4.5 million TPA ore production and beneficiation from 4.25 million TPA to 5.0million TPA, of which 4.5million TPA ore will be from Sindesar Khurd underground mine and 0.5 million TPA ore from BamniaKalan underground Mine. The proposed expansion will not require any acquisition of additional lease area. Thus, no alternate site is applicable since it is an underground mining brown field expansion.

5.1.2 Analysis of Alternative technology

a. Mining:-

The deposit is concealed 100m below the surface and thus amenable to underground mining only. The deposit is shallow seated and hence initial feasibility study was carried out for mode of entry and mining method. Due to shallow depth of deposit and low cost of production with decline mining by trackless operations, it was decided to open North decline/ramp for ore production with secondary access via incline. Further, with expansion of mining operation, south decline/ramp was developed to add to ore production capacity. Presently, the mining is done by blast hole stopping and for the proposes expansion same methodology will be used

Stoping is done by blast hole stoping method. In the blasthole mining method, slot is opened at the widest portion of ore body and rings are retreated towards the end of the stope. The muck is then withdrawn at extraction level through LHDs and then directly loaded in to mine trucks for hauling through ramps from underground to surface stock yard. From stock yard, ore is fed to the primary crusher using surface dumpers through haul road after sizing with hydraulic breakers.

Mining will be done using trackless operations upto -55mRL level using both declines for hauling. Mining below this level will be done using shaft hoisting system as the depth of hoisting will be increasing and service ramp will be available for the movement of machineries & services. Ramps will be further developed to lower levels for hauling as well as material movement to the lower block. Shaft will also be commissioned to haul the ore from lower block. Auxiliary lenses will be mined as the mining commences in the levels approximate to them. Mining of Sill/Crown pillar will be planned after due consideration studies of local & regional

stability. Post filling will be done in all primary/ secondary stopes to enhance ore recovery keeping in view of mineral conservation.

Blast Hole Stoping Method (BHS)

In blast hole stopping method, the strike length of mining block is divided into 30-55m stope and intervening vertical rib pillars of 10-20 m or in primary-secondary sequence. Stope and pillar dimensions are as per the recommendations of CMIFR, Dhanbad based upon geotechnical modeling.

Stopes are being mined using EHS drilling (64mm) for trough drilling at extraction level and DTH/ITH (115mm)/ EHS drill machines (102/89mm) holes for down drilling from upper level. Blasting is done against a slot raise. For preparation of slot at each level in the mining block, a cross cut is developed first across the strike of the ore in full width of the ore body from footwall to hanging wall and later stripped to 6m width. A raise is opened from lower level to drill level by drop raising technique. Subsequently parallel holes are blasted against this raise for making a slot over the width of ore body. This slot provides free face for subsequent blasting of drill rings.

After the stopes are mined out, stopes are back filled and thereafter secondary stopes / rib pillars are mined out, in cases mining is feasible.

Benefits of stoping method compared with the conventional sub-level stoping methods are:

1. Reduction in quantum of developments, drilling cost and explosive cost;
2. Overall reduction in the cost of mining;
3. Reduction of manpower and
4. Reduction in stopes preparation time.

Thus, the company is already suing the best technology thus no alternative technology is required.

b. Beneficiation Plant:-

Salient features of Beneficiation Plant

- A highly automated and instrumented process control has been envisaged in the beneficiation plant.
- On-line Stream Analysis System for measurement of elements concentration in slurries to control metal losses.
- Advanced Process Control operating system is designed to optimize, stabilize and control individual unit operations as well as the entire plant for optimum metal recovery.

- Froth Camera System makes use of machine vision technologies to measure the speed of the froth.
- Particle Size Analyzer is a sizing system installed in grinding circuit for mineral slurries. It takes automatic samples from streams and measures their particle size distribution for liberation of minerals.
- Magnetic Pro flot system for fine particle recovery in zinc flotation.
- Any drive will be in running condition if all the start permissive conditions are simultaneously fulfilled.

Currently, the tails from plant is being pumped to exiting tailing dam of Rajpura-Dariba mine through pipelines. It is also proposed to utilize 65% of the tailings in the stope backfill.

5.2 ALTERNATE SITES CONSIDERED

No alternate site was considered since it is an brownfield underground expansion of existing ug mining project.

5.3 NO PROJECT SCENARIO

The scenario of no project was also considered and in the absence of the project, it will be difficult for HZL to cater to the current demand of Zinc and Lead. Thus, considering the closeness and the substantial availability of ore deposits at the project site, this is the best possible option for the project as well as for expansion of the site.

CHAPTER -6

ENVIRONMENTAL MONITORING PROGRAMME

6.1 INTRODUCTION

Environmental monitoring can be defined as the systematic sampling of air, water, soil, and biota in order to observe and study the environment, as well as to derive knowledge from this process.

Post Project Monitoring is an essential part to check the impact of any project activity. Hence, monitoring of various environmental parameters will be carried out on a regular basis to ascertain the following:

- Status of Pollution within the mine site and in its vicinity.
- Generate data for predictive or corrective purpose in respect of pollution control.
- Examine the efficiency of pollution control system adopted at the site.
- To assess environmental impacts.

Monitoring will be carried out at the site as per the norms of CPCB and statutory requirements. Environmental Monitoring Programme will be conducted for various environmental components as per conditions stipulated in Environmental Clearance Letter issued by MOEF & Consent to Operate issued by RSPCB. Six monthly compliance reports will be submitted every year to Regional office of MoEF Quarterly compliance Report for conditions stipulated in Consent to Operate will be submitted to RSPCB on regular basis.

Monitoring will ensure that commitments are being met with. This will take the form of direct measurement and recording of quantitative information, such as amounts and concentrations of discharges, emissions and wastes, for measurement against corporate or statutory standards, consent limits or targets. It may also require measurement of ambient environmental quality in the vicinity of a site using ecological/ biological, physical and chemical indicators. Monitoring may include socio-economic interaction, through local liaison activities or even assessment of complaints.

The preventive approach by management may also require monitoring of process inputs, for example, type and method used, resource consumption, equipment and pollution control performance etc.

The key aims of monitoring are, first to ensure that results/ conditions are as per forecast during the planning stage and where they are not, to pinpoint the cause and implement action to remedy the situation. A second objective is to verify the evaluations made during the planning process, in particular with risk and impact assessments and standard & target setting and to measure operational and process efficiency. Monitoring will also be required to meet compliance with statutory and corporate requirements. Finally, monitoring results provide the basis for auditing.

6.2 ENVIRONMENTAL MONITORING CELL

A centralized environmental monitoring cell is established for monitoring of important and crucial environmental parameters which are of immense importance to assess the status of environment during mine operation. With the knowledge of initial parameters, deviations in environmental conditions due to operation of the mine can be assessed and suitable mitigation steps will be taken in time to safeguard the environment. The following routine monitoring program will be implemented under the post – project monitoring as per CPCB guidelines.

Environmental monitoring schedules are prepared covering various phases of project advancement, such as constructional and regular operational phase.

6.2.1 Responsibilities of EMC

The responsibilities of the EMC include the following:

- **i.** Monitoring and measurement of various environmental parameters in core and buffer zone of the site to ensure the prevention ,protection & control of pollution.
- **ii.** Improve the awareness of Environmental regulation among the operational team to manage the operation accordingly at site.
- **iii.** Commissioning of environmental monitoring and pollution control equipment's at plant site.
- **iv.** Ensure the compliance to internal Policy,Standards , procedures made internally.
- **v.** Ensure the compliance to the conditions given in Environment Clearance, Consent to Establish and Consent to Operate issued by MOEF /RPCB.
- **vi.** Ensure the compliance to the Environment Protection Act 1986 and Rules made and amended there under.
- **vii.** Developing and maintenance of green belt.
- **viii.** Preparation and submission of various reports to statutory authorities within given timeline.
- **ix.** Optimize the uses of natural resources by reduction in consumption of water, fuel, electricity and other natural sources.
- **x.** Ensures that activities are operational activities are managed in an effective manner so as to not impact land use, biodiversity and ecosystem services.
- **xi.** Preparation and Implementation of Waste Management plan to promote the Reduce, Reuse, Recycle and ensure proper management and handling the hazardous waste and non-hazardous waste.

xii. Develop and review Environmental Management Plan.

6.3 MEASUREMENT METHODOLOGIES

6.3.2 Monitoring Programme

The post project monitoring will include details of any major/ minor impact in the core zone and area within buffer zone for the following parameters: -

- Micro - Meteorological data
- Ambient Air Quality Monitoring
- Noise Level Monitoring
- Surface and ground water quality monitoring.
- Soil quality monitoring
- Routine Medical Check-up – pre employment.

6.3.3 Monitoring schedule

The major attributes which merit regular monitoring based on the environmental setting and nature of project activities are listed below:-

- Source emission and ambient air quality;
- Ground water levels and ground water quality;
- Water and waste water quality (water quality, effluent & sewage quality etc);
- Soil quality;
- Noise levels (equipment and machinery noise levels, occupational exposures and ambient noise levels); and
- Ecological preservation and afforestation.

Details of the Environmental Monitoring schedule, which will be undertaken for various environmental components, are detailed below:

Table 1: Post Project Monitoring Schedule

S. No	DESCRIPTION	FREQUENCY OF MONITORINC
1	Meteorological Data	Daily
2	Ambient Air Quality at mine site	Monthly
3	Water Quality	Monthly

4	Noise Level Monitoring	Monthly
5	Soil Quality	Half Yearly

6.4 ENVIRONMENT MONITORING PROGRAMME

The following routine monitoring programme as detailed under will be implemented at mine site. Besides to this monitoring, the compliances to all Environmental Clearance conditions and permissions from SPCB/ MoEF&CC will be monitored and reported periodically.

Table 2 Environmental Monitoring

S. No.	***Attributes***	***Sampling***		***Measurement Method***	***Location***
		Parameter	*Frequency*		
1	*Air Environment*				
		PM_{10}, $PM_{2.5}$, SO_2, NO_x CO,	*Revised National Ambient Air Quality Standards (NAAQS) vide MoEF circular, dated 16.11.2009*	*As per CPCB Norms*	*4-6 in the project impact area (Minimum 2 locations in upwind side, more sites in downwind side / impact zone)*
		Meteorological *• Wind speed • Wind direction •Dry bulb temperature •Wet bulb temperature •Relative humidity • Rainfall*	*Regularly in one season by Weather Monitoring Station*	*Mechanical/automatic weather station*	*Minimum 1 site in the project impact area*
2	*Noise*				
		Spot Noise Level	*Monthly*	*As per CPCB*	*Mine Boundary, High*

		recording; Leq(night), Leq(day), Leq(dn)		*norms*	*noise generating areas within the lease*
3	*Water Environment*				
		pH, Turbidity, Colour, Odour, Taste, TDS, Total Hardness, Calcium hardness, Magnesium hardness, Chloride, Fluoride, Sulphate, Nitrates, Alkalinity, Iron, Copper, Manganese, Mercury, Cadmium, Selenium, Arsenic, Cyanide, Lead, Zinc, Chromium, Aluminum, Boron, Phenolic compound, Bio Assay Testing	*Half yearly*	*As per IS 10500-*	*Set of grab samples during pre and post monsoon for ground and surface water (in 10 km from mine boundary.*
		•	*Annually*	--	--
6	*Soil quality*	• *Physico-chemical parameters and metals.*	*Half Yearly/*	*As per CPCB*	*Plantation areas*
7	*Subsidence*	• *Vertical and horizontal*	*Monthly*	--	*Surface area directly above working stopes*

		displacement,		
8	*Emergency preparedness, such as fire fighting, rescue etc.*	*Fire protection and safety measures to take care of fire and explosion hazards, to be assessed and steps taken for their prevention, monitoring of underground support systems.*	*Mock drill records, on site emergency plan, evacuation plan*	--
9	*Waste Management*	*Implement waste management plan that identifies and characterizes every waste arising associated with proposed activities and which identifies the procedures for collection, handling & disposal of each waste arising.*	*Records of solid waste generation, treatment and disposal*	--
10	*Health*	*Employees and migrant labour health check ups*	*All relevant parameters*	--

6.5 REPORTING SCHEDULES OF THE MONITORING DATA

It is proposed that voluntary reporting of environmental performance with reference to the EMP will be undertaken.

The Environmental Monitoring Cell will co-ordinate all monitoring programmes at site and data thus generated will be furnished as per statutory conditions.

The frequency of reporting will be on six monthly basis to the State PCB and to Regional Office of MoE&F, New Delhi. The Environmental Audit reports form-V will be prepared for the entire year of operations and will be regularly submitted to regulatory authorities.

6.6 INFRASTRUCTURE FOR MONITORING OF ENVIRONMENTAL PROTECTION MEASURES

Required equipments and consumable items will be provided at the project site to for effective monitoring of Air, Water and Noise

6.7 POST PLANTATION CARE

Boundary wall is provided around the area where mass plantation has been completed to protect unauthorized entry of out-side person and fire. Due care is being taken by Watering ,Manuring ,Dweeding, unwanted vegetation removal ,trimming etc to ensure better survival rate of plantation.

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CHAPTER 7

ADDITIONAL STUDIES

7.1 RISK ANALYSIS AND DISASTER MANAGEMENT PLAN

Mining is an ancient occupation, long recognized as being arduous and liable to injury and disease. The lifecycle of mining consists of exploration, mine development, mine operation, decommissioning and land rehabilitation. Mining is a multi-disciplinary industry, drawing on several professions and trades. To ensure precision in clinical and epidemiological work, it is important to enquire about the details of tasks, as the term 'miner' is relatively non-specific. Mining is traditionally classified as metalliferous or coal, and as surface or underground. Metalliferous mining can also be classified according to the commodity being mined.

Unsafe conditions and practices in mines lead to a number of accidents and causes loss and injury to human lives, damages the property, interrupt production etc. Risk assessment is a systematic method of identifying and analysing the hazards associated with an activity and establishing a level of risk for each hazard. The hazards cannot be completely eliminated, and thus there is a need to define and estimate an accident risk level possible to be presented either in quantitative or qualitative way. Because of the existing hazards of mining as an activity and the complexity of mining machinery and equipment and the associated systems, procedures and methods, it is not possible to be naturally safe. Regardless of how well the machinery or methods are designed, there will always be potential for serious accidents. It is not possible for an external agency to ensure the safety of an organisation such as a mining company nor of the machinery or methods it uses. The principal responsibility for the safety of any particular mine and the manner in which it is operated rest with the management of that mine.

Hazard identification and risk analysis involves identification of undesirable events that leads to a hazard, the analysis of hazard mechanism by which this undesirable event could occur and usually the estimation of extent, magnitude and likelihood of harmful effects.

7.2 NEED FOR RISK ASSESSMENT

Risk assessments will help the mine operators to identify high, medium and low risk levels. Risk assessments will help to prioritise risks and provide information on the probability of harm arising and severity of harm by understanding the hazard, combine assessments of probability and severity to produce an assessment of risk and it is used in the assessment of

risk as an aid to decision making. In this way, mine owners and operators will be able to implement safety improvements. Different types of approaches for the safety in mines various tools and appropriate steps have to be taken to make mining workplace better and safer. A Hazard Identification and Risk (HIRA) analysis is a systematic way to identify and analyse hazards to determine their scope, impact and the vulnerability of the built environment to such hazards and its purpose is to ensure that there is a formal process for hazard identification, risk assessment and control to effectively manage hazards that may occur within the workplaces.

7.3 OBJECTIVE

Keeping the afore mentioned problems in mind, the project work has been planned with the following objectives

Review of literature on Hazard Identification and Risk Assessment

- Review of accidents in mines and their analysis.
- Study of risk assessment methodologies.
- Application of Hazard Identification and Risk analysis for improvement of workplace safety in mines.

7.4 HAZARDS IN UNDERGROUND WORKING

1. Fall of roof and sides
2. Collapse of pillar in mines
3. Air blast
4. Rock burst and bumps
5. Rope haulage
    - Runaway of tubs due to breakage of rope, failure of attachment to rope, failure of couplings and drawbars.
    - Non functionality of safety devices.
    - Travelling along haulage roadway
    - Uncontrolled movement of tubs.
    - Derailment of tubs.

- Poor construction of curves.

6. Electrical hazards
    - Electric shock and/or burn.
    - Ignition of firedamp or coal dust.
    - Fire arising from electric defects.
7. Fire hazard
8. Inundations
9. Ventilation
    - Failing of cooling system.
    - Oxygen deficiency (<19%)
    - Gas evolution
    - Presence of CO >50ppm
    - Presence of CO2 > 1%
    - Presence of H2S > 20ppm
    - Presence of NOX
    - Increase in temperature due to rock temperature and heats from machines
10. Illumination
    - Insufficient illumination system

7.5 METHODOLOGIES FOR RISK ANALYSIS

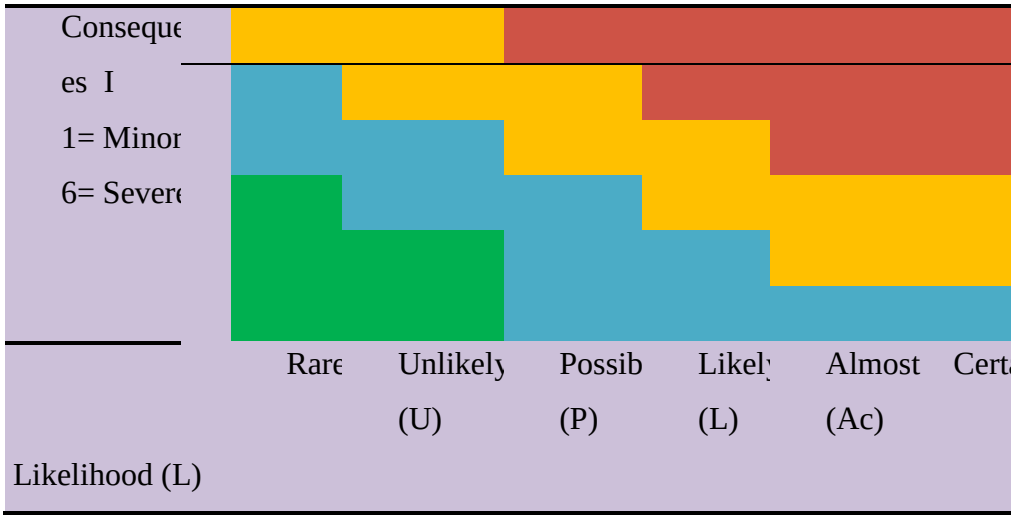
The objective of risk analysis is to produce outputs that can be used to evaluate the nature and distribution of risk and to develop appropriate strategies to manage risk. Events or issues with more significant consequences and likelihood are identified as „higher risk" and are selected for higher priority mitigation actions to lower the likelihood of the event happening and reduce the consequences if the event were to occur. Qualitative methods use descriptive terms to identify and record consequences and likelihoods of the events and resultant risk. Quantitative methods identify likelihoods as frequencies or probabilities. They identify consequences in terms of relative scale (orders of magnitude) or in terms of specific values (for example estimate of cost, number of fatalities or number of individuals lost from a rare species). For both qualitative and quantitative methods it is important to invest time in developing

appropriate rating scales for likelihood, consequence and resultant risk. The full range of risk situations likely to be encountered within the scope of the exercise should be considered when developing rating scales.

7.5.1 SEMI QUANTITATIVE METHODS

Semi-quantitative approaches to risk assessment are currently widely used to overcome some of the shortcomings associated with qualitative approaches. Semi-quantitative risk assessments provide a more detailed prioritised ranking of risks than the outcomes of qualitative risk assessments. Semi-quantitative risk assessment takes the qualitative approach a step further by attributing values or multipliers to the likelihood and consequence groupings. Semi-quantitative risk assessment methods may involve multiplication of frequency levels with a numerical ranking of consequence. Several combinations of scale are possible.

Risk Matrix



From the above Risk Assessment Matrix, risks I are assigned a risk ranking that is used to determine their priority for management. The risk rankings are:

A	Critical Risk
B	High Risk
C	Moderate Risk
D	Low Risk

Risk and Hazard analysis for different phases of Project

S.N	Risk and Hazard	Control Measures	Environment and Land			Human Health		
			C	L	R	C	L	R
1	Interaction with vehicles, machinery and equipment (Physical).	Refer Section 10 ESMP	1	L		2	U	
2	Interaction with onsite and offsite traffic	Implementation of traffic management plan	4	P		6	U	
3	Fugitive Dust Emission	Refer Section 10 ESMP	3	U		1	U	
4	Fatigue	• work rosters that include rest between shifts; • training and awareness; and • Health and well-being improvement program.	1	P		4	P	
5	Food Hygiene	• provision and supply of food	1	R		6	R	

S.N	Risk and Hazard	Control Measures	Environment and Land			Human Health		
			C	L	R	C	L	R
		to be undertaken in accordance with relevant food and hygiene legislation.						
6	Physical injuries from manual handling.	• documented standard operating procedure; • education and training; • education and awareness program; • Job Hazard Analysis covering manual handling; and • Effective pre-employment fitness for work screening and health and well-being improvement program.	1	R		2	L	

S.N	Risk and Hazard	Control Measures	Environment and Land			Human Health		
			C	L	R	C	L	R
7	Leaks of oil, fuel or chemicals from vehicles during transport and/or at designated fuelling stations	• Provision of auto-shut off nozzles; • Follow SOP of fuelling procedures; • Provision of impervious containment and bunding of stationary / fixed tanks; • overfill protection; • prompt reporting and clean-up; • major equipment maintenance to be conducted in dedicated facilities; • clean up equipment; and storage and handling in accordance with AS	1	P		1	P	

S.N	Risk and Hazard	Control Measures	Environment and Land			Human Health		
			C	L	R	C	L	R
		1940						
8	Ventilation failure	• The underground mining area will be provided with good ventilation as per the DGMS guidelines; • Provision of backup ventilation provision, in case of failure of ventilation equipment's; • Provision CO, NOx, O_2 and Methane level detectors;	NA	NA	NA	6	U	
9	Chemical release – liquid from leaks, ruptures, overflows, spillage or pooling.	• storm water is directed away from potentially contaminated areas; • site drainage system designed to allow retention of spills on site; • Hazard and	3	U		4	U	

S.N	Risk and Hazard	Control Measures	Environment and Land			Human Health		
			C	L	R	C	L	R
		Operability (HAZOP) reviews conducted during detailed design; • personnel trained in use, appropriate storage, handling and incident response; • Material Safety Data Sheets (MSDS) available on site; • appropriate personal protective equipment and adequate supply of spill materials; • Chemical incidents included in Emergency Management Plan; and effective						

S.N	Risk and Hazard	Control Measures	Environment and Land			Human Health		
			C	L	R	C	L	R
		preventative maintenance.						
10	Natural Flooding and ground water interception and associated flooding	• Site is not prone to flood; and • Pumping will be done at regular interval; • • Provision of	5	U		5	U	
11	Noise and vibrations	explosive materials handled only by competent authorised personnel; • induction and training of all staff on safety procedures during blasting; • strict control of ignition sources; • advise surrounding neighbours, where appropriate; • personal protective	1	R		1	R	

S.N	Risk and Hazard	Control Measures	Environment and Land			Human Health		
			C	L	R	C	L	R
		equipment (PPE) provided; and • storage of explosives and accessories in accordance with the Explosives Act						
12	Failure of waste dumps		6	U		6	U	
13	Failure of tailing storage dams		6	P		6	P	
14	Hazards due to poor illuminations	• The work area will be kept well lighted. Lightening in different areas will be provided as per DGMS guidelines; • Energy efficient light sources with minimum heat emission will be used in	3	P		5	P	

S.N	Risk and Hazard	Control Measures	Environment and Land			Human Health		
			C	L	R	C	L	R
		underground mining activities and mine office;						
15	Hazard due to Blasting associated activities	• Protective devices will be provided to workers during handling explosives; • Blasting will be carefully planned and executed under supervision of a responsible officer to avoid any accident; • Explosives will be handled as per guidelines of DGMS; • Strict prohibition of smoking in fuel and hazardous chemical storage area; • Signage in hazardous and	2	P		5	P	

S.N	Risk and Hazard	Control Measures	Environment and Land			Human Health		
			C	L	R	C	L	R
		risky areas; • Blasting sites will be checked post blast by qualified personnel for malfunctions and any unexploded blasting material prior to resumption of work in the area; • Provision of storage of magazine at separate area at safe distance from ML area with necessary security arrangements; • Provisions of fire fighting in the mine area and • beneficiation plant with sufficient number of fire extinguishers at						

S.N	Risk and Hazard	Control Measures	Environment and Land			Human Health		
			C	L	R	C	L	R
		fuel storage area, mine office, electrical substation and other strategic locations to take care of any eventuality; • Following Emergency Response Plan in case of any accident at site;						
16	Storage of fuel and hazardous chemicals	• Specific warning siren will be blown before each blasting activity to alert all the workers and local people residing in the surrounding areas; • Material Safety Data Sheet (MSDS) for hazardous	5	P		5	P	

S.N	Risk and Hazard	Control Measures	Environment and Land			Human Health		
			C	L	R	C	L	R
		chemicals will be maintained and followed to ensure safety of workers; • Eye wash and emergency shower system will be provided in hazardous chemical storage area; • Signage in hazardous and risky areas;						

Note: C= Consequences, L = Likelihood and R = Risk

7.6 MITIGATION MEASURES FOR POSSIBLE RISK AND HAZARDS IDENTIFIED

1. Fire and Explosions

- Identify the sources of fire and fire hazards at regular intervals;
- Undertake regular training and awareness programmes on dos/ don't on in-case of fires; use of fire distinguishers; handling flammables;
- Develop well established emergency exit plan showing emergency exits,
- The boundaries of each explosion risk zone at the mining operation are clearly indicated by signage at each boundary;
- Inflammable material shall not be stored in underground;

- Underground mining infrastructure's such as shaft, ventilation systems, Ramp, incline etc will be made of noncombustible materials;
- Proposed underground workshop, surface workshop, HSD filling station, compressor house and electrical sub-station shall be provided with adequate firefighting equipment's and the functioning status of the same shall be verified at periodic intervals as per the supplier requirement;
- Regular inspection/audit will be done to check the accumulation of greasy material cotton waste, old conveyor pieces, waste hose pipes, wooden scrap, wood cuttings etc. Regular removal of the same shall be ensured;
- A proper communication system shall be installed to warn underground worker about outbreak of fire;
- Electric apparatus, electric cables etc. shall be checked regularly;
- Adequate number of persons will be trained in firefighting;
- There is appropriate signage at the entrance to fuel storage areas advising:
    - Flammable materials are stored inside;
    - Access to experienced mine workers only;
    - No flames or naked lights;
    - No hot work;
    - Engines will shut down before firefighting;
    - Emergency procedures in the event of fire;
- Mock drills will be conducted periodically
- All fuel transfer systems are constructed with non-flammable materials, brass, or non- metallic components and have automatic sealing using fast fill couplings.

2. Failure of Ventilation systems

- Ventilation levels to be monitored as per statutory guidelines;
- Measures the quantity of air being delivered to every working place in the underground parts of the mining operation;
- Determines whether air is being recirculated in the underground parts of the mining operation and takes suitable action to stop any such recirculation;

- The mine management must ensure, in respect of any underground parts of a mining operation where a mine worker is doing work or may travel, that the air in that part is provided at an adequate quantity and velocity to ensure the mine worker will not be exposed to a concentration of dust that is likely to cause harm to the mine worker;
- The emergency supply of electricity to the underground parts of the mining operation, other machineries and equipment's that does not require power supply will be isolated as soon as reasonably practicable;
- The supply of electricity will not be restored until after the ventilation system has been safely restored and a competent person considers it is safe to restore the supply of electricity to the remaining machineries and equipment's.
- The mine operator will ensure regularly the air supplied to every underground place where mine workers are working meets the requirements of the applicable Regulations, and safe levels, in relation to:
    - Air velocity, quantity and composition.
    - Fire.
    - Methane or noxious gases.
    - Humidity.
    - Diesel emissions.
    - Radon.

3. Entrapment of miners

- To prevent premature collapse of any workings, effective supports will be erected based upon the geotechnical mapping;
- All workings will be systematically supported to safeguard against any possibility of premature collapse;
- Numerical modelling techniques will be used to determine the stable spans of stopes, safe locations of developments and stable pillars;
- The hang wall and crown pillar will be instrumented with multi point boreholes extensometer and stress meter for ground monitoring on regular basis;
- The rescue mode and methods are clearly identified and communicated and shall be continued and adequately extended in mine expansion;

4. Transportation, Storage and Handling of Hazardous substance

- Containers or systems in which hazardous materials are contained will be labelled.
- Storage and Disposal of hazardous substance containers is carried out as per Hazardous Waste Management Rule 2008& its amendments;
- Requirements for storage, handling and disposal are determined before a chemical is purchased.
- All personnel handling these substances are trained in the associated procedures, including clean-up.
- Essential safety equipment will be made available at all times.

5. Fuel and Oil

- Ignition sources will be monitored and managed to avoid fire;
- Training will be provided in the safe operation of equipment and knowledge of emergency response procedures in the event of diesel leakage
- Equipment inspection and testing programs will be undertaken to ensure reliable performance of fuel tanks and bunds;
- Spill containment equipment (e.g. bunds) will be built to contain any spillage of liquids
- Clean storm water will be diverted away from the bunded fuel storage areas
- Sumps will be constructed to collect any spillage and allow recovery
- Standard operating procedures will be developed for operators
- Spill kits will be available at all fill/transfer points
- Appropriate firefighting facilities and suppression systems will be installed, maintained and available to extinguish fires
- An approved fire protection system is to be installed and maintained around new storage area

6. Irruption of Water

- The position of the workings below ground;
- Every borehole and shaft (with depth) drive, crosscut, winzes, raise, excavation and air passage connected therewith;
- The position of every dyke fault and other geological disturbance, with the amount and direction of throw;

- Levels taken in workings below ground at easily identifiable points sufficient in number to allow the construction of sections along all drives main headings and haulage roadways;
- Every source of water such as river, stream, water course, reservoir, water-logged workings on the surface, and also the outline of all water logged workings below ground lying within 60 meters of any part of the workings measured in any direction;
- Every reservoir, dam or other structure, either above or below ground, constructed to withstand a pressure of water or to control an inrush of water, along with reference to its design and other details of construction;
- Surface contour lines drawn at vertical intervals shall not exceed five meters; and
- Mine entries shall be developed above the highest flood level of the area.

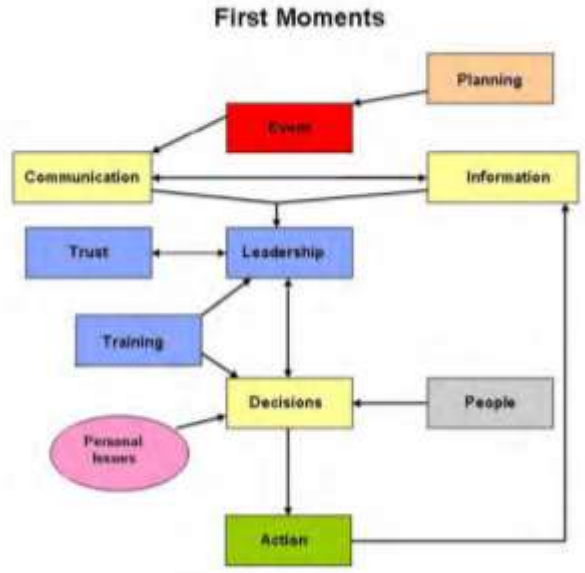
7. Working at height

- Perform the task on the ground if possible;
- Use a passive fall prevention device;
- Use a work positioning system to ensure employees work within a safe area;
- Install a fall arrest system to limit the risk of injuries in the event of a fall;
- Use a fixed or portable ladder incorporating a risk assessment, safe work procedures and training; and if you are not able to work on the ground or on a solid construction prior to working at height then;
- Establish emergency procedures and First Aid provision prior to undertaking the task;
- Review documented safe systems of work for contractors who are required to work at height; and
- Monitor the work at height practices of all employees and contractors to ensure they are working safely.

7.7 DISASTER MANAGEMENT PLAN

An underground mine is an inherently dangerous workplace. The safety of workers depends upon many interrelated factors, including knowledge of the dynamic, ever-changing environment, the ability to recognize and respond to hazards, training, experience, and communication. During an emergency, these factors can be crucial to response. When something goes awry in an underground mine, seconds count and the

initial response can be critical to the outcome. Understanding the behaviors and issues present in the initial moments of a response to mine emergency may enhance escape, facilitate rescue, and be helpful for training miners and decision-makers.



Framework of first moments in mine emergency escape

(a) Identification of potential emergencies

- personal injury
- unplanned explosion
- fires, including for tyres and explosives
- strata or ground failure
- entrapped or missing workers
- inundation or inrush
- outburst
- irrespirable or noxious atmospheres
- hazardous material incident
- explosives incident
- vehicle or machinery accidents

- air blast or wind blast
- significant ventilation failure
- mechanical or electrical equipment out of control
- natural disasters, such as bushfires, flooding, earthquakes, cyclones
- medical emergencies e.g. stroke
- spontaneous combustion
- structural failure (plant)
- loss of radiation sources
- intersection of utilities (gas pipeline, underground water/power).

(b) Mine Emergency Planning

All miners should be trained to understand and follow the mine emergency plan where they work. A response plan is only one piece of the continual, dynamic process of emergency response planning. Identifying threats and their associated risks will help establish planning process priorities. As a first critical step in emergency response planning, a thorough hazard analysis and risk assessment should be conducted. This will help in keeping emergency response plans simple and easy to use.

The Mine Safety Technology & Training Commission report (2006) recommends developing a comprehensive emergency response plan that is riskbased and mine specific. A risk-based plan is targeted for the most likely threats and assumes that preparing for them also prepares for unrecognized hazards.

Competencies required for successful escape include:

- Technical knowledge : understanding and proficiency in the use of emergency breathing apparatus (self-contained self-rescuers), lifelines, refuge chambers, etc.
- Mine specific knowledge : knowledge of the mine maps, the escapeways, the ventilation system, the mine emergency response plan, and familiarity with escape capsules.

- Escape conceptual knowledge : ability to think and adapt to changing conditions, to be resilient, to be able to problem solve and make decisions, and to understand the dynamic of human behavior in escape, including leadership and other psycho-social issues.

(c) Communication

Information about the situation affects the initial response and defines the first moments of an incident. NIOSH studies indicate that the effectiveness of a mine's communication system is a key factor in the initial response. Research has suggested that effective communication will reduce confusion, increase confidence in decisions, stop rumors and incorrect information, and improve the likelihood of success.

(d) Training

Training is considered to be one of the most essential elements in the emergency response planning process. Training, in the form of drills, mock disasters, and even tabletop simulations, affords the opportunity for planners to identify and resolve problems, examine and evaluate the utility of developed procedures, refine plans, and train individuals who will be responding to emergency events.

(e) Decision-making

Decision-making directly relates to communications issues. In an emergency, decision-making relies on :

- The quality of the information received by everyone immediately following the incident
- The technical communication system in place in the mine.
- The process is iterative, meaning that one choice leads to another until the incident is resolved. Decision-making is also affected by the experience level of the people involved.

(f) Personal protective equipment for first aid and rescue

People entering the mine as part of first aid and rescue procedures should have the appropriate personal protective equipment (PPE).

Considerations for ensuring capacity to provide PPE include:

- potential or actual atmospheric contaminants
- potential or actual inundation or inrush
- availability of the appropriate equipment
- availability of persons trained in the equipment
- specific protocols for use of the equipment
- procedures for any specialist emergency response team who may enter the mine.

7.8 Protective measures to be taken

(i) Measures taken to avoid mine gases are as follows:-

- The quantity of inflammable gas given out in each ventilation district will be determined at least once in a month and similarly borehole samples once in a quarter.
- The quantity of air sent into each district will be such as to keep the percentage of inflammable gases in the district return airway below a percentage of 0.75 to 1.25 at any place in the mine.
- The state of atmosphere near the stopping will be continuously monitored by flame safety lamps, air sampling and analysis.
- There should be strict adherence to latest safety manuals and statutory acts.
- Working will be ventilated by a suitable mechanical ventilator installed on the surface.
- The Manager will be assisted by a ventilation officer in each and every operative area.
- Adequate quantity of air will be coursed to well within meters of the working face, and
- Air samples will be frequently collected of the roof of the working face and analyzed timely for the presence of CH_4.

(ii) Measures to avoid fires in the underground mine are as under:-

- Check the workers, before the proceed underground, for matchbox, lighters and other contrabands,
- Do not allow burning of fire inside the mine and also within 15m of an incline/pit,
- Avoid welding of headgear pulley or the headgear frame unless adequate timely precautions are taken,

- Avoid welding in underground repair shops without adequate precautions.
- Restrict the storage of inflammable and combustible material like oil, grease, timber etc.
- Remove all wood cuttings as also oily and greasy cotton wastes out of the mine.
- Install the electrical cables and equipment with due care and maintain them properly with regular inspections.
- Use only approved safety lamps, which should be taken underground in locked condition.
- Machinery to be used underground should be meticulously assembled and properly operated so as to ascertain that during use it does not cause any dangerous sparks or for that matter generate any hot surface.
- Break blocks of underground machinery like haulage engines, locomotives, etc., should be adjusted periodically to avoid their overheating and
- Avoid at any cost accumulation of dangerous static electric charges on the equipment using air by earthing.

(iii) Measures to avoid Subsidence

- Long faces: Long faces or longer width of panel are to be preferred to reduce the number of rib-sides, where differential movements occur resulting in high subsidence.
- Rapid face Advantage: Temporary interruptions in face advance should be scrupulously avoided as the rapid face advance necessarily aims at diffusing the rib side conditions to control the subsidence.

(iv) Measures to avoid Inundation

- Working place approached within a distance of 60m of any other working (likely to contain accumulation of water) shall not be extended further unless it is examined physically and found to be free from accumulation of water.
- Whenever seepage of water is noticed at any place of working, such working shall be immediately stopped. The height of such working shall not extend 2.4m and at least one borehole near the center of working place shall be maintained with sufficient number of

flank holes. The boreholes drilled above and below the workings at intervals of not more than 5m. Such boreholes constantly maintained 3m in advance of the working.

7.9 EMERGENCY PLAN

Emergency is any unplanned event that causes serious injuries or loss of life; causes extensive property damage; shuts down or disrupts the mining operations; or threatens the operation's financial standing or public image.

Emergency preparedness is a well designed and executed plan that can eliminate or control hazards so they don't become a disaster; or if this isn't possible, it can turn a potential disaster into a well managed situation with minimal effect on the miners and property of the mining operation.

- **Emergency Management**

Emergency management is the collective arrangement of personnel to plan for, mitigate/control, respond to and recover from an emergency. It provides for a structured framework for completing all perceived activities in an emergency situation. Emergency management ensures a solid, complete and collaborative arrangement of personnel, resources and services. An emergency preparedness plan is not to be confused with an emergency response plan. Emergency response is just one of the key elements of the emergency preparedness plan. Emergency preparedness plans include risk management activities, prevention and/or control measures, response procedures and guidelines, and recovery efforts. Each of these components requires training, drills and periodic revisions.

- **A well-developed, implemented and maintained emergency preparedness plan can:**
  - Help mining companies fulfill their moral responsibility of protecting their miners, property and possibly the public and environment.
  - Ensure compliance with federal and state mining regulations.
  - Enhance a company's liability to recover more quickly from financial loss, regulatory fines, loss of market, and damages to property and equipment.

- Reduce exposure to civil or criminal liability.
- Provide employees, customers and suppliers with a sense of security.
- Reduce insurance premiums.

➢ **Planning team**

- General Mine Manager/Superintendent •
- Mine Foreman •
- Maintenance Manager/Supervisor •
- Labor Representative •
- Safety Manager/Director •
- Human Resources Manager •
- Engineering Manager/Supervisor •
- Security Director

7.10 INFRASTRUCTURE

Following infrastructure and operational system will be provided to meet any emergencies.

(a) Emergency Control Room

This will be situated in an area away from the places of fire and will be provided with the following facilities:-

1. Master plan of the mines.
2. First aid boxes.
3. Gas masks.
4. Telephone line with STD facility.
5. Emergency lighting system
6. Stretchers.
7. Transport facility.
8. Emergency control room will function as control base.
9. Lifebuoys

(b) Assembly Points

Assembly points are to be set up farthest from the location of likely hazardous events, where pre-designated persons from the works, contractors and visitors would assemble in case of emergency. Up-to-date list of pre-designated employees of various departments must be available at these points so that roll call could be taken. Pre-designated persons would take charge of these points and mark presence as the people come into it.

(c) Warning System and Control

The Control Centers will be located at an area of minimum risk or vulnerability in the premises concerned, taking into account the areas which might be affected by fire/explosion, toxic releases, etc. For promptness and efficiency, the premises/storage sites may be divided into number of zones, which should be clearly marked on the site plan.

(d) Emergency Services

This includes the fire-fighting system, first aid center, hospital etc. Alternate sources of power supply for operating fire pumps, communication with local bodies, fire brigade etc., will also be clearly identified. Adequate number of external and internal telephone connections will be installed.

(e) Fire Protection System

The fire protection system for the proposed mine will consist of:-

a. Hydrant system for all the areas of the mine.

b. Portable hand appliances of suitable types/ capacities for extinguishing small fires in selected areas of the mine/storage areas.

7.11 OCCUPATIONAL HEALTH AND SAFETY

The main areas of concern for ensuring adequate occupational health and safety are:-

- All working places will have safe means of access, safe working platform and exit. Persons working in hazardous dust prone area will be provided with dust mask.
- Personal protective equipments like respirators, ear plug, noise muff, helmet etc. will be provided to the workers.

- Proper unit design and engineering controls in order to protect workers, including by control of process and fugitive emissions.
- Adequate arrangement of drinking water will be done.
- Education & training will be provided to the workforce about facilities, protective equipment, risk associated, potential health effects, etc.
- Display board will be provided showing the hazards associated and recommended precautionary measures.

❖ MEDICAL SURVEILLANCE

Following are the proposed Medical Surveillance will be conducted for all employees:-

- Pre-employment medical check-up.
  * Pulmonary Function Test
  * Complete Physical Examination
  * Blood Test
  * Urine Test
  * Chest X ray
- Once in Six months medical check-up of each employee.
- Form 27A Fitness Certificate will be obtained every year from certified surgeon.
- Form 17 Health Register of each employee will be obtained every year from certified surgeon.
- Individual medical record will be maintained.

❖ OCCUPATIONAL HEALTH

Occupational health needs attention both during construction and operation phases. However, the problem varies both in magnitude and variety in the above phases.

Construction

The occupational health problems envisaged at this stage can mainly be due to constructional accident and noise. To overcome these hazards, in addition to arrangements to reduce it within TLV's, necessary protective equipments will also be supplied to workers.

Operation and Maintenance

The problem of occupational health, in the operation and maintenance phase is primarily due to dust and noise which could affect the workers from respiratory and hearing problems. The necessary personal protective equipments will be given to all the workers. The working personnel will be given the following appropriate personnel protective equipments.

- Industrial Safety Helmet;
- Crash Helmets;
- Face shield with replacement acrylic vision;
- Zero power plain goggles with cut type filters on both ends;
- Zero power goggles with cut type filters on both sides and blue color glasses;
- Welders equipment for eye and face protection;
- Cylindrical type earplug;
- Ear muffs;
- Dust mask;
- Self contained breathing apparatus;
- Leather apron;
- Safety belt/ line man's safety belt;
- Leather hand gloves;
- Asbestos hand gloves;
- Acid/ Alkali proof rubberized hand gloves;
- Canvas cum leather hand gloves with leather palm;
- Lead hand glove;
- Electrically tested electrical resistance hand gloves; and
- Industrial safety shoes with steel toe.
- Lifebuoys

Full-fledged hospital facilities will be available round the clock for attending emergency arising out of accidents, if any. All working personnel will be medically examined at least once in every year and at the end of his term of employment. This is in addition to the pre-employment medical examination.

7.12 SAFETY PLAN

The planning stage in the continuous improvement cycle is made up of the following four elements:

1. Policy 2.
2. Legal and Other Requirements 3.
3. Hazard Identification and Risk Management
4. 4. HSEQ Management Improvement Planning

Underground Mine safety Management Plan must include but may not limited to :

- Ventilation
- Spontaneous combustion
- Gas management
- Innudation
- Emergency evacuation
- Transportationm machinery
- Starata control

Safety of both men and materials during construction and operation phases is of concern. Safety plan will be prepared and implemented in the proposed site. The preparedness of an industry for the occurrence of possible disasters is known as emergency plan. The disaster is possible due to collapse of rock structures and fire/ explosion etc.

Keeping in view the safety requirement during construction, operation and maintenance phases a safety policy will be formulated with the following regulations:-

- To allocate sufficient resources to maintain safe and healthy conditions of work;
- To take steps to ensure that all known safety factors are taken into account in the construction, operation and maintenance of men, 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 upto date

knowledge;

- To provide appropriate facilities for first aid and prompt treatment of injuries and illness at work;
- To provide appropriate instruction, training, retraining and supervision to employees in health and safety, first aid and to ensure that adequate publicity is given to these matters;
- To ensure proper implementation of fire prevention methods and an appropriate fire fighting service together with training facilities for personnel involved in this service;
- To organize collection, analysis and presentation of data on accident, sickness and incident involving people 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/processes involved in at site; and
- To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipments, work places and operations.

(a) SAFETY ORGANIZATION

A qualified and experienced safety officer will be appointed. The responsibilities of the safety officer include identification of the hazardous conditions and unsafe acts of workers and advice on corrective actions, conduct safety audit, organize training programs and provide professional expert advice on various issues related to occupational safety and health. He is also responsible to ensure compliance of Safety Rules/ Statutory Provisions in accordance with the requirement of Factories Act / DGMS and their duties and responsibilities will be as defined thereof.

(b) SAFETY CIRCLE

In order to fully develop the capabilities of the employees in identification of hazardous

processes and improving safety and health, safety circles would be constituted in each area of work. The circle would consist of 5-6 employees from that area. The circle normally will meet for about an hour every week.

(c) SAFETY TRAINING

A full-fledged training center will be set up at the plant. Safety training will be provided by the Safety Officers with the assistance of faculty members called from Professional Safety Institutions and Universities. In addition to regular employees, limited contractor labors will also be provided safety training. To create safety awareness safety films will be shown to workers and leaflets will be distributed. Some precautions and remedial measures proposed to be adopted to prevent fires are:-

- Spread of fire in horizontal direction would be checked by providing fire stops;
- Reliable and dependable type of fire detection system with proper zoning and interlocks for alarms are effective protection methods;
- Housekeeping of high standard helps in eliminating the causes of fire and regular fire watching system strengthens fire prevention and fire fighting; and
- Proper fire watching by all concerned would be ensured.

(d) HEALTH AND SAFETY MONITORING PLAN

The health of all employees will be monitored once in a every five year for early detection of any ailment due to exposure of dust, heat and noise.

7.13 REHABILITATION & RESETTLEMENT (R&R)

R&R is proposed for shifting of Sindesar Khurd Village. There is provision of Rs. 60 crore towards R&R plan. It is proposed for utilization of the land for Green belt post shifting of village. Details of R&R is given below-

S. No.	Particulars	Amount (in Lacs)	Total Amount (in Lacs)	Status
1	Cost of Land for village shifting (120 Bigha @ Rs. 5.0 lacs/ bhigha)	600	600	72 Bigha already acquired and for remaining land, acquisition is in process

2	Compensation to Inhabitants	723.1	1590.2	The valuation of all dwelling units of SK Mine except has been completed by independent valuer which is now given for cross verification and certification to PWD as same is nodal agency nominated by District Collector .
	Land (83Bigha*Occupancy 50%)*(132*132)*Rs.100/Sq ft	867.1		
	Property (120% of Land Cost)			
3	Compensation as per LARR Act:-	105.2	2026.65	No movement depends on point 1 &2.
	Displace allowance: (195*Rs.36000+70*Rs.50000)	132.5		
	Resettlement allowance: (265*Rs.50000)	132.5		
	Transportation allowance: (265*Rs 50000)	66.25		
	Cattle Shed allowance: (265*Rs25000)	1590.2		
	Solatium on Property			
4	Development of Rehabilitation site e.g. Construction of Roads, community Centre, School, Hospital and other Infrastructure (Lumpsum) and Compensation	2000	2000	
5	Allotment of existing village land	400	400	
Total Broad Financial Implication			**6616.85**	

7.14 CORPORATE SOCIAL RESPONSIBILITY (CSR)

- Need & impact assessment was done by M/s Total Synergy Consulting Pvt Limited (TSCPL), Delhi.
- Socio-economic Index was developed to represent the Quality of Life, which is repeatable and verifiable over medium to longer duration to replicate the impacts of the Corporate Social Responsibility interventions by HZL

- Reaching more than 37738 people through CSR activities.
- Positively impacting the lives of 8103 families in 32 Villages under CSR activities.
- 26 Members team comprising of CSR Professionals & field level functionaries.
- CSR initiatives prioritized on local needs which focus on:

✓ Education

✓ Health, Water & Sanitation

✓ Sustainable Livelihood

✓ Infrastructure Development

✓ Agriculture & Animal Husbandry

✓ Women Empowerment

Proposed CSR Projects for 2016-18

In Lacs

S. No.	Initiatives	Timeline	Budget (in Rs. Lac)
1	Construction of 10000 Household Toilets in collaboration with Swacch Bharat Mission. 100 toilets completed	2016-17: 3500, 2017-18: 3000	300
2	Construction School Toilet and Electrification works in Govt. schools. 43 school toilets completed out of 71	2016-18	200
3	Construction of state of arts at Anganwadi Centers (Nandghar) in Rajsamand District	2016-17: 50, 2017-18: 100	2000
4	Proposed to develop 30 Government Schools into Model Schools in Relmagra Block	2016-17:10, 2017-18:10	600
5	Installation of Solar Street light & Solar Pump in villages	2016-18	100
6	Construction of Road and Drainages at Sindesar Kalan Village	2016-17	25
7	Construction of Road at Dariba	2015-16	400

8	Construction of Community Hall at Kabra Village	2016-17	25
9	Laying of Pipe line for Drinking water for Rajpura & Mataji Ka Kheda Village	2016-17	35
10	Construction of Over Head Tank at Rajpura Village	2016-17	20
11	Construction of Community Hall at Rajpura, Anjana, Mahenduriya & Anopura	2016-17	134
12	Mega Health Project for nearby operational villages	2016-18	60
Sub Total			3899
13	Women Empowerment under Sakhi Program (Self Help Groups)	2016-18	100
14	Construction work at Relmagra Bus Stand	2016-17	50
15	Green belt Development work near Suraj Badi Mata Temple	2016-18	100
16	Construction of Link Road nearby villages	2016-18	200
17	Repairing of road from SK village chouraha to Relmagra	2016-17	44
18	Construction of Road at Surajbari Mata ji to Mali Kheda	2016-17	28
19	RO Plants & maintenance for drinking water-nearby villages	2016-17	40
20	Educational program in the Govt. Schools	2016-18	100
21	Integrated Agriculture and Livestock Development Project	2016-18	200
22	Village Drinking water project	2016-18	100
23	4 Nagar Palika areas- Deogarh, Amet, Rajsamand and Nathdwara for declaring these Nagar Palikas ODF	2016-18	2400
24	DAV Zinc School	2016-18	420
25	Local Infrastructure Development as per need during FY	2016-18	300
26	Construction of Vedanta Sports Complex, Rajsamand	2016-16	216
27	Construction of Vedanta Auditorium, Rajsamand	2016-17	300
Sub Total			4598
Total			8497

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CHAPTER 8

PROJECT BENEFITS

8.1 INTRODUCTION

Zinc is a very versatile non-ferrous metal. Zinc's different applications rank it as the 4th most common metal in use after iron, aluminum and copper. In India, zinc demand growth continues to remain strong at around 7%, and is expected to leverage support from the automotive and the white goods sectors. Other major uses for Zinc include its utility in brass and bronze among many alloys; die casting, batteries, chemical compounds such as paints, ceramics, pharmaceuticals and fertilizers.

Over the medium term, growth in consumption is projected to average 7% a year which is also likely to remain stable till Year 2020. Global zinc demand continues to be driven mainly by galvanizing sector in the emerging economies of Asia and Africa. The reported increase in Chinese manufacturing activities and US automotive sales along with emerging signs of stability in Europe's manufacturing and services sector are expected to support zinc demand.

The mining and associated activities in the mineral bearing areas bring about gains in gross domestic product, i.e. there is though a small contribution by the proposed expansion project but will add to the gains in the G.D.P.

The existing capacity of the Mine is 0 is 3.75 mTPA of Lead-Zinc Ore Production & 4.25 mTPA Lead-Zinc ore Beneficiation, and the proposed capacity after expansion will be 4.5 mTPA of Lead-Zinc Ore Production & 5.0 mTPA Lead-Zinc ore Beneficiation.

Zinc is a very volatile metal and small movements in its demand may produce price fluctuations. The mining industry has witnessed continuous modernization and adoption of new technologies in recent years for the excavation of mineral like Zinc. The proposed expansion of mine will cater to the huge market demand presently, which can be analyzed by the demand and supply gap as shown below:-

The proposed expansion will bridge the gap between supply and demand of zinc not only in the region but also at national level. This will also generate much needed employment to the local people. Economy of the area will get a boost and there will be overall growth of the region in terms of education, health, training, transport, automobile, industry. The standard of living accordingly will also get an upliftment on the positive side.

8.1.1 National Economic Development

The present production capacities of Zinc in India are sufficient to meet the domestic requirements. However, the demand for zinc in India is expected to grow at a rate of 7.1%which makes it viable for the expansion of the zinc production capacities. Further the deficit in international market during the upcoming years provides opportunity for export.

8.1.2 Export Possibility

Indian exports majorly catered to South East Asian and African nations. In India, since, Hindustan Zinc is the largest producer of primary zinc, export of zinc is highly feasible and shall bring value addition.

8.1.3 Land value appreciation

The infrastructure development related to the proposed project is likely to cause appreciation of real estate prices in the nearby areas. Locals with land holdings in neighbouring areas are likely to benefit economically.

8.2 IMPROVEMENTS IN PHYSICAL AND SOCIAL INFRASTRUCTURE

The proposed project will enhance the socio-economic activities in the adjoining areas. This will result in following benefits:-

1. Improvements in physical infrastructure.
2. Improvements in social Infrastructure.
3. Increase in indirect employment potential
4. Contribution to the exchequer.
5. Post-mining enhancement of green cover.

8.3 IMPROVEMENTS IN PHYSICAL INFRASTRUCTURE

This project will have numerous induced impacts on society such as growth in schools (as part of CSR), hospitals, and transport etc.

8.4 EMPLOYMENT POTENTIAL –SKILLED; SEMI-SKILLED AND UNSKILLED

The proposed debottlenecking will be managed by the existing resources.The existing project has already provided huge opportunity for development of the area and the proposed expansion project is also anticipated to provide additional indirect employment opportunities to number of people from the Railmagra tehsil and its surrounding area. The proposed expansion project will also bring in people for secondary employment like transporters, vendors, local canteen and tea stall operators etc. Sourcing of consumable will be carried out from local region which will also provide considerable opportunity for local economy.

8.5 IMPROVEMENTS IN SOCIAL INFRASTRUCTURE

The proposed expansion project will bring in people from different cultures for secondary employment like transporters, vendors, local canteen and tea stall operators etc. such as:

- Generate indirect employment opportunities;
- Real estate development;
- Increase in purchasing power;
- Development of ancillary small scale supporting electro mechanical services for automobile's, civil, electrical and mechanicals etc. as part of CSR.
- Agriculture marketing and increased demand for locally produced farm products for large number of employees existing in the project;
- Access to high quality health care facilities;
- Women empowerment;

8.6 VARIOUS TANGIBLE SOCIAL BENEFITS IN THE STUDY AREA

As part of existing project, HZL has initiated many developmental activities for the surrounding area. A brief description of each of the activities and details are given below in table

Table 1: Ongoing CSR Activities

S. No	Focus Area	Activities	Particulars
1	Education	• School Adoption Program • Adoption of Ananwadi Centers • Scholarship, • SikshaSambal Project (Remedial classes for board students) • Help for Higher Education to Rural Girls	• Adopted 300 AWCs of Rajsamand district, benefiting 6700 children with ICDS and providing preschool education and nutritional supplements; • Adopted 20 Govt. Schools for improving basic infrastructure and quality of education; • Sponsored Poor Girls for Higher Education; and • Covered 1400 students of 24 schools under ShikshaSambal Project (Rs.50 lac)
2	Health and Nutrition	• Mobile Medical Camps • General Health Camps • Eye camps	• Installed 5 Nos. 500 LPH RO plants at Gawardi, Kotri, Mehanduria, Dariba and SunariaKhera villages and 10 mini RO plants in nearby schools.

S. No	Focus Area	Activities	Particulars
		• Blood Donation camps • Immunization Camp • Drinking Water	• 161 Medical & other camps at village level benefitted 15000 people. • Eye screening of all school going children of Railmagra block and 12 Cataract camps benefitting 22000 persons.
3	Sustainable Livelihood	• Providing training in different market driven trades viz; Computer, House keeping, Driving, Mining, Drilling, Electrician, House wiring, Plumbing, Motor Rewinding, Welder, Mobile repairing, etc.	• Providing training in different market driven trades viz; Computer, House keeping, Driving, Mining, Drilling, Electrician, House wiring, Plumbing, Motor Rewinding, Welder, Mobile repairing, etc.
4	Infrastructure	• Providing Link roads Community halls, Village roads, Additional class rooms, Drainage system, Overhead tanks, Pipeline and bore wells, Vedanta stadium, Sports complex, Renovation of school building etc.	• Vedanta Indoor Stadium in Rajsamand (Rs.2.5 Cr) • Widening of 38 KM road from Fatehnagar to Khandel on PPP Model. (Rs.20.00 Cr) • Bus Stand in Railmagra Block (Rs.1 Cr) • Vedanta Stadium in Railmagra block (Rs.1.50 Cr) • 105 Solar Lights. (Rs.15.00 lacs) • Constructed 10 Km Cement Concrete roads and 7 Km Bitumen roads in Rajpura, Sindesar Khurd, Sindesar Kalan, Amarpura, Makanpuria, SunariaKhera, Naya Dariba, Kotri, Anjana, ManoharKheri&Chouthpura villages, benefitting more than 12000 people (Rs.1.20 Cr)

S. No	Focus Area	Activities	Particulars
			• Constructed 6 Water Tanks & 7 Pipelines for drinking water in Kabra, SunariaKhera, Naya Dariba, Sindesar Khurd, Dariba, MatajikaKhera, SarvariaKheri and Mali Khera villages, benefiting more than 10000 people.(1.5 cr)
5	Agriculture and Animal husbandry	• Farmers Training & exposure Visits • Distribution of Hi-yield seeds • Orchard Development • Establishment of Green House • Artificial Insemination • Veterinary Camps • Distribution of Fodder seeds	• Covered more than 10,000 farmers in joint collaboration with BAIF for Kharif/Rabi season, Production enhancement of cereal crops, orchard development, and vegetable & commercial crop cultivation. • Established 162 orchards; • 14000 Artificial Insemination, breed improvement • Yield Improvement (Milk), • Veterinary Camps/ vaccination, Covered more than 145000 cattle (Rs.1.30 Cr)
6	Women Empowerment	• Formation & meetings of SHG's, • SHG Training, • Artisan based training • Micro Enterprises etc.	• Formed 272 SHGs covering 2990 women • 640 SHG women trained in various market driven trades (Meenakari, tailoring, Quilt utility items, Embroidery, Hand Block with Appliqué Embroidery and Tie & Dye, Paper bag & washing powder.

Various activities listed above will be continued for the lifetime operation of the project and any other similar or different activities, which are required for the further improvement of the surrounding area, will be carried out in consultation with the villagers, district and state administration.

Figure 1: CSR Activities carried out by HZL

Support for Formal Education at Sansera

Renovation of Sr. Sec.. School Kotri

Table 2: Proposed CSR Activities

S. No.	Description of Activities	Sindesar Khurd	Naya Dariba	Railmagra	Amount Sanction	Beneficiaries
1	Health camp	2	2	2		
2	Eye camp	1	1	1		Patients identified
3	Animal health camp	1	1	1		
4	Community hall	--	--	1		40 household
5	Plantation	--	--	--		enrichment of environment
6	Sprinkler system	15	15	15		15 household
7	Street solar light	13				public place
8	Repair and Maintenance of village roads	Approach road for mines and plant	Approach road for mines and plant	Approach road for mines and plant		Local People
9	Adoption of girl child for education till Senior Secondary	1	1			Girl child Education

10	Toilet and Sanitation in Rajkiye Uchch Madhyamik Vidayalay, Railmagra	--	--	1		Promoting Sach Bharat Mission
	Total					

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CHAPTER - 9

COST-BENEFIT ANALYSIS

NOT RECOMMENED IN SCOPING STAGE

CHAPTER – X

ENVIRONMENT MANAGEMENT PLAN

10.1 INTRODUCTION

An Environmental Management Plan (EMP) is drawn up after an EIA has been conducted as per the requirement of Terms of Reference. EMP is then implemented throughout the project life cycle.

An EMS (Environment Management System) provides a systematic framework and approach to minimize risk and manage environmental aspects (i.e. activities that cause impact) and impacts (i.e. affect change to the environment from activities).

10.1.1 METHODOLOGY

The system is depicted graphically as follows:-

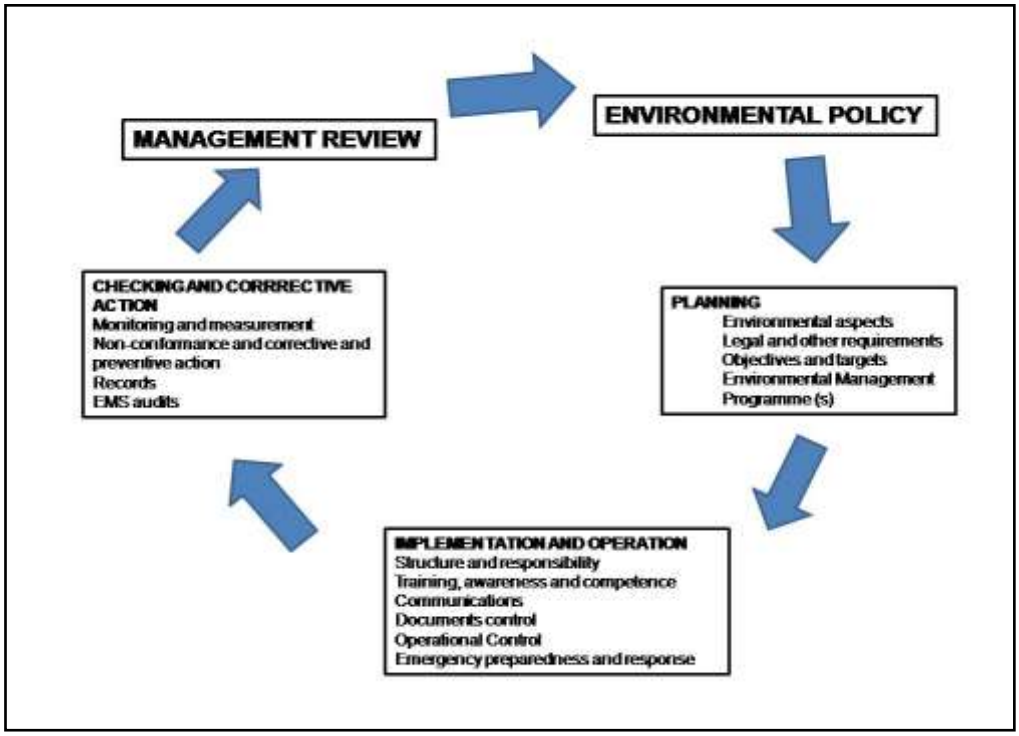


Figure 10.0: Environmental Management Methodology

10.1.2 CORPORATE GOVERNANCE

Project proponent is responsible for the development and implementation of the EMP and, where relevant, ensuring that the conditions in the Term of Reference and approved Environment Clearance are satisfied.

Roles and responsibilities of proponent/ stakeholder's will depend on the scale and scope of the EMP.

10.2 MANAGEMENT STRUCTURE

The Company will identify a Project Manager who will have overall responsibility for managing the project and for ensuring that the Environmental Management requirement is met.

All decisions regarding environmental procedures and protocols must be approved by the Project Manager who also has the authority to stop activities in contravention of the EMP.

In addition to Project Manager, Environmental Officer (EO) will also be appointed to implement the EMP.

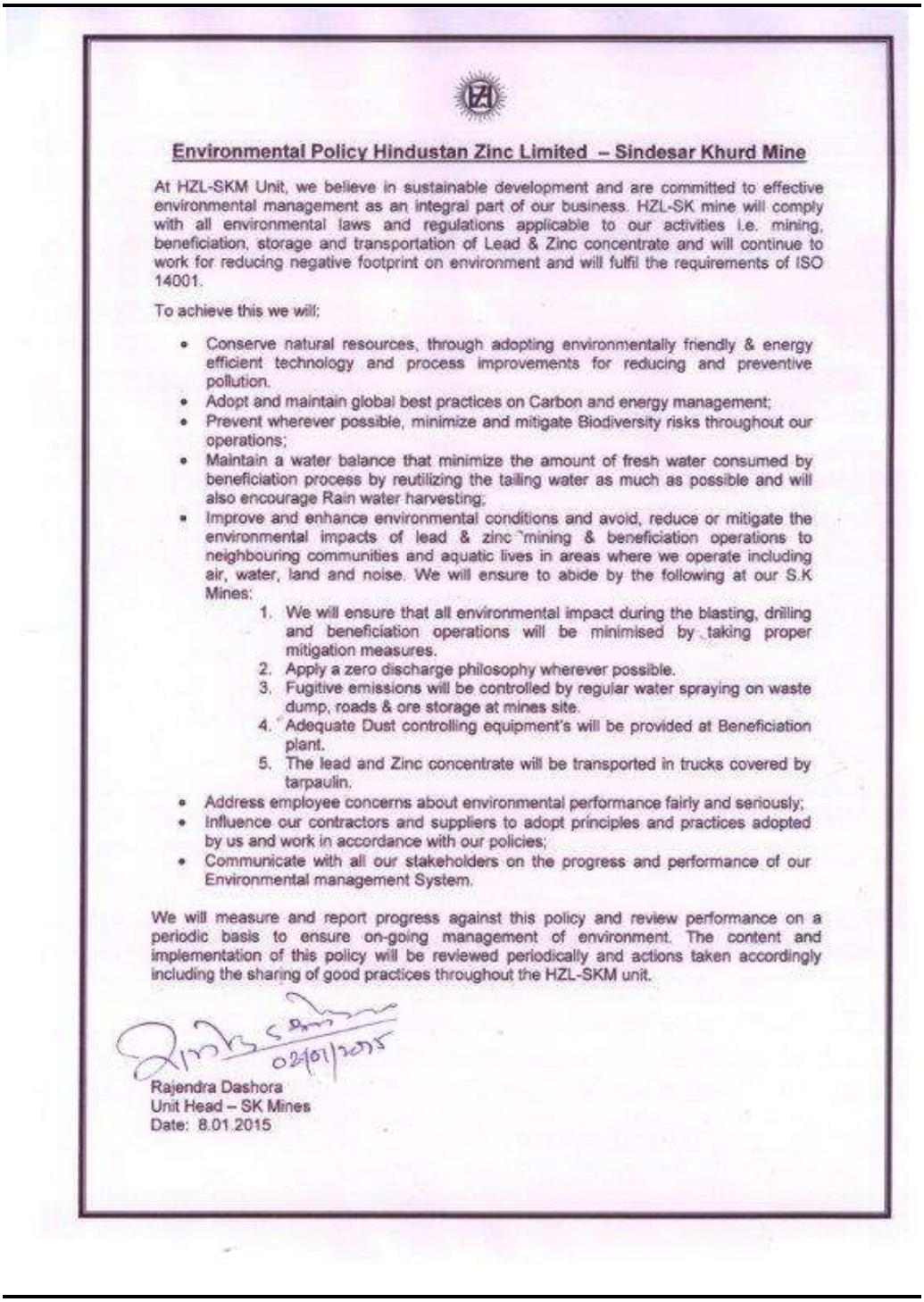
They will provide feedback to Project Manager regarding all environmental matters. The duties and responsibilities will be well defined for implementation/ monitoring of both the persons enumerated as below:-

1. Maintenance , update and review of EMP;
2. Compilation and administration of Environmental Monitoring Plan to ensure that Environmental Management Measures are implemented and are effective;
3. Checking the EO records of environmental incidents (spills, impacts, legal transgressions etc.) as well as corrective and preventive actions taken;
4. Checking of the public complaints register maintained by EO in which all complaints are recorded as well as action taken;
5. Communication of all modifications to the EMP to the relevant stake holders.
6. Conducting regular audits to ensure that the system for implementing the EMP is operating effectively;

10.3 COMMITMENT & POLICY

Project specific EHS Policy of SK Mines is given in **Figure 1..**

Figure 1.1 EHS Policy of HZL SK Mines



Environmental Policy Hindustan Zinc Limited – Sindesar Khurd Mine

At HZL-SKM Unit, we believe in sustainable development and are committed to effective environmental management as an integral part of our business. HZL-SK mine will comply with all environmental laws and regulations applicable to our activities i.e. mining, beneficiation, storage and transportation of Lead & Zinc concentrate and will continue to work for reducing negative footprint on environment and will fulfil the requirements of ISO 14001.

To achieve this we will;

- Conserve natural resources, through adopting environmentally friendly & energy efficient technology and process improvements for reducing and preventive pollution.
- Adopt and maintain global best practices on Carbon and energy management;
- Prevent wherever possible, minimize and mitigate Biodiversity risks throughout our operations;
- Maintain a water balance that minimize the amount of fresh water consumed by beneficiation process by reutilizing the tailing water as much as possible and will also encourage Rain water harvesting;
- Improve and enhance environmental conditions and avoid, reduce or mitigate the environmental impacts of lead & zinc mining & beneficiation operations to neighbouring communities and aquatic lives in areas where we operate including air, water, land and noise. We will ensure to abide by the following at our S.K Mines:
    1. We will ensure that all environmental impact during the blasting, drilling and beneficiation operations will be minimised by taking proper mitigation measures.
    2. Apply a zero discharge philosophy wherever possible.
    3. Fugitive emissions will be controlled by regular water spraying on waste dump, roads & ore storage at mines site.
    4. Adequate Dust controlling equipment's will be provided at Beneficiation plant.
    5. The lead and Zinc concentrate will be transported in trucks covered by tarpaulin.
- Address employee concerns about environmental performance fairly and seriously;
- Influence our contractors and suppliers to adopt principles and practices adopted by us and work in accordance with our policies;
- Communicate with all our stakeholders on the progress and performance of our Environmental management System.

We will measure and report progress against this policy and review performance on a periodic basis to ensure on-going management of environment. The content and implementation of this policy will be reviewed periodically and actions taken accordingly including the sharing of good practices throughout the HZL-SKM unit.

02/01/2015

Rajendra Dashora
Unit Head – SK Mines
Date: 8.01.2015

10.3 PLANNING

Various components of planning for the proposed expansion Project will include as per the following sub sections.

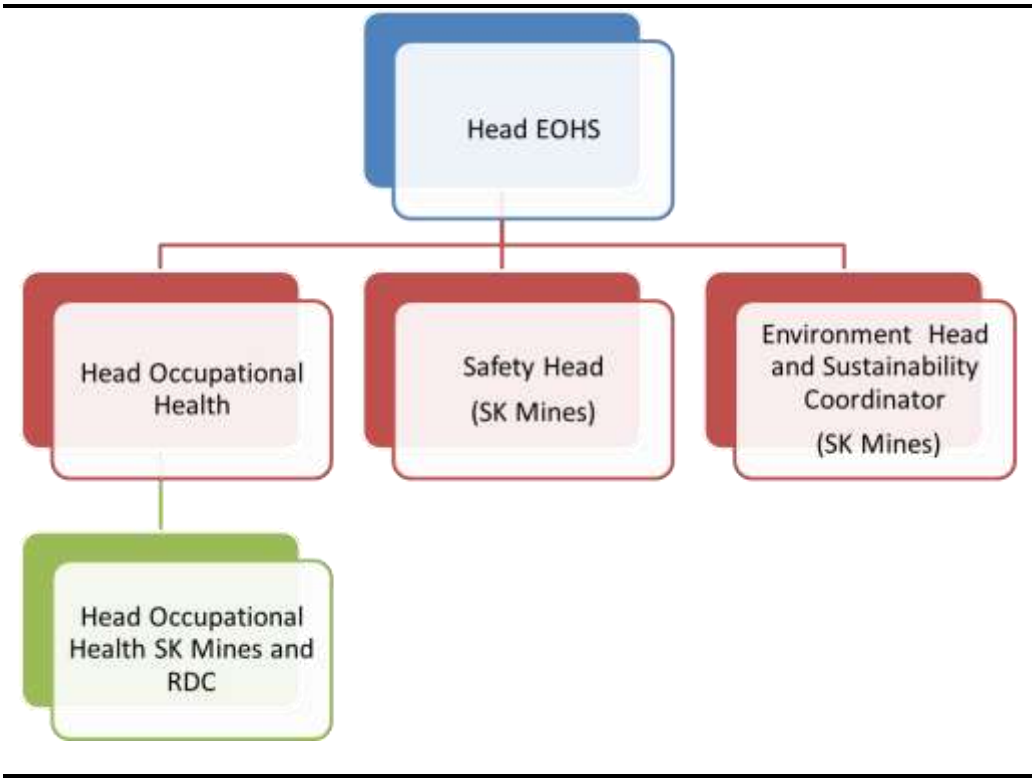
10.3.1 Organization, Roles and Responsibilities

Role of HZL SK Mine

HZL SK Mine will have ultimate responsibility for implementing the provisions of the EMP. This role will include the ongoing management of environmental impacts, monitoring of contractor performance as well as development of mechanisms for dealing with environmental problems.

HZL SK Mines will also ensure that the activities of its contractors are conducted in accordance with 'good practice' measures, implementation of which will be required through contractual documentation. In order to facilitate this, and to demonstrate commitment to the EMP, HZL SK mines will conduct regular internal site inspections, the results of which will be documented. The organisation structure of the HZL is given in figure

Figure 0.1 HSE Organisation Structure



Inspection, Monitoring and Audit

Inspection and monitoring of the environmental impacts of the Project activities will increase the effectiveness of EMP. Through the process of inspection and auditing, HZL SK Mines will ensure that the conditions stipulated in previous EC, Consent for Establishment, Consent to Operate, Storage of explosives, and storage of petroleum products etc. are complied with. It is proposed that the audit will be conducted by Audit Team (comprising of HZL SK Mines) for implementation of management system. The entire process of inspections and audits will be documented and inspection and audit findings will be implemented HZL SK Mines.

Monitoring, Reporting and Documentation

The operational HZL SK Mine has currently developed a well-documented reporting requirement for all stages of the Project with delegated personal to meet the reporting requirements and timely submission of all compliance reports and the same will be adopted for the proposed expansion project.

External Monitoring, Reporting and Communication, HZL SK Mines currently hire an external agency to conduct monitoring for air emissions, noise levels and domestic wastewater quality for submission to RSPCB/MoEF&CC and the same arrangements will be extended for the proposed expansion project.

Records of all of the monitoring activities will be maintained and will be available for review as required by RSPCB/MoEF&CC similar to the existing operational project.

Annual environmental report known as 'Environmental Statement' as per Form V of EPA Rules, 1986, Six monthly compliance report as per EC of MoEF&CC, compliance reports as per CTE/CTO etc. are to be submitted to the regulatory agencies., Head Environment will be the responsible person for ensuring that communication with regulatory agencies is maintained as per the requirement similar to the existing operational Project..

Internal Monitoring, Reporting and Communication

Internal monitoring will focus on measuring and reporting progress of implementing EMP activities. The Head Environment will be responsible for internal monitoring.

Inspection and audits finding along with their improvement program will be regularly reported to the senior management for their consideration.

Documentation

Documentation is an important step in implementing EMP. HZL has already established a well documentation and record keeping system to ensure recording and updating of documents per the requirements specified in existing EMP. The documents are kept as hardcopies as well as in electronic format. Responsibilities has been assigned to relevant personnel for ensuring that the EMP documentation system is maintained and that document control is ensured through access by and distribution to, identified personnel in form of the following:

- Master Environment Management System document;
- Legal Register;
- Operation control procedures;
- Work instructions;
- Incident reports;
- Emergency preparedness and response procedures;
- Training records;

- Monitoring reports;

- Auditing reports; and

- Complaints register and issues attended/closed

All the above documentation system will be extended to the proposed expansion project and maintained as per the requirement of RSPCB/MoEF&CC and other relevant regulatory authority.

10.3.4.EMP Review & Amendments

The EMP would be reviewed periodically to update it addressing any changes in the organisation, process or regulatory requirements.

IMPLEMENTATION

The implementation of EMP mainly comprises of resources available for the project, accountability of contractors and documentation of measures to be taken. HZL's Department of Health Safety and Environment has the overall mandate for coordination of the actions required for environmental mitigation and management and monitoring the progress of the proposed management plans and various action plans to be implemented for the project. The Cell will have following functions:

- Preparation of required EMS documents;
- Ensuring availability of resources and appropriate institutional arrangements for implementation of EMP;
- Selection of appropriate MoEF&CC approved monitoring agency for carrying out monitoring and analysis;
- Co-ordinating with monitoring agency in collection and analysis of water, air and soil samples, water samples, monitoring of noise levels within and outside the work zone;
- Implementation of the health and safety measures;
- Conducting routine medical check-ups of workers;
- Land reclamation and afforestation activities in consultation with local horticulture department;
- Green belt development including nursery management;
- Co-ordination of the environment related activities within HZL;
- Collection of the statistics of health of workers;
- Awareness and implementing safety programmes;
- Providing job specific training;
- Compliance of regulatory requirements;
- Carrying out environmental audits;
- Monitoring the progress of implementation of EMP; and
- Reviewing and updating the EMP as and when required for its effective implementation.

10.4 ENVIRONMENTAL MONITORING COMMITTEE (EMC)

EMC's have become an effective mechanism for monitoring the implementation of the EMP. This will take care of the in-house implementation programme and also statutory / legal holders like Regional Office of MoE&F, New Delhi and State Pollution Control Board.

The monitoring programme will comprise of three main aspects:-

1. Baseline measuring;
2. Impact (all performance);
3. Compliance Monitoring.

The monitoring should be implemented to ensure the prescribed mitigation measures are having the predicted and desired effect. Monitoring will be conducted periodically. It will also be ensured that the levels of specific environmental parameters are compliant with laws, regulations, standards or guidelines as applicable.

An implementation schedule must be prepared showing the sequence and timing (including frequency and duration) of the management action and monitoring activities or the EMP, where monitoring reports are produced, the timing of such report should be indicated. The schedule must be drawn up with the Project proponent, to ensure necessary links are made between the implementation schedule of the EMP and overall project schedule.

10.5 CRITICAL ACTIVITIES FOR EMP IMPLEMENTATION

1. Training and Environmental awareness;
2. Documentation and record keeping;
3. Reporting procedures;
4. Stakeholder/ project proponent engagement;
5. Auditing;
6. Responding to non-compliance;

10.6 MANAGEMENT OF VARIOUS FACTORS OF ENVIRONMENT

Environmental Management Plan (EMP) aims at the preservation of ecological system by considering in-built pollution abatement facilities at the existing site. Some of the major criteria governing the environmental measures will be adopted.

Sustainable development in the study area needs to be intervened with judicious utilization of non-renewable resources of the study area and within the limits of permissible capacity. The assimilative capacity of the study area is the maximum amount of pollution load that can be discharged in the environment without affecting the designated use and is governed by dilution,

dispersion and removal due to physico-chemical and biological processes. The EMP is required to ensure sustainable development in the study area of 10 km radius of the mining site; hence it needs to be an all encompassive plan for the existing activity. Government regulating agencies like Pollution Control Board working in the region and more importantly the people living in the study area need to extend their co-operation and contribution.

It has been evaluated that the study area has not been affected adversely with the existing activity and likely to get new economical fillip, not only for the study area but also for the region as a whole. Mitigation measures at the source level and an overall management plan at the study area level are elicited so as to improve the supportive capacity of the receiving bodies. The EMP aims at controlling pollution at the source level to the possible extent with the available and affordable technology followed by treatment before they are discharged.

Environmental management for the existing mining activity is discussed for the environmental impact pertains to the operational phase. Even though reversible in nature - all the impacts will be visible only during operational phase. It is planned to take corrective measures to ensure that these effects are kept to bare minimum. The EMP will therefore, be initiated during planning stage itself.

Critical Activities for EMP Implementation for Various Factors

S. No.	Particulars	Proposed Activities
1.	Top Soil storage, preservation and utilization	The topography of the lease area is hilly and it is an underground mine. Being brownfield expansion, no new area is required for this project. Hence, top soil will not be disturbed.
2.	Land reclamation and rehabilitation	This is an underground mine situated in a hilly terrain. Land will be disturbed only to a small extent. Mine has large potential and will therefore be continued to work for a long time. Exploration work being carried out may further enhance the reserves and there by the life of the mine will increase. However dumping area will be gradually reclaimed. Reclaimed area will be utilized for plantation which will help in improving the vegetal cover of the region.
3.	Waste dump management	In the proposed expansion of SK Mine, no additional waste will be dumped on the surface beyond the already approved waste quantity. The increased waste generated will be disposed off into the underground voids. No new dump will be required except for augmentation of already approved waste dump of 8 ha area.
4.	Afforestation programme with	*Time bound Green Belt action plan is already incurred as a part of 3.75 Mtpa Mine & 4.25 Mtpa Beneficiation Plant project. The Project area has no protected sensitive areas like National Park, Sanctuaries, RF, Wetlands etc. Status of Green Belt development is given below-*

S.No	*Particulars*	*Existing*	*Proposed*	*Total*

	precautions proposed for survival and protection of plantations.	

1	*Acquired Area (ha)*	*148.84*	*0*	*148.84*
2	*Area under plantation (ha)*	*46*	*4*	*50*
3	*No. of Plants*	*70,000*	*6,000*	*76000*
4	*% Area*	*30.91%*	*-*	*33.59%*
5	*Major Plant species*	*Fruit Trees: Ber (Ziziphus mauritiana), Jamun (Syzygium cumini), Mango (Magnifera indica), Sitafal (Annona squamosa), Amrood (Psidium guajava) Native Species: Neem (Azadirecta Indica), Kachnar (Bauhinia varigata), Shisham (Delbergia sisso), Dhaak (Butea monosperma), Amaltas (Cassia fistula), Bauhnia (Bauhinia purpurea) etc*		
S.No.	*Particulars*	*2017 -18*	*2018-19*	*2019-20*
1	*No. of Plants*	*3000*	*3000*	*3000*
2	*Area to be covered in plantation (in ha)*	*2*	*2*	
3	*Total Area under plantation*	*48*	*50*	

Note: 1. Local plant species will be planted with drip irrigation system for better plant survival rate. 2. From 2019-20 onwards plantation will be done for gap filling and taking care of survival rate of plants.

6.	Biological Environment	**Impact**	**Evaluation**	**Mitigation**
		Changes in ambient air quality (dust & gases) and degradation of vegetation	Due to the proposed mining project transportation of material with the movement vehicles will increase and Dust concentration is expected to increase because of Heavy vehicle movements in the area.	Schedule-1 species conservation plan is attached as **Annexure No 5** Greenbelt development program with specific plant species which can act as bio-filters can further reduce the level of pollutant concentration and also will improve the overall ambient air quality in and around the project environment. The detailed Green Belt development is given in point no 4.
5.	Air Environment	Following standards in ambient air quality of mining area will be achieved:-		

Parameter	Standard Ambient Air
$PM_{2.5}$ ($\mu g/m^3$)	60.0 max
PM_{10} ($\mu g/m^3$)	100.0 max
NO_X ($\mu g/m^3$)	80 max
CO ($\mu g/m^3$)	2000 max
SO_2 ($\mu g/m^3$)	80 max

		Operations of mining activities such as transportation, ore handling, crushing will generate dust which usually gets air borne. Dust is controlled by adopting following practices:- ➢ Effective water spraying arrangements in underground working places as well as at ore loading/ unloading at surface. ➢ Effective water spraying at all transfer points. ➢ Water spraying arrangement along ore transport route within the mine premises. ➢ Plantation with the premises and also along the transportation route. ➢ Proper periodic maintenance of vehicles. ➢ Trucks carrying ore will be covered with tarpaulin sheets. Underground workings of the mine are ventilated by adequate ventilation arrangements. The requirements and standards specified by Director General of Mines Safety (DGMS) are adhered to. To control radon, radon daughters, dust and diesel engine fumes in underground workings the following provisions have been made. ➢ Water spraying in freshly broken rock. ➢ Maintenance of adequate ventilation throughout all working points. ➢ Wet drilling will be practiced.
7.	Quality and make of water including surface and ground water.	Natural flow of water in the drainage system of this area has a trend towards NNE. Water quality monitoring will be carried out as per statutory requirements and records maintained and reports submitted to authorities. Zero discharge is being maintained in the operations. Water from tailing dam is being recycled through the closed pipeline system and being reused in the process. There is no additional groundwater is envisaged from the proposed project. As per CGWB approval, Mine dewatering due to intersection (121 m3/day) is being consumed in the process.
8.	Noise Control	Duct fan operation, drilling & mucking operations are the sources of noise generation in underground workings. ➢ Noise generated by blasting is momentary and isolated in nature. ➢ Blasting is done at underground n between shifts; hence exposure to high noise level is restricted. ➢ All operators, helpers and persons nearby the machine operations producing noise more than 85 dB (A) are being provided with PPE's. ➢ Regular maintenance of equipment is done to reduce the noise levels. ➢ Leakage of compressed air which produces noise is restricted. ➢ All transfer points will be lined with hard rubber to reduce noise generation. ➢ The prime movers / diesel engines will be of proper design maintained. ➢ Noise level monitoring will be carried out as per CCOM' circular 3/92. ➢ As it is an underground mine and use of explosive is not on a large scale, vibrations will be contained.

		At Surface The mine ventilation fans and compressor are the main sources of noise mining activities. Other sources of noise on surface are not substantial. The following measures has been taken up:- ➢ The ventilation fans are located at remote paces from mine entry hence impact of noise is not anticipated. ➢ During normal maintenance, being lubrication and fastener tightness is checked regularly to limit undue noise and vibration. ➢ Compressors are installed in isolated building and sound protective cubicles are provided for operators. However, to reduce the noise further, acoustic enclosures will be provided. ➢ Regular noise level monitoring is practiced for taking corrective action. ➢ Drill machine operators and pneumatic loaders drivers are issued ear plugs and ear muffs. Duty hours of operators of noisy machinery are regulated to keep their noise exposure levels within limits. ➢ Plantation will be carried out all around the mine boundary to reduce the noise level exposure. ➢ Board has been displayed at defined locations of noisy are to use PPE's.
9.	Ground Vibrations	**BLASTING HAZARDS** Blasting in mining areas may give rise to ground vibrations. Fly rock is another problem area. However the magnitude of blast is not high. Proper precautions will be taken during blasting operations for controlling the ground vibrations.
9.1	Blast vibrations & Control measures	Controlled blasting technique will be adopted in this project in order to reduce blast vibrations. Further, charge per delay will be regulated to minimize blast vibrations. Proper hook-up will be adopted while firing the drill holes. Moreover the experience gained in other open cast mines will be gainfully utilized to limit the ground vibration levels within the prescribed limit. In practice, this is kept much less to about 10mm/ sec or even 8mm/sec. In addition, the following guidelines will be adopted wherever required to check the ground vibrations:- ➢ The maximum charge per delay will be so as to limit the PPV values below 8mm/ sec. ➢ Design of optimum blast hole geometry considering bench height, diameter of hole, type of explosive, nature of rock, level of fragmentation required etc.
10	Socio-Economic Environment	➢ Non workers and unskilled workers (local within 10.0 km) will be trained to work in mines. ➢ A proper direction given to the villagers would help route the income and savings for growth. ➢ Ensure the optimum use of excavated material for domestic market from the mine. ➢ Vocational training camps for various stages. ➢ People will find indirect employment / income opportunities in the region. ➢ Regular health camps to trace the develeopments and control any ill-consequences due to any mining pollution.

		➢ Greivance redressal mechanism is made to handle complaints from the study area. ➢ The proposed project expansion will promote neither selective, nor relative, but universal respect through contribution in various festivities, equal observance and protection among employees and societies at large in all CSR activities.
11.	Occupational Health and Safety	The following measures relating to Occupational health and safety will be practiced:- ➢ Safety officer look after the safety aspect. ➢ Dedicated safety & Environmental committees in mine review the safety and environmental aspect of industrial operations on monthly basis. ➢ Safety Committee comprises of Engineers, Geologists, Surveyor, Environmental Engineer, Medical officer, Training Officer, Occupational health In0Charge, Workmen, Union representative etc. ➢ Minutes of the Meeting of safety committee communicated to Directors/ officials and concerned regulatory authorities. ➢ Recommendations of safety committee are implemented. ➢ Provision of rest shelters for mine workers with amenities like canteen, drinking water etc. ➢ Provision to use of safety appliances, safety awards, display of posters, slogans etc. Celebration of safety week on annual basis. ➢ First – aid organization in mines including training and retraining of first – aider's. ➢ Use of personal dosimeters, dust samplers **Prevention of Injury.** ➢ Training in safety measure. ➢ Use of PPE's e.g. uniforms, helmet, earplugs, ear seals, earmuffs, safety goggles, respirators, hand gloves, rubber canvas shoes, gum boots etc. ➢ Regular monitoring of work environment.
12.	Environmental Protection Measures	As given below:-

Environment Expenditure Cost:

Particulars	Approved Cost in cr.		Proposed Cost in cr.	
	Capital	**Recurring**	**Capital**	**Recurring**
Excavation & installation of Dust control/suppression systems for crushers & cement silos	5	2	5	2
Tailing Dam management (height raising, HDPE lining on side wall, pumping system and water recycle line)	55		61.5	
Tailing thickener	5	5	5	5
Surface water sprinkler	1	0.1	1	0.1
Mechanical road sweeper	1	0.1	1	0.1
Ventilation System	68	4.1	80	4.8
Rainwater harvesting	1	0.2	1	0.2
Plantation/Green belt development and drip irrigation system	1	0.5	1	0.5
Different Environmental Monitoring equipment	1	5.1	1	5.1
Automation in Environment Monitoring & Safety	17		17	
Construction of Garland drain and silt settling tank and recycle system for waste dump management	1	0.1	1	0.1
Schedule-I fauna conservation plan cost	2	0.4	2	0.4
Installation of Sewage treatment plant and Oil grease trap system	3	0.5	3	0.5
Water hydrant system	1	0.1	1	0.1
Water tanker with pumps	3	0.1	3	0.1
Grand Total (Rs. in cr.)	**165**	**18.3**	**183.5**	**19.0**

10.7 CONCLUSION

Environmental Management plan will be dynamic, flexible and subject to periodic review. For project where the major environmental impacts are associated, EMP will require regular review. Senior management responsible for a project should conduct a review of EMP and its implementation to ensure that the EMP remains effective and appropriate.

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CHAPTER – 11

Disclosure of Consultants Engaged

National Accreditation Board for Education and Training

NABET

NABET/EIA/RA0/021

Oct 01, 2015

Vice President, Technical
Wolkem Consultancy Services
Post Box No. 21, E – 101, Mewar Industrial Area
Udaipur 313003, Rajasthan
(Kind Attention: Mr. Yashwant Bordia)

Dear Sir,

Sub: Re-Accreditation

This has reference to the application of your organization under QCI-NABET Scheme. Accreditation of Wolkem Consultancy Services was renewed for a period of three years from Feb 04, 2015 to Feb 04, 2018 as informed vide NABET letter dt. Mar. 27, 2015. It has been confirmed vide your mail dt. Sep. 29, 2015 that all the experts (EIA Coordinator, FAE, AFAE) approved vide RAAC MoM dt. Mar. 04, 2015 and Apr. 22, 2015 are associated with Wolkem as on date as well. Further to our letter dated Mar 27, 2015 and RA AC meeting dated Mar. 04, 2015 and Apr. 22, 2015, Wolkem is now accredited for the following sectors:

Sl. No.	Sector number		Name of Sector	Cat. A/B
	As per MoEF Notification	As per NABET Scheme		
1.	1 (a) (i)	1	Mining of minerals including Opencast / Underground mining	A
2.	2 (b)	7	Mineral beneficiation including pelletisation	A
3.	3 (a)	8	Metallurgical Industries (Secondary Ferrous)	B
4.	3 (b)	9	Cement plants	A
5.	5 (a)	16	Chemical Fertilizers	A
6.	5 (b)	17	Pesticides industry and pesticide specific intermediates (excluding formulations)	A
7.	5 (f)	21	Synthetic organic chemicals industry (dyes & dye intermediates; bulk drugs and intermediates excluding drug formulations; synthetic rubbers; basic organic chemicals, other synthetic organic chemicals and chemical intermediates)	A
8.	8 (a)	38	Building and large construction projects including shopping malls, multiplexes, commercial complexes, housing estates, hospitals, institutions	B
9.	8 (b)	39	Townships and Area development projects	B
Total = 09 Sectors				

With best regards,

Yours sincerely,

(Abhay Sharma)
Assistant Director

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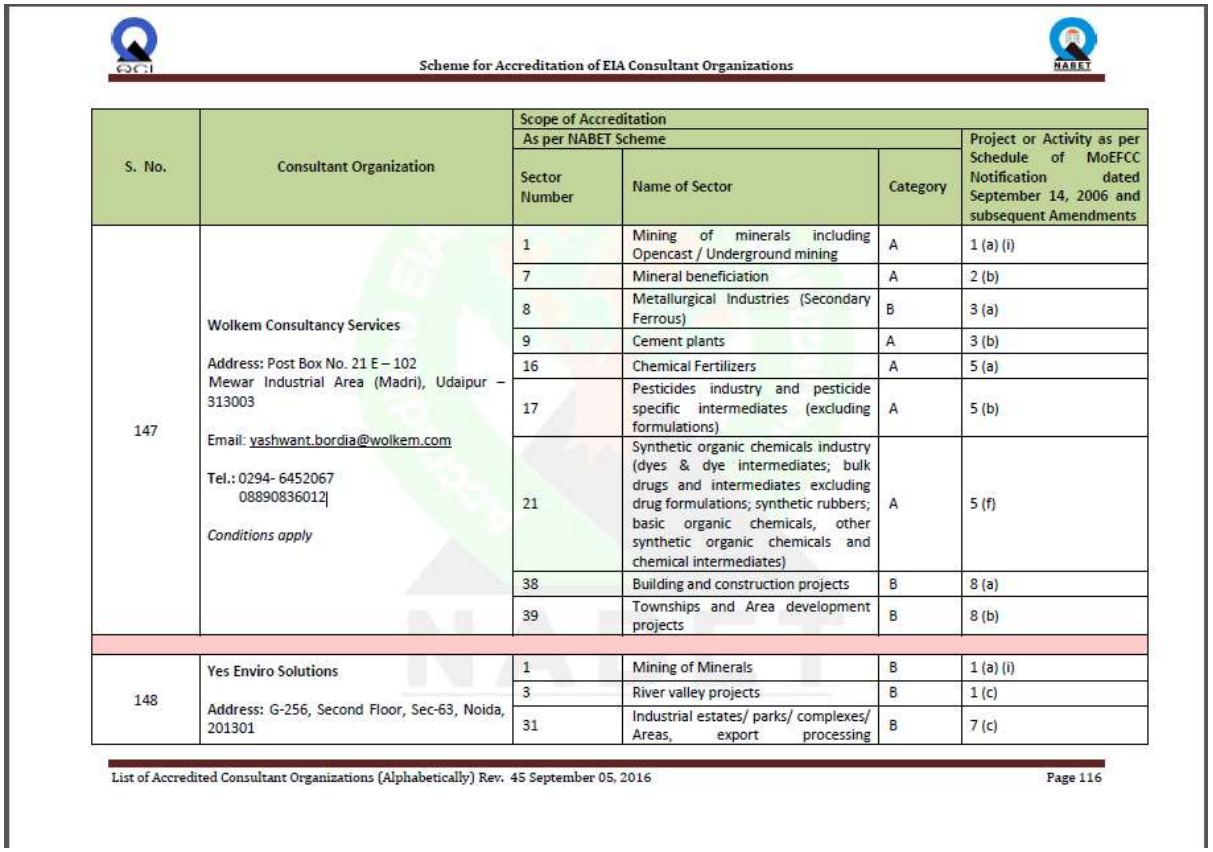
e-mail : nabet@qcin.org Website : www.qcin.org



Scheme for Accreditation of EIA Consultant Organizations

S. No.	Consultant Organization	Scope of Accreditation			
		As per NABET Scheme			Project or Activity as per Schedule of MoEFCC Notification dated September 14, 2006 and subsequent Amendments
		Sector Number	Name of Sector	Category	
147	Wolkem Consultancy Services Address: Post Box No. 21 E – 102 Mewar Industrial Area (Madri), Udaipur – 313003 Email: yashwant.bordia@wolkem.com Tel.: 0294- 6452067 08890836012 *Conditions apply*	1	Mining of minerals including Opencast / Underground mining	A	1 (a) (i)
		7	Mineral beneficiation	A	2 (b)
		8	Metallurgical Industries (Secondary Ferrous)	B	3 (a)
		9	Cement plants	A	3 (b)
		16	Chemical Fertilizers	A	5 (a)
		17	Pesticides industry and pesticide specific intermediates (excluding formulations)	A	5 (b)
		21	Synthetic organic chemicals industry (dyes & dye intermediates; bulk drugs and intermediates excluding drug formulations; synthetic rubbers; basic organic chemicals, other synthetic organic chemicals and chemical intermediates)	A	5 (f)
		38	Building and construction projects	B	8 (a)
		39	Townships and Area development projects	B	8 (b)
148	Yes Enviro Solutions Address: G-256, Second Floor, Sec-63, Noida, 201301	1	Mining of Minerals	B	1 (a) (i)
		3	River valley projects	B	1 (c)
		31	Industrial estates/ parks/ complexes/ Areas, export processing	B	7 (c)

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