R E P O R T

HINDUSTAN ZINC LIMITED

Udaipur, Rajasthan

ENVIRONMENTAL IMPACT ASSESSMENT

FOR

PROPOSED RAMPURA AGUCHA LEAD ZINC OPENCAST AND UNDERGROUND MINE PROJECT EXPANSION FROM 5.0 Mtpa TO 6.15 Mtpa, BENEFICIATION CAPACITY FROM 5.0 Mtpa TO 6.5 Mtpa AT AGUCHA VILLAGE HURDA TEHSIL, BHILWARA DISTRICT, RAJASTHAN

For and on behalf of VIMTA Labs Limited

Approved by : **M. Janardhan**

Signed :

Position : **Vice President (Env)**

Date : April 18, 2009

This report has been prepared by Vimta Labs Limited with all reasonable skill, care and diligence within the terms of the contract with the client, incorporating our General Terms and Conditions of Business and taking account of the resources devoted to it by agreement with the client.

Table of Contents

Chapter #	Title	Page #
	Table of Contents	I
	List of Figures	IV
	List of Tables	VI
1.0	**Introduction**	
1.1	Background	C1-1
1.2	Significance of the Project	C1-1
1.3	Objective of the Environmental Impact Assessment Studies	C1-2
1.4	Environmental Impact Assessment Studies	C1-3
1.5	Site Selection	C1-3
1.6	Evaluation of Industrial Development in the Study Area	C1-9
1.7	Infrastructure and Auxiliary Facility	C1-9
1.8	Land Requirement	C1-9
1.9	Salient Features of the Project	C1-9
1.10	Administrative and Legislative Requirements	C1-17
1.11	Scope of the Present Study	C1-17
1.12	Methodology of the Study	C1-17
2.0	**Project Details and Sources of Pollution : Existing Mine**	
2.1	Introduction	C2-1
2.2	Geology, Mining and Beneficiation Plant – Existing Status	C2-1
2.3	Measures Adopted for Controlling Pollution	C2-38
2.4	Disposal of Mine Waste/Overburden and Reclamation	C2-44
2.5	Green Belt Development	C2-44
3.0	**Project Details and Sources of Pollution : Proposed Expansion**	
3.1	Introduction	C3-1
3.2	Exploration Details in Expansion Phase	C3-1
3.3	Conceptual Mine Plan	C3-1
3.4	Drilling and Blasting	C3-18
3.5	Extent of Mechanization	C3-19
3.6	Handling of Waste/sub-grade Material	C3-22
3.7	Proposed Expansion of Beneficiation Plant	C3-25
3.8	Improvements in Efficiency Parameters	C3-36
3.9	Sources of Pollution	C3-37
3.10	Greenbelt Development	C3-43

Table of Contents (Contd.)

Chapter #		Title	Page #
4.0	**Baseline Environmental Status**		
	4.1	Introduction	C4-1
	4.2	Hydrology and Hydrogeology	C4-1
	4.3	Micro-Meteorology	C4-13
	4.4	Air Quality	C4-29
	4.5	Water Quality	C4-42
	4.6	Soil Characteristics	C4-53
	4.7	Noise Level Survey	C4-59
	4.8	Traffic Density Survey	C4-64
	4.9	Biodiversity Studies	C4-66
	4.10	Landuse Studies	C4-96
	4.11	Demography and Socio-Economics	C4-102
5.0	**Anticipated Environmental Impacts and Mitigation Measures**		
	5.1	Identification of Impacts	C5-1
	5.2	Impacts during Construction Phase	C5-2
	5.3	Impacts during Operational Phase	C5-3
	5.4	Impact on Topography and Climate	C5-4
	5.5	Impact on Landuse	C5-5
	5.6	Impact on Air Quality	C5-5
	5.7	Impact on Soil	C5-12
	5.8	Impact on Water Resources	C5-12
	5.9	Impact on Water Quality	C5-14
	5.10	Impact of Solid Waste	C5-17
	5.11	Impact on Noise Levels and Ground Vibrations	C5-28
	5.12	Subsidence-Prediction and Prevention	C5-32
	5.13	Impact on Flora and Fauna	C5-32
	5.14	Impact on Traffic Density	C5-34
	5.15	Impact on Socio-economic Aspects	C5-35
6.0	**Environment Health and Safety Management Plan**		
	6.1	Corporate Philosophy of HZL	C6-1
	6.2	Environment Management Plan	C6-4
	6.3	Air Pollution Management	C6-4
	6.4	Water Pollution Management	C6-6
	6.5	Noise and Vibrations	C6-7
	6.6	Solid Waste Generation	C6-8
	6.7	Greenbelt Development	C6-10
	6.8	Steps to be taken to Improve Socio-economic Conditions	C6-17
	6.9	Community Development	C6-18
	6.10	Post Project Monitoring Schedule	C6-20
	6.11	Infrastructure for Environmental Protection	C6-22
	6.12	Post Project Monitoring Equipment	C6-23
	6.13	Budgetary Allocation for Pollution Control	C6-25

Table of Contents (Contd.)

Chapter #	Title	Page #
7.0	**Risk Assessment and Disaster Management Plan**	
7.1	Introduction	C7-1
7.2	Scope of the Study	C7-2
7.3	Hazard Identification	C7-3
7.4	Visualization of MCA Scenarios	C7-7
7.5	Hazard Assessment and Evaluation	C7-9
7.6	Disaster Management Plan	C7-22
7.7	Emergencies	C7-23
7.8	Identification of Hazards in Open Cast Mines	C7-24
7.9	Emergency Organization	C7-26
7.10	Emergency Responsibilities	C7-27
7.11	Emergency Facilities	C7-34
7.12	Emergency Actions	C7-36
7.13	General	C7-37
7.14	Off-site Emergency Preparedness Plan	C7-38
7.15	Occupational Health and Safety	C7-43
8.0	**Conceptual Final Mine Closure Plan**	
8.1	Introduction	C8-1
8.2	Conceptual Final Closure	C8-1
9.0	**Additional Studies**	
9.1	Geotechnical Studies for Stability of Surface Crown Pillar Underground Stope Modeling	C9-1
9.2	Geotechnical Study Analysis of Waste Dump	C9-2
9.3	Effects of Blasting & Blast Vibrations	C9-2
9.4	Rain Water Harvesting	C9-3
9.5	Raising of Tailing Dam Height	C9-3
9.6	Socio- economic study of the village Bherukhera (I)	C9-4
10.0	**Disclosure of Consultants**	
10.1	Introduction	C10-1
10.2	The Quality Policy	C10-1
10.3	Milestones and Accreditations	C10-1
10.4	Services Offered	C10-2
10.5	Services	C10-3
10.6	Facilities	C10-4
10.7	Quality Systems	C10-4
10.8	Achievements	C10-5

Annexures

Annexure-I	Environmental Clearance	AI-1
Annexure-II	Terms of Reference	AII-1
Annexure-III	NOC – RSPCB	AIII-1
Annexure-IV	Compliance of Environmental Clearance granted by MoEF	AIV-1
Annexure-V	Mining Plan Approval for Existing Mine	AV-1
Annexure-VI	Central Ground Water Allocation Letter	AVI-1
Annexure-VII	Letter Regarding Aravalli Notification	AVII-1
Annexure-VIII	Applicable Standards	AVIII-1
Annexure-IX	Details of Blasting & Vibrations	AIX-1
Annexure-X	Ambient Air Quality Levels	AX-1
Annexure-XI	Ecological Details	AX-1
Annexure-XII	Landuse Pattern	AXII-1
Annexure-XIII	Demographic Details	AXIII-1

List of Figures

Figures #	Title	Page #
1.1	Geographical Location of the Mine Site	C1-5
1.2	Study Area Map (10 km Radius)	C1-6
2.1	Geological Section	C2-6
2.2	Layout of the Plant and Mine	C2-16
2.3	Pit Plan as on 30.09.2008	C2-18
2.4	Mine Pit Longitudinal Sections	C2-19
2.5	Surface Geological Plan	C2-20
2.6	Geological Sections N/S 00	C2-21
2.7	Waste (OB) Dump Plan	C2-22
2.8	Waste Dump Locations	C2-24
2.9	Schematic Diagram of Beneficiation Plant	C2-31
2.10	Cross Section of the Tailing Dam	C2-32
3.1	Isometric View	C3-7
3.2	Longitudinal Section showing Ultimate Pit and Proposed Approach to Underground	C3-10
3.3	Transverse Section showing Ultimate Pit and Proposed Approach to Underground	C3-10
3.4	Isometric View	C3-11
3.5	Isometric View	C3-11
3.6	Conceptual Plan	C3-13
3.7	Sub-Level Open Stoping Diagram	C3-14
3.8	Bench Open Stoping Diagram	C3-15
3.9	Avoca Method	C3-16
3.10	Stope Filling System	C3-26
3.11	Beneficiation Plant : Flow Sheet	C3-29
3.12	Fill Reticulation	C3-31
3.13	Water Balance for Expansion Project	C3-35
4.2.1	Hydro-Geological Map	C4-5
4.3.1	Wind Rose – Winter Season	C4-16
4.3.2	Wind Rose – Pre Monsoon – IMD Ajmer	C4-21
4.3.3	Wind Rose Monsoon – IMD Ajmer	C4-22
4.3.4	Wind Rose Post-Monsoon – IMD Ajmer	C4-23
4.3.5	Wind Rose Winter – IMD Ajmer	C4-24
4.3.6	Wind Rose Annual – IMD Ajmer	C4-25
4.4.1	Air Quality Sampling Locations	C4-30
4.4.2	Air Quality Trends	C4-39
4.4.3	Stack Monitoring Results (Monitored by HZL)	C4-41
4.5.1	Water Sampling Locations	C4-43
4.5.2	Heavy Metal Trends in Monitoring – Plezometer - I	C4-49
4.5.3	Heavy Metal Trends in Monitoring – Plezometer - K	C4-50
4.5.4	Heavy Metal Trends in Agucha Village	C4-51
4.5.5	Heavy Metal Trends in Kothiya Village	C4-52
4.6.1	Soil Sampling Locations	C4-54
4.7.1	Noise Sampling Locations	C4-61
4.9.1	Ecological Sampling Locations	C4-70

List of Figures (Contd..)

Figures #	Title	Page #
4.10.1	Landuse Pattern – 1991 Census	C4-98
5.1	Groundlevel Concentrations	C5-10
5.1	Waste Dump Typical Section	C5-19
5.2	Photograph of Existing Waste Dump Rehabilitation Site	C5-19
5.3	Proposed 3 year Plan of the Waste Dump	C5-20
5.4	Construction of Tailing Damp	C5-27
6.1	Progressive Mine Closure Plan showing Green Belt	C6-16
6.2	Environmental Management Cell	C6-24
7.1	Protocol for Identification of Hazards	C7-4
7.2	Flow chart for MCA Analysis	C7-13
7.3	Steps in Hazard Identification	C7-14
7.4	Failure of Storage Tanks – 37.5 kw/m^3 contour	C7-17
7.5	Failure of Storage Tanks – 1.6 kw/m^3 contour	C7-18
7.6	Organization Chart of HZL	C7-28
7.7	On-site Emergency Plan for HZL	C7-29
7.8	Off-site Emergency Plan	C7-42
8.1	Conceptual Mine Closure Plan	C8-7

List of Tables

Tables #	Title	Page #
1.1	Environmental Setting of the Site	C1-8
1.2	Salient Features of Project	C1-10
1.3	Proposed Plantation Schedule on Overburden Dump	C1-16
1.4	Proposed Year wise Greenbelt Development Program	C1-16
1.5	List of TOR conditions and their reference in EIA report	C1-18
1.5	Environmental Attributes & Frequencies of Monitoring	C1-23
2.1	Precambrian Stratigraphy	C2-2
2.2	Analysis of Ore	C2-9
2.3	Level Wise Dips of the Ore Zone	C2-10
2.4	Average Width of the Ore Zone	C2-11
2.5	Exploration Inputs	C2-12
2.6	Category Wise Ore Reserves as on 01.04.2009	C2-13
2.7	Mine Parameters	C2-15
2.8	Drill and Blast Design Parameters	C2-17
2.9	Available Mining Equipment	C2-25
2.10	Existing Equipment of Beneficiation Plant	C2-29
2.11	Factor of Safety for the Tailing Dam	C2-33
2.12	Capacity of Tailing Dam	C2-34
2.13	Raw Material Requirement and Storages	C2-36
2.14	List of Equipment	C2-36
2.15	Details of the Quarters in Township	C2-37
2.16	Landuse Pattern of the Acquired Land	C2-38
2.17	Acquisition Status of Land of Mining Lease	C2-38
2.18	Existing Landuse Pattern of the Acquired Land	C2-38
2.19	Solid Waste Generation	C2-42
2.20	Chemical Analysis of Tailings	C2-43
2.21	Chemical Analysis of Over Burden Rock Waste	C2-43
2.22	List of Species	C2-45
3.1	Status of Ore Reserves & Resources	C3-1
3.2	Bench Parameters for Footwall	C3-3
3.3	Bench Parameters for Footwall	C3-3
3.4	Five Year Ore Production Schedule	C3-5
3.5	Yearwise production Details Since 1994	C3-5
3.6	Excavation Schedule for Openpit and Underground	C3-8
3.7	Yearwise Mine Development	C3-8
3.8	Excavation Schedule for Openpit	C3-8
3.9	Excavation Schedule for Underground Mining	C3-9
3.10	Conceptual Mine Parameters	C3-17
3.11	Drill and Blast Design Parameters	C3-18
3.12	Openpit Mining Equipment	C3-21
3.13	Proposed Underground Mining Equipment	C3-22
3.14	Year Wise Schedule of Overburden Dumping	C3-23
3.15	Year wise Generation of Topsoil for Proposed Plan years	C3-24
3.16	Existing and Additional Equipment of Beneficiation Plant	C3-27
3.17	Pre-Operational Land Use pattern	C3-32

List of Tables (Contd..)

Tables #	Title	Page #
3.18	Acquisition Status and Additional Acquisition Proposed Details of Land of Mining Lease	C3-33
3.19	Operational and Post-Operational Land use Pattern	C3-33
3.20	Proposed Fresh Water Consumption	C3-34
3.21	Requirement of Consumbales, Products and Storage Capacity	C3-36
3.22	Wastewater Generation	C3-40
3.23	List of Additional Mining Equipment and Noise Levels	C3-41
3.24	Noise Level – Beneficiation Plant	C3-42
3.25	Solid Waste Generation	C3-42
3.26	Chemical Analysis of Tailings – Existing Status	C3-43
4.2.1	Salient Features of Existing Surface Water Projects	C4-2
4.2.2	Hydrological data of key wells monitored during 2006	C4-9
4.2.3	Details of the Observatory Wells in the Study Area	C4-11
4.2.4	Ground Water Levels in the Study Area	C4-12
4.3.1	Summary of the Meteorological Data Monitored by HZL at Site	C4-13
4.3.2	Summary of the Meteorological Data at Site by Vimta	C4-13
4.3.3	Yearwise Rainfall Recorded at RA Mines	C4-14
4.3.4	Summary of Wind Pattern at the Study Area	C4-15
4.3.5	Climatological Data Generated at IMD Station, Ajmer	C4-17
4.3.6	Summary of Wind Pattern	C4-17
4.3.7	Percentage Frequencies Ground Based Inversion	C4-26
4.3.8	Percentage Frequencies Elevated Inversions	C4-27
4.4.1	Details of Ambient Air Quality Monitoring Locations	C4-31
4.4.2	Techniques used for Ambient Air Quality Monitoring	C4-35
4.4.3	Summary of Ambient Air Quality Results - Winter 2008	C4-37
4.4.4	Summary of Dustfall Rates	C4-38
4.4.5	Stack Monitoring Results	C4-38
4.5.1	Details of Water Sampling Locations	C4-44
4.5.2	Analysis Results for Ground Water	C4-45
4.5.3	Analysis Results for Surface Water	C4-46
4.5.4	Mine Water Analysis Results	C4-48
4.6.1	Details of Sampling Locations	C4-53
4.6.2	Soil Analysis Results – Winter	C4-56
4.6.3	Standard Soil Classification	C4-57
4.6.4	Soil Quality Monitored by HZL for the year 2008	C4-58
4.6.5	Soil Quality Monitored by HZL for the year 2008	C4-58
4.7.1	Details of Noise Monitoring Locations	C4-62
4.7.2	Ambient Noise Levels	C4-63
4.7.3	Ambient Noise Levels	C4-64
4.8.1	Traffic Count	C4-65
4.9.1	Details of Forestland in Study Area	C4-68
4.9.2	Details of Terrestrial Ecological Sampling Locations	C4-68
4.9.3	Classwise Distribution of Plant Species in the Study Area	C4-71
4.9.4	Comparison of Biological Spectrum with Regional Scenario	C4-71
4.9.5	Floristic Richness and Species Diversity Indices	C4-77
4.9.6	Trace Mental Concentrations in Earth Crust	C4-78

List of Tables (Contd..)

Tables #	Title	Page #
4.9.7	Lit of Plant Species for Heavy Metal Analysis	C4-81
4.9.8	Concentration Lead in Leaves Study Area	C4-83
4.9.9	Concentration Cadmium in Leaves Study Area	C4-83
4.9.10	Concentration Zinc in Leaves Study Area	C4-83
4.9.11	Concentration Copper in Leaves Study Area	C4-83
4.9.12	Concentration Iron in Leaves Study Area	C4-84
4.9.13	Concentration Manganese in Leaves Study Area	C4-84
4.9.14	List of Birds Observed at All Sampling Locations	C4-86
4.9.15	List of Butterflies Observed at All the Sampling Locations	C4-87
4.9.16	Mammals Recorded in the Study Area	C4-87
4.9.17	Amphibians and Reptiles in the Study Area	C4-88
4.9.18	Fauna and their Conservation Status in the Study Area	C4-89
4.9.19	Plants and Animals Recorded in Rampura Agucha Mines	C4-90
4.9.20	Plants and Animals Recorded Colony and Its Environs	C4-91
4.9.21	Details of Greenbelt	C4-92
4.10.1	Landuse Pattern in the Study Area	C4-97
4.10.2	Details of Predominant Cropping Pattern	C4-100
4.11.1	Distribution of Population in Study Area – 2001	C4-103
4.11.2	Distribution of Population by Social Structure – 2001	C4-104
4.11.3	Distribution of Literates and Literacy Rates – 2001	C4-104
4.11.4	Occupational Structure – 2001	C4-105
4.11.5	Educational Facilities in the Study Area	C4-106
4.11.6	Health Facilities in the Study Area	C4-106
5.1	Emission Factors in gm/km/vehicle	C5-8
5.2	Emission Factors for Vehicular Impact Predictions	C5-11
5.3	Total Traffic After Expansion near RA Mine Gate	C5-11
5.4	Peak Hourly Prediction Incremental Concentrations	C5-12
5.5	Pre-Project Water Quality (Khari River Basin)	C5-15
5.6	Pre-Project Water Quality (Mansi River Basin)	C5-15
5.7	Post-Project Water Quality (Khari River Basin)	C5-16
5.8	Post-Project Water Quality (Mansi River Basin)	C5-17
5.9	Year Wise Schedule of Overburden dumping for the Plan Period is given as Below	C5-18
5.10	List of Environmental Studies on Impact of Tailing Dam	C5-22
5.11	Yearly Generation of Topsoil for Proposed Plan years	C5-26
5.12	List of Additional Mining Equipments and Noise Levels	C5-28
5.13	Noise Due to Beneficiation Plant	C5-31
5.14	Predicted Noise Levels at Plant Boundary	C5-31
5.15	Existing and Proposed Traffic on National Highway	C5-34
5.16	Recommendations on Traffic Capacity	C5-34
6.1	Yearwise Handling of Overburden Waste	C6-9
6.2	Recommended Plantation Species for Waste Dumps and Peripheral Plantations	C6-14
6.3	Proposed Plantation Schedule	C6-15
6.4	Proposed Yearwise Greenbelt Development Progrram	C6-17
6.5	List of Projects Undertaken	C6-18
6.6	Monitoring Schedule for Environmental Management	C6-21

List of Tables (Contd..)

Tables #	Title	Page #
6.7	Budgetary Allocation for Pollution Control	C6-25
6.8	Proposed Plantation Schedule	C6-26
6.9	Proposed year wise Greenbelt Development Program	C6-26
7.1	Category-wise Schedule of Storage Tanks	C7-5
7.2	Properties of Fuel/Chemicals used at the Plant	C7-5
7.3	Applicability of GOI Rules to Fuel/Chemical Storage	C7-5
7.4	Fire Explosion and Toxicity Index	C7-7
7.5	Fire Explosion and Toxicity Index for Storage Facilities	C7-7
7.6	Preliminary Hazard Analysis for Process and Storage Areas	C7-10
7.7	Preliminary Hazard Analysis for the whole Plant in General	C7-11
7.8	Damage due to Incident Radiation Intensities	C7-15
7.9	Radiation Exposure and Lethality	C7-15
7.10	Distance of Occurrence of Various Thermal Radiation Intensities	C7-16
7.11	Distance between Storages	C7-21
7.12	Fire Hydrant Points in the Exiting Plant	C7-35
8.1	Proposed Plantation Schedule	C8-2
8.2	Tentative Closure Schedule	C8-5
8.3	Final Mine Closure Tentative Cost	C8-6
8.4	Conceptual Mine Closure Plan	C8-8

1.0 INTRODUCTION

1.1 Background

Hindustan Zinc Limited today is one of the top six global companies. Hindustan Zinc Limited (HZL) is the only integrated Lead & Zinc manufacturer in India and owns captive Lead and Zinc mines that supply complete requirement of Lead and Zinc concentrate for its smelters. HZL operates mechanized open cast mine at Rampura Agucha as well as underground Mines at Rajpura Dariba and Zawar Mines in the state of Rajasthan with state of the art technology. HZL is having Lead-Zinc mining, smelting and marketing operation, with a capacity of 7.13 Mtpa ore production and matching beneficiation facilities. The smelting capacity stands at 0.74 (0.67 Mtpa for Zinc and 0.085 Mtpa for Lead metal and associated by-products i.e. Cadmium, Silver, Sulphuric acid etc.

Rampura Agucha is presently having mining and beneficiation capacity of 5.0 Million Tonnes Lead Zinc ore. The smelters are situated at Chanderiya, Debari and Visakhapatnam and the mines are situated at Zawar, Dariba.

Rampura-Agucha Mine is an ISO 9001, ISO 14001 & OHSAS 18001 and SA-8000 certified unit. Commissioned in the year of 1991 and it is located in Bhilwara district at 225-km North of Udaipur (Rajasthan). This open cast mine is having a world class deposit with good mineralogy leading to higher recovery and resultant low cost of production. The present capacity of the mine is 5.0 Mtpa ore production and beneficiation plant to produce zinc and lead concentrates of 53-54% and 60-65% respectively.

1.2 Significance of the Project

Due to liberalization and in an globalization scenario the Indian lead and zinc industry has changed from a protected administered price scenario to a globally competitive industry. The rising trend of Indian economy has increased growth and also the continuing boom in manufacturing and in steel production coupled with the growth in automobile industries in particular has raised demand for base metals.

- ***Lead Metal***

Of the global lead metal production of 755000 Million Tonnes in 2007-08, India's share stands at 59000 Million Tonnes. With the commissioning of Ausmelt lead plant at Chanderia (HZL) with an annual capacity of 0.05 Mtpa the supply demand deficit is bridged partially. The capacity expansion plans of HZL are in the line. It is planned to set up 0.125 Mtpa capacity lead smelter in Rajpura Dariba.

India is poor in lead resources with no viable lead mines and thus limited availability of lead concentrates is a major inhibiting factor both for capacity expansion in existing smelters and for establishing new primary smelters which warrants opening of new deposit.

- ***Zinc Metal***

The production of primary Zinc metal production in the country has increased from level of 175000 Tonnes in 1999-2000 to 669000 Tonnes in the year 2007-08. Further HZL is expanding its zinc metal production by installation of new smelter of 0.5 Mtpa at Rajpura Dariba by end of 2009.

In a report that compares India's economic growth with China, London-based analyst Matt Fernley (research firm USB Ltd) said India's appetite for materials, such as cement, mined copper and zinc, is exceeding its supply. "India's growing demand for copper and zinc concentrate is likely to further strain already tight supply/demand balances," Fernley said in the report. India's current zinc consumption per capita is about 2.5-kg, he wrote.

To fulfill the demand satisfaction, expansion of smelting capacity needs to be done by increasing constrained supply of concentrates through the mine needs the expansion of mine and beneficiation plant.

1.3 Objective of the Environmental Impact Assessment Studies

The mine was commissioned in the year 1991 with capacity of 0.9 Mtpa after obtaining the Environmental Clearance from MoEF, New Delhi. The capacity of the mine was increased from 0.9 Mtpa to 1.35 Mtpa for which HZL obtained the Environmental Clearance in 1999 vide letter no. J-11015/10/98-IA.II (M) dated 18/03/1999.

The ore production/treatment capacity was enhanced from 1.35 Mtpa to 3.7 Mtpa for which HZL obtained the Environmental Clearance in March 2005 vide letter no. J-11015/167/2004-IA.II (M) dated 01/03/2005.

The ore production and beneficiation capacity was enhanced from 3.75 Mtpa to 5.0 Mtpa for which HZL obtained the Environmental Clearance in July 2007 vide letter no. J-11015/367/2006-IA.II (M) dated 27/07/2007, a copy is enclosed as **Annexure-I**.

Further, exploration (Phase II) has proved that orebody extends up to a depth of 1065 m with mineralization still open at depth. Thus there is good potential to increase the mining capacity by open Pit as well as going underground to mine beyond Ultimate Pit Bottom. Presently mine has reached to a depth of 170 m (Current depth of Open Pit).

HZL is proposing to increase the mine production and ore treatment to a level of 6.15 Mtpa with corresponding increase in beneficiation capacity production from 5.0 Mtpa to 6.5 Mtpa. Expansion of ore beneficiation is planned to process the increased output. The total process capacity is planned for 6.5 Mtpa as against ore production of 6.15 mtpa from Rampura Agucha mine and additional ore of 0.35 Mtpa from Kayar underground Lead-Zinc mine project located in ajmer district 95-km from Rampura Agucha mine.

For the proposed expansion of the mine and beneficiation plant, HZL is seeking the Environmental Clearance.

Environmental Impact Assessment (EIA) studies have been conducted for proposed capacity expansion of the mine and beneficiation plant to 6.15 and 6.5 Mtpa respectively.

1.4 Environmental Impact Assessment Studies

In line with its Corporate Environment, Health and Safety Policy, HZL has been in forefront of adopting appropriate pollution control and environmental protection measures in all its operations. Environment Impact Assessment studies are undertaken for new projects to formulate Environment Management Plans for mitigating any possible environmental impacts.

M/s. VIMTA Labs Limited (VLL) Hyderabad, have been retained to carry out Environmental Impact Assessment (EIA) study and preparation of Environment Management Plan (EMP).

Reconnaissance survey of the region was carried out in the months of 1st December 2008 to 28th February 2009 and various sampling locations to monitor environmental parameters were identified. Subsequently, monitoring was carried out for meteorology, ambient air quality, surface water and ground water quality, soil characteristics, noise levels and flora and fauna at the specific locations. The other studies such as socio-economic profile, land use pattern etc. are based on secondary data collected from various government agencies and through primary surveys. The air monitoring locations have been selected based on the predominant wind directions recorded through meteorological data generated at IMD, Ajmer. The fieldwork to study all the above environmental attributes was conducted as per the guidelines specified by Ministry of Environment and Forests (MOEF), Govt. of India, New Delhi. This report includes the field data generated during winter season (1st December 2008 to 28th February 2009). In addition to this, data being monitored by HZL has also been incorporated. The geographical location of the project site is shown in **Figure-1.1**.

1.5 Site Selection

The capacity expansion will be carried out within the existing mine lease area. Being a site-specific project, alternative sites are not relevant.

1.5.1 General Description of the Project Area

The capacity enhancement/expansion of the mine and the beneficiation plant will be restricted within the mining lease area.

Location co-ordinates of the existing mine are 25° 50' 00" North Latitude and 74° 44' 15" East Longitude. The altitude of the site is about 390 m above Mean Sea Level (MSL). Geographically, the study area is covered by Survey of India (SOI) Toposheets No. 45 K/9 and 45 K/13. The study area of the mine/plant location is shown in **Figure-1.2.**

Rampura-Agucha mine is located on a flat plain approximately mid-way between Udaipur and Jaipur. The gradient is generally from west to east but locally slopes

decrease in elevation to the north and south. The mine area is located 9-km away from Gulabpura in Southeast direction and is well connected by an all weather road. Gulabpura is located about 67-km away from Bhilwara and 72-km from Ajmer on Bhilwara-Ajmer section of NH-79. Gulabpura and Rupaheli are the nearest meter gauge railheads, located about 9-km and 10-km from the mine respectively. Gulabpura and Bijainagar towns are also connected with a meter gauge rail line on Western Railway linking Ajmer and Khandwa via Chittorgarh. The airports at Dabok near Udaipur and at Sanganer near Jaipur are the nearest airports at distances of approximately 200-km and 225-km respectively.

The main road connecting Jaipur and Udaipur runs parallel to the railway line in this region. This main road has recently been expanded to four-lane double carriageway. The mine site is at the end of a single lane metal road between Gulabpura and Agucha. To avoid the town of Gulabpura and Hurda, a double-track metal road passing through Rupaheli has been built from Rampura-Agucha to connect NH-79 about 10-km south of Gulabpura town. Within the 10-km radius of the mine, another single lane metal road connects Gulabpura and Shahpura. This road runs NNW-SSE, North of the site through village of Kothiyan. There are numerous non-metalled tracks connecting the villages around the mine site. Most of the tracks are traversable by motor vehicles.

The Industrial center nearest to the mine area is at Gulabpura hosting a textile factory and is the major industrial employer at present in the vicinity of the mine.

The main occupation in the region is agriculture. Crops are primarily rain fed during the monsoon with predominantly single crop per year. The majority of crops are grown for local consumption. The land surrounding the mine area falls under the category of fallow land during the winter and pre-monsoon period.

The area is drained by presence of seasonal Khari and Mansi rivers, which are located in the north and south of the mine site respectively. Both the rivers meet near Phuliya village 20-km northeast of the mine. The earth bunds are constructed by local villagers to retain surface runoff water during the monsoon season. The stored water is used for agricultural and domestic purposes. One such tank in the area is Agucha tank, which has a storage capacity of 4.5 Million m^3. A dam is constructed across Mansi river near Arwar village with two feeder canals.

The area is classified as semi-arid region, which is characterized by high temperatures in the months of April to October. Rainfall occurs predominantly during the monsoon between June and September months.

The area does not host any major archaeological monuments, national parks and biosphere reserves except for few small temples.

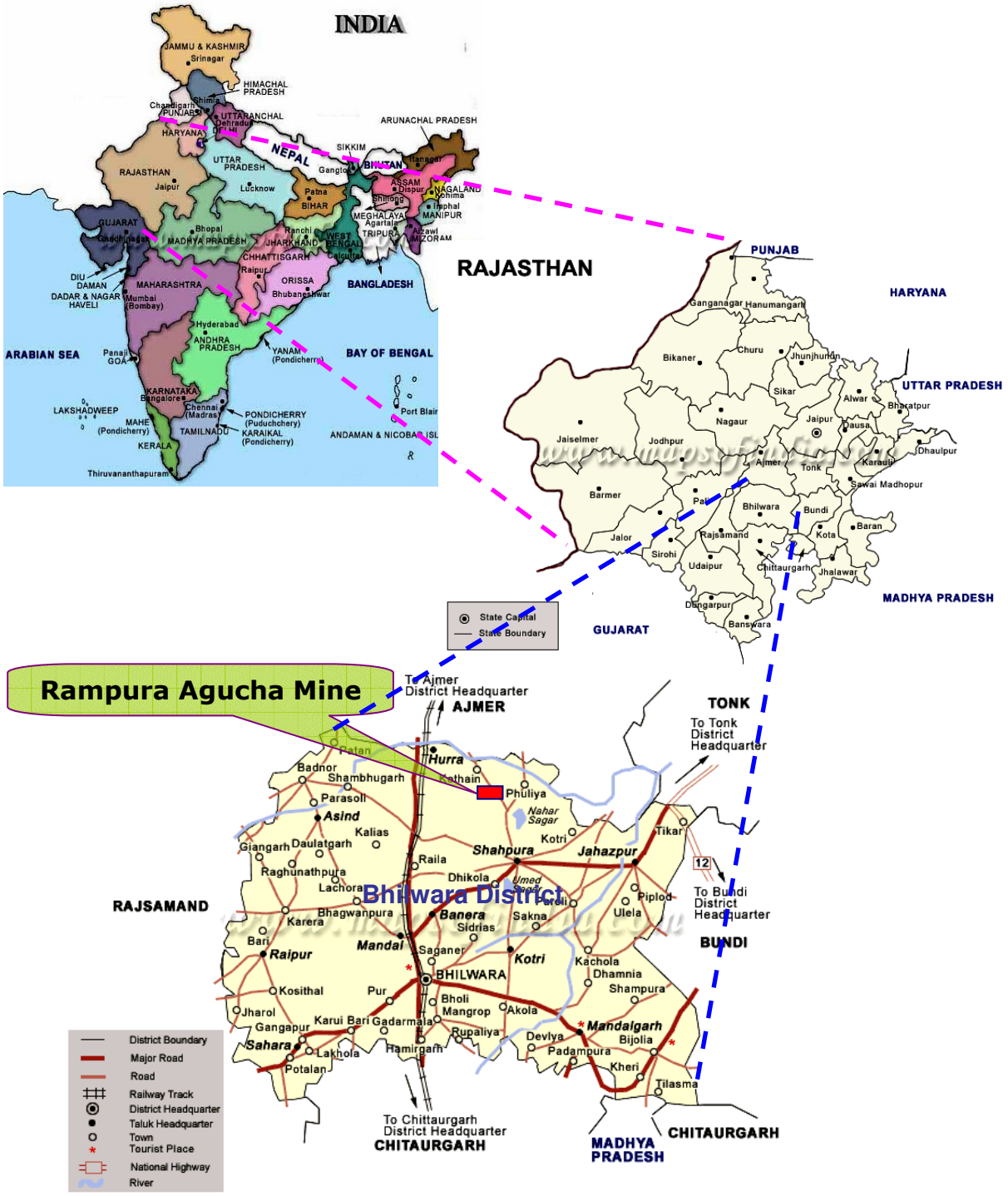


FIGURE-1.1
GEOGRAPHICAL LOCATION OF THE MINE SITE

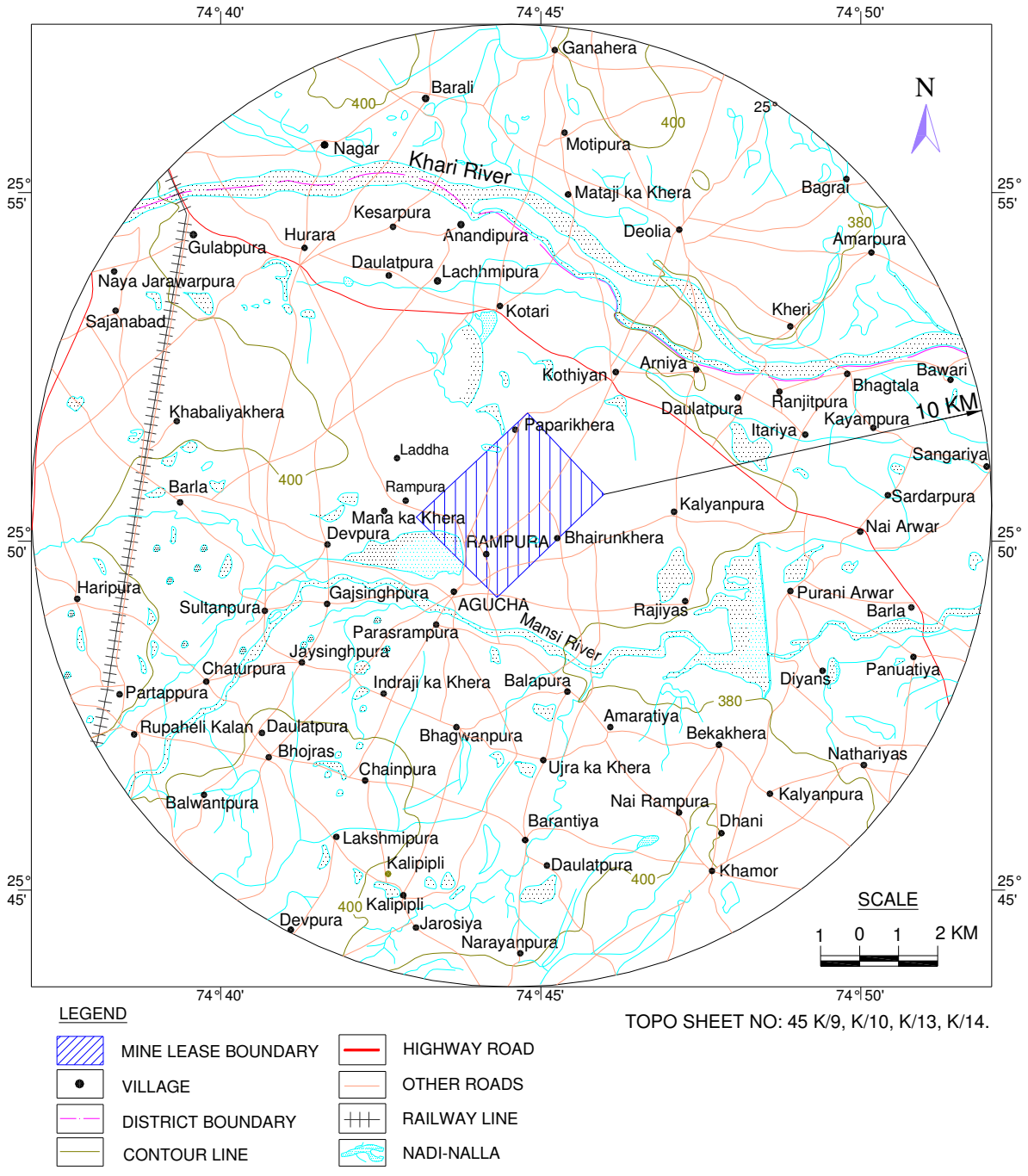


FIGURE-1.2
STUDY AREA MAP (10-KM RADIUS)

1.5.2 Project Philosophy

1.5.2.1 Opencast Operations

The estimated ore reserves as on 01.04.2009 is 118.76 million Tonnes, out of which 43.03 million Tonnes are amenable to opencast mining up to a depth of below 372-m.

The present proposal is to accelerate the rate of exploitation by enhancing capacity from 5.0 Mtpa to 6.15 Mtpa to reach the ultimate economic pit depth and for expansion of beneficiation capacity from 5.0 to 6.5 Mtpa. The Environmental Clearance is for the opencast mining phase which is likely to continue up to 2018-19 and for commencement of production from underground mine from 2011-12.

1.5.2.2 Underground Operations

The mineralized resource below the open pit at Rampura Agucha mine has very good potential for underground operation. R.A.Mine has carried out conceptual underground study from M/s SRK, UK and AMC Australia independently. The deposit has potential of producing 2.0-2.4 Mtpa as well as it is possible to carry out concurrent mining in open pit as well as underground. Accordingly the infrastructures will be developed. The mining will be "Stoping with backfilling" and will be a Trackless mining system. The proposed underground layout is conceptualized for:

- Approach to the deposit below Ultimate Pit by a Decline and a Shaft from surface;
- Footwall drives at safe distance (about 30-40m) from ore body. Footwall drives to be connected to Decline and Shaft;
- A production Shaft equipped with Winder;
- Two ventilation shafts one each at south & north ends of ore body; and
- First block of 200m vertical depth below Ultimate Pit bottom, proposed for commencement of production. Subsequent blocks to be developed as the mining advances.

Underground will deliver ore production of 2 - 2.4 Million Tonnes/year and based on the current reserve/resource potential of 75.73 Million Tonnes (including reserves of 7.01 Million Tonnes) the approximate mine life of 30 years is expected.

1.5.2.3 Progressive Environmental Clearance Process

The application for Prior Environmental Clearance (Form-1) has been submitted to MoEF for approval of Terms of Reference and the proposal was considered by the Expert Appraisal Committee during its meeting held during November 19th to 21st 2008, for determination of the Terms of Reference (TOR) for preparation of the EIA report. The committee has suggested specific Terms of Reference (TORs) for preparation of the EIA report and EMP vide it's letter no. J-11015/267/2008-IA.II (M) dated 22nd December, 2008 and is enclosed as **Annexure-II**.

1.5.2.4 Compliance Status

Rampura Agucha Mine is operating at the sanctioned capacity of 5.0 Mtpa of ore extraction and beneficiation. The Environmental Clearance was granted on 27th July 2007. The Consent Letter to operate under Air and Water Acts, have been renewed from time to time, Ref. Letter No: F: 12(8-109) /RPCB/GR.MINE /4865 dated 23.10.2008 and valid up to 28.02.2010 and is enclosed **Annexure-III**. The valid authorization under HWM Rules (1989, 2003) is also available. A detailed compliance status of all the specific conditions under environmental clearance from Ministry of Environment & Forests is also provided along with approvals from Indian Bureau of Mines for the mining scheme of enhanced capacity and permission from Central Ground Water Authority for drawl of water for industrial and domestic use by the project. The copy of Compliance status-MoEF environmental clearance condition is enclosed as **Annexure-IV.** Approvals letter from Indian Bureau of Mines (IBM) and permission from Central Ground Water Authority is enclosed as **Annexure-V** and **Annexure-VI** respectively. The mine lease area does not come under Aravalli and a letter to this effect from the State Government of Rajasthan is enclosed as **Annexure-VII**.

1.5.3 Environmental Setting of the Project Area

The study area of 10-km radius from the periphery of the mine lease boundary is considered as buffer zone. For the study of reserve forest, wildlife sanctuary, biodiversity etc and archaeological monuments, study area of 25-km radial distance from the mine lease boundary is considered. There are no industries within 10-km radius of the mine lease boundary. The environmental setting of the site is given in the **Table-1.1.**

TABLE-1.1
ENVIRONMENTAL SETTING OF THE SITE

Sr. No.	Particulars	Details
1	Latitude	$25^0$50'00" N
2	Longitude	$74^0$44'15" E
3	Elevation above MSL	390 m
4	Climatic conditions (Based on previous site data monitored by HZL)	A] Annual Maximum Temp: 46.8 ^{0}C b] Annual Minimum Temp: 2.8 ^{0}C c] Annual Average Rainfall: 450-mm
5	Present land use at the expansion project site	Industrial
6	Nearest highway	Ajmer-Chittorgarh NH-79 (10-Km, W)
7	Nearest railway station	Gulabpura (9-Km, NW) and Rupaheli (10-Km, SW)
8	Nearest airport	Dabok (225-Km, SW) and Jaipur (200-Km, NE)
9	Nearest village	Bherukhera: 0.8-Km in East from mine pit
10	Nearest town/City	Bhilwara: 70-Km in South
11	Hills/valleys	Nil in the study area
12	Topography	Plain
13	Archaeologically important places/ Monuments	Nil in 10-Km radius of the mine site.
14	National Parks	Nil in 25-Km radius of the mine site.
15	List of Industries	Nil in 10-Km radius of the mine site.
16	Seismicity	The study area falls under Seismic Zone-II.
17	Water source	Water will be drawn from radial wells dug in Banas river bed (60-Km)
18	Streams/Rivers	Seasonal Khari (4-Km, North) Seasonal Mansi river (1.2-Km, South)

1.6 Evaluation of Industrial Development in the Study Area

This region is industrially backward area. There are no industries in the study area of 10-km. As a matter of fact, population in the study area mostly depends upon rain- fed agriculture and live stock for their livelihood. Educated and skilled people migrate to other places in search of better livelihood. The mine, which was started in 1991, had provided job opportunities to local population and has contributed to development of the region.

1.7 Infrastructure and Auxiliary Facilities

The necessary infrastructure like power, drinking water, transportation, colony, school and telecommunication are available.

Buses of Road Transport Corporation and some private buses ply from Gulabpura to mine area and further ahead to Agucha village. HZL has hired five buses for employees, which ply between mine and township as per the shift timings. Gulabpura is the nearest town for shopping and for any other needs.

Unskilled laborers are available from the nearby villages for about 8-9 months in the year as they are engaged in agriculture in the remaining months.

The power is supplied from Captive Power Plant of HZL located at Chanderia Lead Zinc Smelter (CLZS), Chittorgarh by wheeling through state grid of Ajmer Vidyut Vitran Nigam Limited (AVVNL). The allocated power from AVVNL is standby arrangement. The operation of the existing DG sets will be restricted to emergency purpose only.

1.8 Land Requirement

HZL possess mining lease of about 1200 ha of land, of which 869.5 ha of land is utilized for mining project. The proposed expansion is planned in the existing premises and acquired mining lease only. Additional land proposed to be acquired is 155-ha.

1.9 Salient Features of the Project

1.9.1 Project Details

The salient features of the proposed capacity expansion of the mine and beneficiation plant are given in **Table-1.2**.

TABLE-1.2
SALIENT FEATURES OF PROJECT

Sr.No.	Parameter	Description
I	**Mining Project**	
1	Total Ore Reserves	118.76 Million Tonnes (as on 1/4/2009)
2	Mineable through opencast mining	43.03 Million Tonnes (as on 1/4/2009)
3	Zinc in ore	13.90 %
4	Lead in ore	2.0 %
5	Total Mine Lease Area	1200 ha
6	Additional ML	Nil
7	Lease Period	20 years
8	Date of Expiry of Lease	13-03-2020
9	Present Capacity of Mine	5.0 Million Tonnes/Annum ore production
10	Capacity after proposed expansion of Mine	6.15 Million Tonnes/Annum
11	Overall Stripping Ratio	1:10.8
12	Method of Mining	Opencast and underground method
II	**Beneficiation Plant**	
1	Existing Capacity	5.0 Mtpa
2	Proposed Capacity	6.5 Mtpa
3	Power Requirement of the Beneficiation plant and Mine (together)	30 MW (at Present) 50 MW (after proposed expansion)
4	Water Requirement (For Mines and Beneficiation plant together)	Present water requirement is 8500-m^3/day and additional fresh water required after expansion is 3200-m^3/day Total - 11700-m^3/day
5	Water Source	Radial wells in the bed of Banas river (60-km)

1.9.2 Brief Description of Mining and Beneficiation Plant

Open pit mining method with an overall stripping ratio of 1:10.8 is being used at Rampura-Agucha Mine. Drilling and blasting followed by loading, transportation and unloading of ore/waste rock are involved in the process of mining. These operations are fully mechanized.

Mined ore is crushed in three stages followed by two-stage grinding in close circuit with hydro-cyclones for classification. The classified slurry is subjected to differential froth flotation for separation and concentration of lead and zinc mineral in their respective concentrates. The concentrates are dewatered and filtered before dispatching to smelters for metal extraction.

In the current year of mining i.e., 2008-09 (till the end of March, 2009), ore production of 4.95 Million Tonnes and total excavation of 40.97 Million Tonnes has been achieved, with a strip ratio of 1:7.3.

Rampura-Agucha Mine is an ISO 9001, ISO 14001 & OHSAS 18001 and SA-8000 certified unit. The mine has also got 5-S Certified (TPM) and has obtained four star rating by British Safety Council. Presently mining at Rampura Agucha Mine is being carried out as per approved modified mining plan, vide letter no. 584(6) (3) (268)/2006-AJM, dated 02.11.2006 (under Rule 10 of MCDR 1988).

HZL is proposing to expand the production capacity of the mine and ore treatment to a level of 6.15 and 6.5 Mtpa respectively.

For the proposed expansion, some of the existing equipment and facilities will be used after modification and up-gradation and then the balance required equipment would be installed. Best available technologies would also be adopted for achieving the optimum metallurgical performance and the lowest operating cost. This covers details of the existing plant transformation to achieve the capacity expansion.

1.9.3 Existing and Proposed Mitigation Measures

1.9.3.1 Air Emissions Control

- ***Existing Mitigation Measures***

Various mitigation measures are adopted in the existing mining and beneficiation plant to control the air pollution.

- Track mounted DTH drills with wet drilling system are being used for drilling;
- The production of blast fumes containing noxious gases are reduced by the following methods;
  - Proper mixing of Site Mixed Slurry (SMS) to ensure complete detonation.

0

  - Use of adequate booster/primer.
  - Proper stemming of the blast holes.
  - Use of electrical/non-electrical initiation system.
- A well-equipped workshop is set up for the regular maintenance of vehicles and machineries in order to control emissions. Air Conditioned Cabins are provided to shovel and dumpers to protect the operator from the direct exposure to dust and gaseous emissions;
- Water spray nozzles are provided at crusher, and the locations where enclosure and fugitive dust collection is difficult;
- The primary, secondary and tertiary crushers are provided with wet venturi scrubber to collect the dust while crushing the ore. The scrubbed slurry is pumped to grinding for disposal within the process. Sampling ports are provided for source emission monitoring purpose.
- The dust on the haul road is suppressed by automatic water sprinklers system installed at permanent haul roads and by three water sprinklers of 28-m^3 and two 40 KL capacity each. The haul road is maintained by two motor graders. In addition, an automatic water sprinkling system has been installed on permanent haul roads. The frequency of water sprinkling is once every hour during summer and once every two hours during other seasons like winter and post-monsoon season. The frequency has been increased and will be extended as per the mine development;

- The exhaust of all the earth moving machinery is directed upwards to prevent dust entrapment;
- Truck tyre washing system is installed near the weigh bridge to wash out the concentrates attached to wheels of the truck;
- Cleaning of Industrial roads by Mechanical Road Sweeper;
- The conveyor belts are covered to prevent dust losses into atmosphere;
- The moisture content of 7 % to 8% in the concentrates is maintained to prevent dust generation during loading and transportation. The concentrate carrying trucks are covered with tarpaulins from top and sides;
- Ambient Air quality monitoring is regularly conducted at three locations within the mine area and three locations in nearby villages. Stack emissions are also regularly monitored;
- The Eco-Plan was prepared in the year 1988-89 for the Greenbelt development and the same is meticulously implemented covering 260 ha of land out of 869.5 ha. Till date more than 2,72,000 saplings have been planted in the existing mine and colony with survival rate of more than 80%;
- Truck/ tyre washing system will be installed near the concentrate stock yards for washing of concentrate sticking on truck tyres;
- In order to control dust generation during blasting, drill cuttings have been removed before the blasting operation;
- The over burden is dumped by giving less aerial lift and grading is done by gradual dozing. This helps in reduction of dust generation on the waste dumps while dumping the waste;
- Water sprays are sprayed on coarse ore stock piles for reducing dust generated during fall of ore from the tripper conveyors;
- Venturi scrubber is installed in the proposed primary crusher to control dust emissions; and
- The concentrate carrying trucks should be covered with tarpaulin to prevent any possibility of dust generation as per the present practice.

➢ ***Proposed Mitigation Measures***

The mitigation measures adopted in the existing mine to control air pollution will be continued in the proposed expansion project also. The plantation in the mine area shall be improved by planting more trees in vacant areas. The following additional measures are proposed:

- Increasing the frequency of the water sprinkling on haul roads ;

- Additional plantation on waste dumps and near tailing dam shall be carried out and year wise schedule for plantation has been prepared for plantation on overburden dump and in mine area. It is envisaged to plant about 14000 plants in 17.4 ha on overburden dumps and about 19000 plants in 23-ha of land as peripheral plantation in the mine area from 2008-09 to 2012-2013; and

- Additional truck / tyre washing system will be installed near the concentrate stockyards for control of dust pollution.

1.9.3.2 Water Pollution Control Measures

➢ ***Existing Mitigation Measures***

- Plant tailings are discharged in tailing dam, tailing water is collected and pumped back to beneficiation plant for reuse in process;

- Mine water is pumped to reclaim water reservoir and gets recycled;

- All spillages, overflows and other wash streams from the industrial area are collected and pumped to reclaim water reservoir for recycling;

- Run-off water from waste dump area is collected during monsoon and pumped to reclaim water reservoir;

- Oil and grease trap is used for collecting oil & grease from Heavy Vehicle Service Center (HVSC) effluents;

- Sewage Treatment Plant having capacity of 425 KL/day is being installed in HZL township and 300 KL/day at mine to treat domestic wastewater; and

- A reservoir of 50000 m^3 was constructed near beneficiation plant to collect and recycle water from tailing dam, mine and other areas for reduction of evaporation losses in tailing dam.

- Improved dumper cleaning system at Heavy Vehicle Service Center (HVSC) including oil trap;

- Sewage Treatment Plants in the industrial area with provision for recycling of treated effluent to increase the water recovery and reduce the fresh water consumption;

- High rate thickeners to improve the water recovery from tailing and concentrates; and

- Flocculants in the thickeners to improve water recovery.

As a result of these measures, an effective zero discharge is maintained from the mine premises. As a part of the improvement measures, recently, a system for tailing dewatering through hydro-cyclones has been commissioned to increase the water recovery from tailings before disposal to tailing dam.

Water quality is being monitored at various locations within and outside the mine area and is observed to be unaffected by mining activities.

- ***Proposed Mitigation Measures***

The existing measures adopted in the mine will be continued in the proposed capacity expansion project. The additional measures recommended are;

- Improvements in dumper cleaning system at HVSC including oil trap;
- A reservoir of 20,000 m^3 was constructed near beneficiation plant to collect and recycle water from tailing dam and other areas for reduction of evaporation losses in tailing dam;
- High rate thickeners will be installed to improve the water recovery from tailing and concentrates; and
- Use of flocculants in the tailing thickeners to improve water recovery.

1.9.3.3 Mitigation Measures for Noise

- ***Existing Mitigation Measures***

Adopted mitigation measures for noise and ground vibrations are of following types:

- Well equipped workshop is set up for the regular maintenance of vehicles and machineries in order to reduce noise generation;
- Steel liners in Ball mill are replaced by Rubber liners;
- Dumpers & excavators are provided with A. C. enclosures;
- Boundary walls (Baffle walls), waste banks and dense belt of trees are erected as acoustic barriers;
- Noise is abated at source by suitable mounting of equipment and ventilation systems and by providing noise enclosures or padding wherever necessary;
- Blasting is performed strictly as per the DGMS guidelines such as blasting during day hours between 2 PM to 3 PM when temperature inversions are unlikely and blasting is avoided during high wind conditions;
- Over charging is avoided;
- Excavators & dumpers supplier has to demonstrate the noise level below 85 dB (A) inside the cabin and they have to maintain the equipment in good health for 5 years;

- Air over pressure is controlled effectively in each and every round of blast by using non-electrical initial system;
- The charge per delay and total charge is minimized and preferably more number of delays are used per blast; and
- Greenbelt is developed in and around the mine area to intercept noise transmission. A 30-40 m wide belt of trees of different heights are useful to act as noise attenuator in the mining areas.

➢ ***Proposed Mitigation Measures***

In addition to the existing mitigation measures, following additional measures are proposed:

- Avoiding secondary blasting by using rock breaker;
- Equipments to be procured will have the noise emission optimal for their design/operation. Proper maintenance/working will be done to keep the equipment in good health;
- Further upgraded technology of the blasting will be undertaken to further reduce the blast-induced noise and vibrations; and
- Further improving the existing greenbelt by planting more trees in the vacant area and increasing the vegetation density to attenuate the noise level.

1.9.3.4 Solid Waste Management

The solid waste is systematically stacked at waste dump having 4 x 10 m lifts with ultimate height of 40-m and with an overall slope of 27^{o}.

➢ ***Existing Mitigation Measures***

- Overall slope of 27^{o} and maximum height of 40-m is maintained to give proper stability to the dump;
- Waste is stacked systematically in layers and leveled by dozer;
- After reaching the benches to their ultimate location, plantation is being done;
- Construction of garland drains around the dump so that surface run off from the dump is collected in a sump and pumped to tailing dam;
- Regular maintenance of the garland drains constructed around the solid waste dump to collect the surface run off;
- Stabilization of the dump by soil cover and vegetative plantation is under progress; and

- Efficacy of the protection measures is monitored by means of monitoring wells downstream of the dump.

➢ ***Proposed Mitigation Measures***

In the proposed capacity expansion project, the overburden generated will be continued to be systematically stacked in the existing waste dumps. Existing measures will be continued and in addition, the plantation will be done as and when area is available on the dump. Additional garland drains will be constructed for the effective collection of the run-off water.

1.9.3.5 Green Belt

- About 2,72,000 number of trees have been planted in the mine area and about 35,000 trees have been planted in the colony area;
- The survival rate has been observed to range from 80-90%;
- Area covered under green belt is 260 ha (246.22 ha in industrial area + 33.5 ha in the colony area) till 2008-09; and
- During the proposed expansion programme, additional total greenbelt of 33,000 plants will be planted in phased manner on overburden dumps and mining area.

The schedule of the plantation is given in **Table-1.3** and **Table-1.4.**

TABLE-1.3
PROPOSED PLANTATION SCHEDULE ON OVERBURDEN DUMP

Year	Area (ha)	No. of Trees
Plantation on Overburden Dump		
Year 1 (2008 – 2009)	0	0
Year 2 (2009 – 2010)	0	0
Year 3 (2010 – 2011)	4.8	3900
Year 4 (2011 – 2012)	4.7	3800
Year 5 (2012 – 2013)	7.9	6300
Total	**17.4**	**14000**

TABLE-1.4
PROPOSED YEAR WISE GREENBELT DEVELOPMENT PROGRAM

Year	Area (ha)	No. of Trees
2008 – 2009	2.0	2000
2009 – 2010	3.0	3000
2010 – 2011	5.0	4000
2011 – 2012	5.0	4000
2012 – 2013	8.0	6000
Total	**23.0**	**19000**

1.10 Administrative and Legislative Requirements

The principal Environmental Regulatory agency in India is the Ministry of Environment and Forests (MoEF), New Delhi. MoEF formulates environmental policies and accords environmental clearance for the projects.

The standards for various environmental attributes as applicable to the industry are presented in **Annexure-VIII.**

1.11 Scope of the Present Study

The study covers an area of 10-km radius from the mine lease boundary. The mine lease area is considered as core area and the 10-km radius from the mine lease boundary is considered as buffer zone for this study. The scope of the study broadly includes:

- Literature review to collect data relevant to the study area;
- Environmental data viz. ambient air quality, water quality, noise levels and soil quality monitored by HZL;
- Environmental monitoring to compare with the environmental data generated by HZL so as to establish the baseline environmental status of the study area;
- Predict incremental levels of pollutants in the study area due to the proposed expansion;
- Evaluate the predicted impacts on the various environmental attributes in the study area by using scientifically developed and widely accepted Environmental Impact Assessment Methodologies;
- Prepare an Environment Management Plan (EMP) outlining the measures for improving the environmental quality and scope for future expansions for environmentally sustainable development; and
- Identify critical environmental attributes required to be monitored.

The literature review includes identification of relevant articles from various publications, collection of data from various government agencies and other sources.

1.12 Methodology of the Study

Reconnaissance survey was conducted by Vimta Labs Limited, Hyderabad along with officials of HZL and sampling locations were identified on the basis of:

- The predominant wind directions in the study area recorded by Hindustan Zinc Limited, RA mine and India Meteorological Department (IMD) at Ajmer;

- Topography, location of surface water bodies like ponds, canals and rivers;
- Location of villages/towns/sensitive areas;
- Accessibility, power availability and security of monitoring equipment, pollution pockets in the area;
- Areas which represent baseline conditions; and
- Collection, collation and analysis of baseline data for various environmental attributes.

To determine existing conditions of various environmental attributes, field studies have been conducted during 1st December 2008 to 29th February 2009 covering winter season. The scope also includes all the conditions outlined in the TOR issued by MoEF vide letter No. J-11015/267/2008-IA.II (M) dated 22nd December, 2008. The list of TOR conditions and their references in the EIA report is given in **Table-1.5.** Environmental attributes and frequency of monitoring are outlined in **Table-1.6**.

TABLE-1.5
LIST OF TOR CONDITIONS AND THEIR REFERENCE IN EIA REPORT

Sr. No.	TOR Conditions	Reference in EIA Report	
		Chapter and Sections	Page No.
1.	Year-wise production details since 1994 onwards and clearly stating the highest production achieved in any one year prior to 1994. It may also be categorically informed whether there had been any increase in production after the EIA Notification, 1994 coming into force w.r.t. the highest production achieved prior to 1994.	Chapter-3, Section-3.3.8	C3-5
2.	All documents including approved mine plan, EIA and public hearing should be compatible with one another in terms of the production levels, waste generation and its management and mining technology.	Shall be complied	
3.	The study area will comprise of 10 km zone around the mine lease from lease periphery and the data contained in the EIA such as waste generation etc. should be for the life of the mine / lease period.	Chapter-5, Section-5.10	C5-16 to C5-27
4.	Land use of the study area delineating forest area, agricultural land, grazing land, wildlife sanctuary and national park, migratory routes of fauna, water bodies, human settlements and other ecological features.	Chapter-4, Section-4.10	C4-96 to C4-101
5.	Land use plan of the mine lease area should be prepared to encompass pre-operational, operational and post operational phases.	Chapter-3, Section-3.7.3	C3-32 & C3-33
6.	Details of the land for OB dump outside the mine lease, if any, such as extent of land area, distance	No dump outside the mine lease area	

Sr. No.	TOR Conditions	Reference in EIA Report	
		Chapter and Sections	**Page No.**
	from mine lease, its land use, R&R issues, if any should be given.		
7.	Status of forestry clearance for the forestland involved in the project, if any.	No forest land involved in the project	
8.	A confirmation duly authenticated by the competent authority in the State Government to the effect whether the project falls in Aravalli and whether it is covered by the order of the Hon?ble Supreme Court dated 8.4.2005 in the contempt petition (c) 412/2004 in writ petition 202 of 1995 in the matter of Godavarman vs Union of India.	The mine lease area does not come under Aravalli, and a letter to this effect is enclosed as **Annexure-VII**.	
9.	Location of National Parks, Sanctuaries, Biosphere Reserves, Wildlife corridors, Tiger/Elephant reserves (existing as well as proposed), if any, within 10 km of the mine lease should be clearly indicated. A location map duly authenticated by Chief Wildlife Warden should be provided in this regard. Necessary clearance, if any, as may be applicable to such projects due to proximity of the ecologically sensitive areas as mentioned above should be obtained from the State Wildlife Department/ Chief Wildlife Warden under the Wildlife (Protection) Act, 1972 and copy furnished.	There are no National Parks, Sanctuaries, Biosphere Reserves, Wildlife corridors, Tiger/Elephant reserves, nor are proposed in the 10-km of the mine lease	
10.	A detailed biological study for the study area [core zone and buffer zone (10 km radius of the periphery of the mine lease)] shall be carried out. Details of flora and fauna, duly authenticated, separately for core and buffer zone should be furnished based on field survey clearly indicating the Schedule of the fauna present. In case of any scheduled-I fauna found in the study area, the necessary plan for their conservation should be prepared in consultation with State Forest and Wildlife Department and details furnished. Necessary allocation of funds for implementing the same should be made as part of the project cost.	Chapter-4, Section-4.9	C4-66 to C4-94
11.	Impact of change of land use particularly agriculture land and gaucher / grazing land, if any.	Chapter-5, Section-5.5	C5-5
12.	R&R plan / compensation details for the project affected people. While preparing the R&R plan, the National Rehabilitation & Resettlement Policy should be kept in view.	R&R studies are being carried out and shall be furnished alongwith the final EIA report.	
13.	Collection of one season (non-monsoon) primary baseline data on ambient air quality, water quality, noise level, soil and flora and fauna. Site-specific meteorological data should also be collected. The location of the monitoring stations should be justified. Date wise collected baseline AAQ data should form part of EIA and EMP report.	Chapter-4	
14.	Air quality modelling should be carried out for prediction of impact of the project on the air quality	Chapter-5, Section-5.6	C5-5 to C5-11

Sr. No.	TOR Conditions	Reference in EIA Report	
		Chapter and Sections	**Page No.**
	of the area. It should also take into account the impact of movement of vehicles for transportation of mineral. The details of the model used and input parameters used for modelling should be provided. The air quality contours may be shown on a location map clearly indicating the location of the site, location of sensitive receptors, if any and the habitation. The wind roses showing pre-dominant wind direction may also be indicated on the map.		
15.	The water requirement for the project, its availability and source to be furnished. A detailed water balance should also be provided. Fresh water requirement for the project should also be indicated.	Chapter-3, Section-3.7.4	C3-33 to C3-34
16.	Necessary clearance from the Competent Authority for drawl of requisite quantity of water for the project should be provided.	Chapter-3, Section-3.7.4, **Annexure -VI**	C3-33 to 34
17.	Details of water conservation measures proposed to be adopted in the project.	Chapter-6, Section-6.4	C6-6 to C6-7
18.	Impact of the project on the water quality both surface and groundwater should be assessed and necessary safeguard measures, if any required should be provided.	Chapter-5, Section-5.9	C5-13 to C5-16
19.	Based on actual monitored data, it may clearly be shown whether working will intersect groundwater. Necessary data and documentation in this regard may be provided. In case the working will intersect groundwater table, a detailed hydro geological study should be undertaken and report furnished.	Chapter-4, Section-4.2 Chapter-5, Section-5.8.3	C4-1 to C4-12 C5-12
20.	Details of first order stream, if any passing through lease area and modification/ diversion proposed, if any and the impact of the same on the hydrology should be brought out.	Chapter-5, Section-5.8.2	C5-12
21.	Details of rainwater harvesting proposed, if any, in the project to be provided.	Studies are in progress and the detailed report will be furnished alongwith final report	
22.	Information on site elevation, working depth, groundwater table should be provided both in AMSL and bgl. A schematic diagram may also be provided for the same.	Chapter-4, Section-4.2 Chapter-5, Section-5.8.3	C4-1 to C4-12 C5-12
23.	Quantity of solid waste generation to be estimated and details for its disposal and management be provided. Details of backfilling proposed, if any, should also be given. It may be clearly indicated that out of the total waste generation during the	Chapter-5, Section-5.10	C5-16 to C5-27

Sr. No.	TOR Conditions	Reference in EIA Report	
		Chapter and Sections	**Page No.**
	mine life, the quantity to be backfilled and the quantity to be disposed off in the form of external dump (number of dumps, their height, terraces etc.).		
24.	Impact of blasting during opencast working on underground working and vice-versa.	Chapter-5, Section-5.11.2, Section-5.11.3 **Annexure-IX**	C5-28 to C5-29
25.	The impact of accumulation of water in the open pit on underground working and the specific safeguard measures proposed in this regard along with their effectiveness.	Chapter-5, Section-5.8.3	C5-12
26.	Design of tailing dam including other parameters such as its height etc.	Chapter-5, Section-5.9.2	C5-13 to C5-16
27.	Adequacy of tailing dam for the entire life of the project.	Chapter-5, Section-5.10.1	C5-20 to C5-25
28.	Safety of tailing pond to ensure no breech and no overflow under maximum rainfall condition.	Chapter-5, Section-5.10.1	C5-20 to C5-25
29.	Chemical composition of the tailings.	Chapter-2, Section-2.3.4	C2-43
30.	Data on water quality monitoring in the wells near the tailing pond.	Chapter-4, Section-4.5.3	C4-44 to C4-52
31.	The proposed height of 100 m for the waste dump to be examined based on safety of the dump and details furnished.	Chapter-5, Section-5.10	C5-16 to C5-20
32.	Subsidence study to be carried out and details furnished along with proposed safeguard measures in this regard.	Studies are underway and the detailed report will be furnished alongwith final report	
33.	A note on acid mine drainage, its impact and related safeguard measures.	Chapter-5, Section-5.8.3	C5-12
34.	Details of Plantation with rate of plantation, species planted and their survival rate.	Chapter-6, Section-6.7	C6-10 to C6-17
35.	The reclamation plan, post mine land use and progressive greenbelt development plan shall be prepared in tabular form (prescribed format) and submitted.	Chapter-8	C8-1 to C8-8
36.	Impact on local transport infrastructure due to the project. Projected increase in truck traffic as a result of the project in the present road network (including those outside the project area) and	Chapter-5, Section-5.14	C5-33 to C5-34

Sr. No.	TOR Conditions	Reference in EIA Report	
		Chapter and Sections	**Page No.**
	whether it is capable of handling the increased load. Arrangement for improving the infrastructure, if contemplated including action to be taken by other agencies such as State Government, if any, should be covered.		
37.	Details of the infrastructure facilities to be provided for the mine workers.	Chapter-2, Section-2.2.28.5	C2-37
38.	Conceptual post mine land use and Reclamation and Rehabilitation of mined out area (with plans and with adequate number of sections).	Chapter-8, Chapter-6	C8-1 to C8-8 Figure-6.1
39.	Phase-wise plan of greenbelt development, plantation and compensatory afforestation clearly indicating the area to be covered under plantation and the species to be planted. The details of plantation already done should be given.	Chapter-6, Section-6.7	C6-10 to C6-17
40.	Occupational health impact of the project. Details of pre-placement medical examination and periodical medical examination schedules should be incorporated in the EMP.	Chapter-6, Section-6.8	C6-17 to C6-18
41.	Measures of socio economic influence to the local community proposed to be provided by project proponent. As far as possible, quantitative dimension to be given.	Chapter-6, Section-6.9	C6-18 to C6-19
42.	Detailed environmental management plan to mitigate the environmental impacts which, should inter-alia also include the impact due to change of land use, due to loss of agricultural land and grazing land, if any, besides other impacts of the projects.	Chapter-6, Section-6.2	C6-4 to C6-10
43.	Disaster Management Plan should be prepared to take into account the breech of tailing pond.	Studies are underway and the detailed report will be furnished alongwith final report	
44.	Public hearing points raised and commitment of the project proponent on the same along with time bound action plan to implement the same.	Public hearing is yet to be conducted.	
45.	Any litigation pending against the project and /or any direction /order passed by any Court of Law against the project, if so, details thereof.	There are no litigation pending against the project and /or any direction /order passed by any Court of Law against the project.	
46.	The cost of the project (capital cost and recurring cost) as well as the cost towards implementation of EMP should clearly be spelt out.	Chapter-6, Section-6.13	C6-25 to C6-26

In addition to this, data being monitored by HZL has also been incorporated.

TABLE-1.6
ENVIRONMENTAL ATTRIBUTES AND FREQUENCY OF MONITORING ADOPTED

Sr. No.	Attribute	Parameters	Frequency of Monitoring
1	Ambient air quality	TSPM, RPM, SO_2, NO_x, CO, Lead, Zinc and Cadmium	24 hours monitoring was carried out at 6 locations at a frequency of twice a week for three months covering winter season. CO samples are collected on 8 hour basis. Besides, this monitoring is carried out at five mobile locations with a frequency of once in a month.
2	Dustfall	Quantity of dustfall	One month during study period at four locations
3	Meteorology	Wind Speed and Direction, Temperature, Relative Humidity, Rainfall and other non instrumental observations like visibility, hail, thunder storms, dust storms, fog and smog.	a] Continuous for one season with hourly recording through setting up of site meteorological station; b] Data collected from secondary sources like IMD - Ajmer.
4	Water quality	Physical, Chemical and Bacteriological Parameters.	Once in a season at Thirteen locations.
5	Ecology	Existing terrestrial and aquatic flora and fauna.	Through field visits (once during study period).
6	Noise levels	Noise levels in dB(A).	Once during study at Ten locations (along with traffic study).
7	Soil characteristics	Soil profile, characteristics, soil type and texture, heavy metal, NKP value etc.	Once during field study at six locations.
8	Land use	Land use for different categories.	Based on data published in district census handbooks (2001 subjected to availability of the latest data),
9	Socio-economic aspects	Socio-economic characteristics, labor force characteristics, boom town effects,	Based on data published in district census handbooks (Year 2001).
10	Geology	Geological history.	Based on data collected from secondary sources.
11	Hydrology (Surface and Ground)	Drainage area and pattern, nature of streams, aquifer characteristics, recharge and discharge areas.	Based on data collected from secondary sources.
12	Risk assessment, Disaster Management Plan and Occupational Health and Safety	Identify areas where disaster can occur and identify areas of occupational hazards	Based on assessment.

2.0 PROJECT DETAILS AND SOURCES OF POLLUTION: EXISTING MINE

2.1 Introduction

The Rampura Agucha Lead-Zinc mine was commissioned in the year 1991 with capacity of 0.9 Mtpa after obtaining the Environmental Clearance from MoEF, New Delhi. The ore production and beneficiation capacity was enhanced 5.0 Mtpa in the year 2007.

In view of the continuous increase in lead and zinc metal consumption in the country by 10% per annum, HZL is also contemplating to increase production capacity in phases to meet the growing demand in India and also to enter overseas market in near future.

This chapter deals with the geology of the mining lease area, exploration details, estimation of ore reserves, method of mining, phase wise ore extraction details, beneficiation plant details and various sources of pollution in the existing capacity of 5.0 Mtpa. The measures already adopted for pollution control and environment management have also been described in this chapter.

2.2 Geology, Mining and Beneficiation Plant - Existing Status

2.2.1 Details of Mining Lease Area

Subsequent to the discovery of the deposit in 1977, the Directorate of Mines and Geology, Government of Rajasthan carried out preliminary exploration and based on this limited data, the detailed exploration scheme was prepared in 1979. Accordingly, Hindustan Zinc Limited (HZL) was granted a lease for 1200 ha for 20 years from 13.03.1980. The lease was renewed for another 20 years w.e.f. 13.03.2000 upto March 2020.

2.2.2 Mine Description

The Rampura-Agucha mixed sulphide deposit is a massive lens shaped ore body with a NE-SW strike length of 1580-m and a width varying from a few meters in the NE direction widening to as much as 100-m in the central to SW section. The ore minerals (mainly Sphalerite and Galena with sulphide gangue, pyrite and Pyrrhotite) are present in schistose matrix of quartz, potash feldspar, sillimanite, graphite and various micaceous minerals. Minor metals include cadmium, silver and copper.

The ore body, which dips from 50^0 to 70^0 towards SE has been drilled and proved to a depth of 1065-m from surface, remaining open in depth. It exhibits relatively sharp contacts with the NW footwall and SE hanging wall, which consists of highly deformed and metamorphosed gneissic rocks. No major faults have been detected in or adjacent to the ore body.

Estimated ore reserves and resources as on 1/04/2009 are 118.76 Million Tonnes with an average grade of 13.9% zinc and 2.0% lead.

2.2.3 Regional Geology

Rampura-Agucha deposit forms a part of Pre-Cambrian Banded Gneissic Complex (BGC) group of rocks, which occupy an extensive area in Central Rajasthan peneplain consisting of gneisses, schists and intrusive of acid and basic igneous rocks, that occupy predominantly the southeast plain of Ajmer and Bhilwara.

The BGC extends from Nathdwara in South upto Sambhar in North and the eastern limit extends upto Shahpura whereas western limit ends with Delhi formation. BGC is composed of heterogeneous rock type of parametamorphics, migmatites, pegmatites, granites and basic intrusive rocks of variable composition. The principal rocks that underlie Rampura-Agucha are gneisses and schists and their variants of BGC (renamed as Mangalwar complex). The rocks have been profusely intruded by igneous rocks of acidic and basic type.

- ***Stratigraphy***

Quaternary alluvium associated with the Khari and Mansi rivers is the youngest unit in the area. This alluvium band, which is about 3-km in width, has been drilled to a depth of 18-m by Central Ground Water Board (CGWB). The alluvium is composed of fine to coarse-grained sands with very little clay content. The alluvium is very heterogeneous with widely varying permeability.

The underlying Pre-Aravalli metamorphic rocks are mostly covered by either the alluvium or thin soil. The poor development of the soil cover gives the evidence of the arid character of this region.

The Pre-Aravalli rocks comprise of migmatite, gneiss, feldspathised mica schist, silicified quartzite, impure marble, paramphibolite, para-gneisses, pyroxene granulite, amphibolite, biotite-schist, quartzite and ultra-mafic rocks. In the area, the general strike of rocks is NE-SW, which dips fairly steep towards SE.

The revised succession of pre-cambrian stratigraphy is as given in **Table-2.1**.

TABLE-2.1
PRECAMBRIAN STRATIGRAPHY

PROTEROZOIC	Delhi geological Cycle (2.0 – 1.2 billion years)	Delhi Super Group
	Aravalli Geological Cycle	Aravalli super group
ARCHEAN	Bhilwara Super Group Bhilwara Ranthambor group Geological Cycle (3.2 – 2.5 billion years) Rajpura group, Pur Banera group, Jahajpur group, Sawar group, Hindoli group, mangalwar complex, Sandamata complex	Igneous Rocks Undifferentiated granite basic sills / dykes. Berach granite + gneiss/ Jodhpur granite Acidic, Mafic & Ultra mafic bodies associated with migmatisation

2.2.4 Geology of the Prospect

The rocks of the Rampura Agucha constitute a part of pre-cambrian banded gneissic complex (BGC) group of rocks which occupies a large area in central Rajasthan.

The principal rocks that underlie Rampura Agucha prospect are gneisses and schists and their variants of BGC (renamed as Mangalwar complex). The rocks have been profusely intruded by igneous rocks of acidic and basic type.

- *Sequence of Rock Type*

The greater part of the area is capped with soil cover and fresh rock exposures are scanty. The general strike of the formation near the deposit is roughly northeast to southwest and dips fairly steep (75^0-80^0) towards southeast on the hanging wall and about 60^0 to southeast on footwall, near the surface. The sequence of rocks, as examined from hanging wall to foot-wall can be broadly grouped as under:

1. Garnet-biotite-sillimanite gneiss with intermittent bands of calc-granulites amphibolites and aplites/ pegmatites.
2. Graphite-mica-sillimanite schist
3. Calc-silicate rocks
4. Amphibolites
5. Mylonite rocks
6. Pegmatite
7. Granite gneiss

2.2.5 Description of Rocks

- ***Garnet-biotite-sillimanite Gneiss***

This rock forms the predominant hanging wall unit in and around the mine. The gneisses are well foliated with augens composed of an aggregate of predominating feldspar with quartz, sillimanite and occasionally garnet. Foliation within the rocks is defined by layered arrangement of flaky and fibrous minerals around the garnet. Garnet ranges in size from few millimeters to few centimeters.

Feldspar is essentially of microcline variety and occurs in various shades ranging from light gray to deep green. Quartz occurs closely associated with feldspar. Mica is predominantly black to dark brown variety of biotite. Sillimanite is mainly in the form of fibrolites and bundles encircling brittle minerals.

- ***Graphite-mica-sillimanite Gneiss/Schist***

This forms the host for mineralization and consists of mica (white, green and brown varieties), feldspar, quartz and an appreciable amount of graphite. The overall colour of the rock is gray-green. Within the main host rock unit a few patches of calc-silicate and quartz-feldspar-mica rocks with or without garnet are noticed, which is devoid of mineralization.

- ***Calc-silicate Rocks***

These rocks are hard, compact, fine to medium grained, well jointed and occur as thin bands at the HW and FW contact of ore and within garnet-biotite-sillimanite gneiss. The accessory minerals are calcite, epidote, spinel and garnet.

- ***Amphibolites***

These are unfoliated or slightly foliated and brittle rocks essentially consisting of hornblende, feldspar, mica, garnet and quartz. These rocks occur as bands in garnet biotite sillimanite gneiss. Hornblende forms the principal mineral and constitutes 40% to 50% of total volume. Plagioclase feldspar is the next principal mineral. The accessory minerals are hypersthene, biotite, zircon and sphene.

- ***Mylonite Rock***

In general, garnet-biotite-sillimanite gneiss and granite gneiss show mylonitized character. Crushing and granulation of original gneissic rock is quite high. These rocks vary in width and are essentially seen occupying towards the footwall and are traceable from a distance of about 2-Km along the strike direction.

- ***Pegmatite***

The unit essentially comprises of quartz, garnet, biotite, sillimanite and feldspars. Pegmatite and aplite occur as bands of discontinuous veins, boudines of sizable dimensions mainly parallel to the foliation. These rocks are exposed in both hanging wall and footwall side.

- ***Granite Gneiss***

Granite gneiss with varying degree of migmatisation is well exposed all along the footwall of the ore body. This rock unit is light gray in colour and medium to fine grained.

Major mineral constituents of these rocks are quartz and feldspar, which have been elongated along with flakes of biotite and sillimanite. Accessory minerals are sericite, muscovite, aplite and zircon. Garnets are noticed to be of varying sizes.

2.2.6 Structural Geology

The deposit is a plunging isoclinal synform with rock units showing NE – SW strike with steep dips (75^0–80^0) in hanging wall & moderate dips (60^0–65^0) in footwall towards SE. The host rock occupies the core of the synform and plunge in southwestern limit is 65^0 – 70^0 due NE. The strike length of deposit is 1580 m and average width is 58m. The geological section is shown in **Figure-2.1**.

Folds are asymmetric to isoclinal observed in calc-silicate and garnet-biotite-sillimanite gneiss. The rocks of deposit are highly jointed. The strike frequency analysis shows that best developed joints are N 20^0 W to N 50^0 W with strong strike preference to NW.

The existence of a mylonite body traced as far as 2-Km along the strike of the ore body to the northeast represents a zone of intense shearing. This is confirmed by the amount of slickensiding in the host rock and ore body. The mylonite has been cemented, to become a very resistant body. Displacement in the small sympathetic faults is generally very low or negligible. Many of the minor fractures associated with the shearing have subsequently been filled with secondary mineral deposition including calcite, quartz, gypsum, ferro-manganese oxide minerals, dolomite and pyrite.

(a) Folds

The main structural feature of the deposit is interpreted as a plunging isoclinal synform with its axis running NE-SW for about 1.6-Km. The host rock occupies the core of the synform. Folds in mesoscopic scale, showing asymmetric to isoclinal, are prevalent in calc-silicate rocks of both hanging wall and footwall and could be observed to a minor extent in garnet-biotite-sillimanite gneiss. Trend analysis of fold axes revealed that the lineation plunging 70^0 along N 48^0E depicts the behaviour of mesoscopic folds developed in calc-silicate rocks on both the limbs of the synform

The rock types in and around this deposit underwent three successive phases of deformations. The first phase produced NNW-SSE trending isoclinal, reclined folds (F1), on bedding (S1) with an axial plane schistosity (S), while the second phase produced F2 folds, also isoclinal to tight plunging folds on S0 and S1 trending NE-SW. The third phase (F3) was weak and folded all the pre-existing S-planes.

(b) Joints

Calc-silicates, amphibolites, granite gneisses and pegmatites exposed in the deposit area are highly jointed, although the nature, intensity and dimensions of the joints vary with rock types. From the strike frequency diagram of joints, it is observed that the best developed joints trend N20^0 to N50^0W with a strong strike preference to NW. The preferential directions are N45^0E and N68^0W. Joint planes are mostly straight and sharp but in a few places, they are curved with a secondary filling of calcite and gypsum.

The joints are classified as being closely to moderately spaced (7 to 48-cm between joint sets) and the persistence of joints was found to be low to medium (i.e. 1 to 3 m and 3 to 10 m). Few joints, therefore, extend over long distances, but owing to the varying dip of different joint sets, many of the joints would intersect each other. Most joint apertures were measured to be tight to open (0.1 to 1 mm and 1/2 to 2 ½ mm). The joint sets can be divided into three groups by way of their orientation and dip, as follows:

Group	Strike Range	Dip Range
A	N60^0W to N70^0W	60^0NE through vertical to 70^0SW
B	N30^0E to N50^0E	65^0SE through vertical to 65^0NW
C	N70^0W to N80^0E	Dip 35^0 or less, generally north

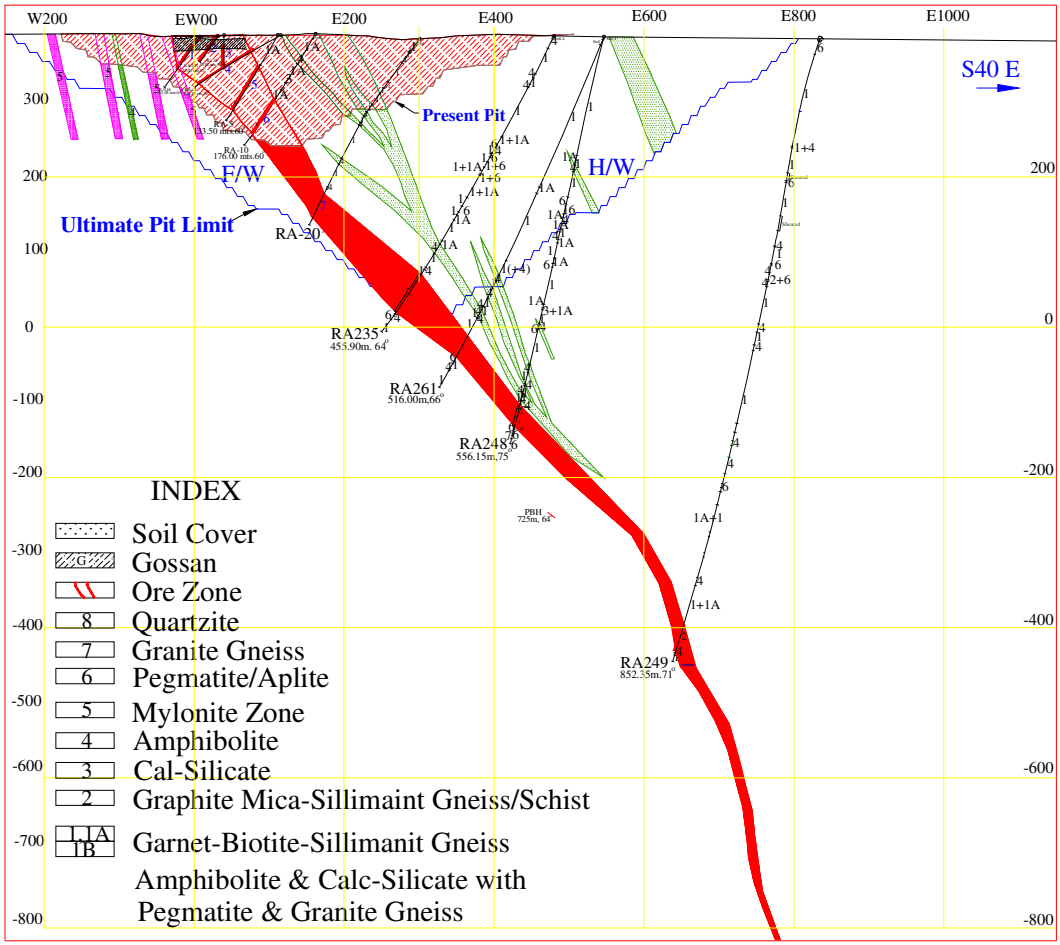


FIGURE-2.1
GEOLOGICAL SECTION (N/S-00)

(c) Faults

The presence of dark, grey, mylonite zone (varying in width from 15-m in south to 40-m in north) along the footwall of the deposit, roughly parallel to general strike, represents an intensely sheared zone. This zone is traceable further along the strike to about 2-Km NE of the deposit where the trend swings to N 60^0E. The footwall of the ore zone and the contact of ore zone with footwall rocks show shearing and mylonitization indicating minor displacements. Localized crushing, intense leaching and slicken-sided planes in host rock unit indicate varying degree of shearing. In many places, the fracture planes exhibit coating and filling of secondary minerals like calcite, quartz, gypsum (selenite and satinspar), ferromanganese oxide minerals, chlorite and pyrite.

(d) Schistosity and Laminations

Schistosity is best developed in the Garnet-sillimanite-biotite gneiss, graphite-mica-sillimanite gneiss, and to a minor extent in amphibolite mainly along the shear zones parallel to the body. Laminations in calc-silicate rocks show banding due to compositional variations.

2.2.7 Metamorphism

The Rampura-Agucha deposit occurs in highly metamorphosed rocks conformable with the surrounding country rocks. The gneisses in and around the deposit are paragneisses which have undergone high temperature/medium pressure metamorphism, in the order of about 700°C and 6.5 kb, respectively. This is indicated by the presence of garnet (almandine), sillimanite, and microcline and by the lack of muscovite in the rock units.

2.2.8 Mineralization

The economic minerals in the order of decreasing abundance along with their ranges of modal percentages are sphalerite (15-20), pyrite (15-18), pyrrhotite (12-14), galena (1-2) and sulphosalts (0.1-0.2). Graphite is ubiquitous in the ore body and its modal abundance varies between 7 and 10%. The gangue minerals which amount up to 45 to 50% of the ore zone, constitute quartz, feldspar (orthoclase, plagioclase), various micaceous minerals (sericite, chlorite, biotite), sillimanite with negligible amounts of garnet, amphibole, pyroxene, rutile, gahnite, apatite and dravite.

The ore body has high-grade borders and a lower grade center. The sulphide content varies considerably but the silicate mineralogy and texture does not vary between the low and high-grade ore.

(a) Sphalerite

The predominant sulphide mineral occurs in various shades of brownish black, black (marmatite) to light brown and yellowish brown. It is present as very fine grain material admixed with galena to coarse grained crystalline concentrations, as veinlets associated with pyrite and pyrrhotite. Microscopically, it exhibits grey,

low reflectively, isotropic and internal reflection, and occurs essentially as aggregates of several small grains, with characteristic 120 triple joint grain boundaries. Mineral grains exhibit annealing twins, inclusions of other sulphides, gangue minerals and graphite. Depending upon the size, shape and frequency of inclusions and their textural relationship, sphalerites can be broadly classified into the following categories: a) sphalerite devoid of inclusion b) sphalerite with irregular exsolved blebs of chalcopyrite and pyrrhotite c) sphalerite with minor inclusions of galena pyrite and pyrrhotite and d) sphalerite with varying amounts of inclusions of graphite shards. Coarse grained variety exhibits evidences of metamorphic recrystailization. The Fe-contents in sphalerite are up to 11.5 wt%, Sphalerite contains minor amounts of Mn and traces of Co and Ni, Cd concentration ranges from 0.03 to 9.0 wt.

(b) Galena

Occurs in the main ore zone as fine to medium grained disseminations and veinlets. Fine-grained galena forms a matrix cementing subrounded to angular gangube minerals of various sizes. Coarse-grained crystalline galena exhibiting bent cleavages, associated with pyrite and pyrrhotile is also present in calc--silicate rocks of the hanging wall section. Remobilization of galena along fissures, cleavages of gangue minerals is widespread forming sandwich like textures. Microscopically, galena is white, isotropic with distinct triangular cleavage pits and high reflectivity. Sphalerite and galena occur in close association, the former being the major phase. Galena is relatively inclusion-free except for occasional isolated grains of sphalerite within it. In a few sections, galena and sphaleritc show mutual boundary relations, suggesting simultaneous crystallization. The occurrence of Ag-minerals in galena depends on grain size and morphology, coarse grained galena and galena forming veinlets in silicate minerals are usually rich in Ag-minerals whereas fine grained disseminated galena, is generally devoid of Ag-minerals. The concentration of minor constituents such as Bi, Sb, As and Se is negligible in galena.

(c) Pyrite

Two generations of pyrite could be distinguished, first form large homogeneous idiomorphic grains (up to 5-mm) which are surrounded and occasionally traversed by the second generation pyrite which is granular. Pyrite and pyrrhotite occur in various proportions in the main lode. Microscopically pyrite is yellow and isotropic and is found to be intergrown with pyrrhotite and marcasite.

(d) Pyrrhotite

Pyrrhotite is Brownish yellow fine-grained, occurs as granular aggregates of various proportions. Microscopically, it is anisotropic without any internal reflection.

The other minor minerals are Arsenopyrite, Chalcopyrite, Nickel -Antimony minerals, Silver minerals as Freibergite, Pyarargyrite, stephanite and Boulangerite.

Typical analysis of ore is given in **Table-2.2**.

2.2.9 Mode of Occurrence

The surface manifestation of economic mineralization was in the form of in-situ gossan outcrops exhibiting mostly of various shades of yellow, brown, red, grey and maroon colors within and on either side of the shallow pit. Cellular, spongy and boxwork development in gossans were seen in a few outcrops. Graphite flakes were noticed in the gossan outcrops in variable proportions, in places gossan bands showed silicification, kaolinization and sericitisation.

Economic mineralization is predominantly in graphite-mica-sillimanite gneiss/schist. The strike length of the deposit is 1580 m. The closure of the synformal structure has been established by the negative drill hole at the southern extremity and by surface geological details. The hanging wall side of the lode is the richest and also wide, followed by comparatively lean grade in the middle and a narrow rich footwall zone. Coarse— grained crystalline galena associated with Pyrite and Pyrrhotite are seen in the hanging wall rocks (essentially in calc-silicates). The ore texture is either coarse or finely laminated in the secondary mylonitized zones which intersect ore and host rock. The mineralization in hanging wall and footwall contacts is invariably fine to coarse grained and is made up of Sphalerite and galena with inclusions or rounded to sub-rounded discrete grains of feldspar (orthoclase + plagioclase), quartz, hornblende, sillimanite and dark green chlorite. Ore forming minerals vary from a few percent to 55% averaging about 35%. Pyrite and Pyrrhotite occur in different proportions with galena and Sphalerite. There is no perceptible mineral zoning either across or along the strike. In depth grade seems to improve, due to convergence of synformal limbs.

TABLE 2.2
ANALYSIS OF ORE

Element	Composition
Pb %	1.99
Zn %	13.34
Fe %	7.25
C %	5.8
Cu ppm	200
Cd ppm	400
Sb ppm	80
Ag ppm	50
Hg ppm	10
Bi ppm	80
Co ppm	50
SiO2 %	40
Al2O3 %	10.3
MgO %	2.55
CaO %	0.43
MnO %	0.16
S (Total) %	17.9

2.2.10 Extent of Ore Zone

The general strike of the ore zone NE-SW. Towards the northern end, the strike of the ore zone gradually swings to N60^{0}E. The dips of hanging wall contact are steeper (75^0 to 70^0 SE) as compared to footwall contact (62^0 to 50^0 SE)). The ore zone shows a variation in width both along strike and dip. The northern most ore intersection at section N-800 is about 7m and between latitudes S-200 and S-400 gradually widens to about 95 to l00m, further south gradually reduces towards the closure. The plunge of the ore body appears to be around 65^0 towards northeast. The deepest ore intersection till date is on S-200 section at –675 mRL and has 65m mean horizontal width.

2.2.11 Ore Body Disposition

(a) Strike

The general strike of the ore zone is parallel to the enclosing rocks which is roughly NE-SW. towards the north the strike of the ore zone gradually swings to N60E - S60W. The strike length of the deposit is 1550m.

(b) Dip

The dip of the ore zone varies along strike and depth. Near the surface the dips of the hanging wall contact is steeper (75^0 - 80^0 towards SE) than the foot wall contact (60^0 - 50^0 towards SE). In depth the dip of hanging wall and foot wall contact shows a tendency of flattening. In general dip varies from 50^0 to 70^0. The level wise dips are given in **Table-2.3.**

TABLE 2.3
LEVEL WISE DIPS OF THE ORE ZONE

Level (mRL)	No. of Bore Holes	Average Dip (in Degree)
360 - 310	16	62
310 - 260	14	59
260 - 210	8	56
210 - 160	10	57
160 - 00	20	50
00 - (-200)	13	53
(-200)- (450)	28	53
(-450)- (650)	6	70

(c)Width

The ore zone shows a variation of width both along the strike and depth. Near N-600 the width is as low as 30 m. it widens gradually to about 95 m. between S-200 to S-400. Further south the width gradually reduces before its closure around S-750. The level wise average true width is given in **Table-2.4**.

(d) Barren Patch

A barren patch of low metal content (1.75 Million Tonnes, 0.15 % Pb, 0.99 % Zn) divides the main ore zone between S 450 and S 100. This patch varies in width from 12m to 25m and appears to follow a northeasterly plunge. It is essentially granular and composed of gangue minerals occurring in the host rock unit with negligible amount pyrite.

TABLE 2.4
AVERAGE WIDTH OF THE ORE ZONE

Level (mRL)	No. of Bore Holes	Avg. T. W.	Max. T.W.	Min. T.W.
360 - 310	16	62.40	97.00	7.00
310 - 260	14	52.20	95.00	29.60
260 - 210	8	42.20	69.00	28.50
210 - 160	10	37.30	66.00	26.00
160 - 00	20	26.55	80.00	2.00
00 - (-200)	13	25.46	48.00	2.00
(-200)- (450)	28	27.00	40.00	15.00
(-450)- (650)	6	35.00	12.00	62.00

(e) Cut off Grade

The ore zones are delineated on +2% (Pb+Zn) total metal content. The assay values indicated sharp termination at hang wall and foot wall contacts and grade of zone is calculated by assimilating <2% (Pb+Zn) partings if weighted average qualifies the cut off.

(f) Ore Density

The measured ore density of every run from 200 boreholes has been incorporated in Data mine resource model 08 and estimated average in situ density for ore is 3.07.

2.2.12 Details of Exploration

Exploration work at Rampura Agucha mine can be classified into two phases. Phase I exploration was carried out before commissioning of the mine, it was in the period of 1977 to 1982. After commissioning of the mine, Phase II exploration commenced from 2004 and is still continuing.

- **Phase-I Exploration before commissioning of the Mine**

After the discovery of Rampura Agucha in 1977, DMG initiated preliminary exploration during the field season of 1978-79. In November, 1979 Hindustan Zinc Limited prepared an exploration scheme for detailed exploration of Rampura Agucha prospect based on two bore holes completed by DMG and surface indications. The scheme envisaged completion of exploration in four stages with sequential evolution of the area.

HZL commenced exploration in February, 1980 and completed in February, 1982. As a matter of practice all the holes have been drilled from hanging wall side so as to intersect the lode at right angle to the strike and dip.

The sampling of drill core was generally done at uniform length and samples were assayed on Atomic Absorption Spectrophotometer (AAS). To ascertain the degree of confidence in grade estimation the check tests which were carried out during the investigation is as follows:

a) Sample bias
b) Analytical technique (instrumental reliability)
c) Analytical bias
d) Laboratory bias

Sampling and analysis reliability were checked at different stages and computer based statistical analysis was carried out to evaluate the same. The results indicated high degree of correlation and confidence.

The details of exploration carried in this period are given in **Table-2.5.**

TABLE 2.5
EXPLORATION INPUTS

Surface diamond drilling	24,800 m in 229 holes (core recovery 90% in mineralized zone)
Underground diamond drilling	256 m in 6 holes
Underground exploratory development	567 m
Sampling	13835 Nos
Mine Sampling	1744 Nos
Bore hole composite samples from	
(a) Sulphide ore	Sent to CRDL(HZL) & M/S Lurgi (W.Germany)
(b) Gossan Zone	M/S Sala International, Sweden & IBM, Nagpur
Geotechnical Sampling	148 Nos
Petro mineralogical	647 Nos
Check sampling	123 Nos
Analytical checks	990 Nos
Laboratory checks	46 Nos
Beneficiation test (bench scale & pilot)	10 Nos
Pilot test (Plant)	3550 M/T R.D.Mines, Udaipur

- **Phase-II Exploration carried out during 2004-2008**

Looking to the enhanced ore production targets and limited life of the open pit, need was felt to establish continuity of ore body in depth and thereby upgrade and further augment the resources in depth

The exploration commenced in September 2004 with the objective of up gradation and enhancement of resources at deeper levels. Approx 66,477-m drilling in 105 completed holes has been achieved till March 08.

The deepest mineralized intersection is at 1065-m below surface. There is general trend of width reduction in depth.

2.2.13 Geological Reserves and Grade

The reserves computation and ore body configuration were based on the exploratory bore holes carried out in two phases i.e., in phase I (during the period 1977 to 1982) total 18095 m of surface drilling in 133 bore holes and in phase II (during the period 2004 to 2008), total 66477-m (4124.70-m non-core and 62352.55-m diamond core) deep drilling below existing pit in different sections. Total 238 numbers of exploratory boreholes are completed in two

phases. Based on the intersected zones and Datamine model 107.3 Million Tonnes with 2.0% Pb and 13.9% Zn reserve has been established up to –675 mRL.

2.2.14 Classification of Resource and Reserves

Inferred Resource: The resource is based on Geological evidence and knowledge, which suggests continuity of mineralization in depth.

Indicated Resource: The resource is based on 100-m x 100-m drilling density with moderate degree of certainty in the tonnage but not the grade.

Measured Resource: The resource is based on 50-m x 50-m drilling density, which is well within the range of semi-variograms and estimated with high level of confidence.

Probable Reserves: These reserves are mineable (In pit) Indicated resource based on techno-economical feasibility and after considering dilution & mining recovery factor.

Proved Reserves: These reserves are mineable (In pit) measured resource based on techno-economical feasibility and after considering dilution & mining recovery factor.

Conversion Factors: A dilution @ 1.5% and mining recovery @ 97% has been applied to measured and indicated resources

Category-wise updated ore reserves and resource with grade as on 1.4.2009 are given in **Table-2.6**.

TABLE-2.6
ORE RESERVES & RESOURCES AS ON 01.04.2009

Sr. No.	Category (UNFC)	Million Tonnes	Zn (%)	Pb (%)
1	Proved (111)	11.71	13.52	2.11
2	Probable (121)	51.85	12.84	1.90
3	Total Reserve	63.56	13.0	1.94
4	Indicated (122)	22.77	15.66	2.21
5	Inferred (222)	21.0	14.92	1.85
6	Total Resource	43.77	15.3	2.04
	Total	**107.3**	**13.92**	**1.98**

2.2.15 Mine Development

The major criteria for mine development are as follows:

- Uninterrupted supply of uniform grade ore to the beneficiation plant;
- Sump of adequate capacity to store the water without affecting the working in the mine and to produce required grade;
- Flexibility in minor variations in planned quantities without affecting the long term planning;

- Availability of developed ore to meet out eventualities;
- Overburden removal is planned up to maximum possible extent so as to keep mine development within the planned boundaries. Lower overburden removal is expected during certain period, hence flexibility in overburden removal upto certain extent is also inbuilt in plan so as to accommodate minor variations within the planned limits.

The ore reserves within the ultimate open cast mine are 43.03 Million Tonnes (as on 01.04.09) and these reserves are adequate to sustain the open cast mine for approximately 10 years at proposed annual ore production rate. The overall strip ratio at ultimate pit depth is 10.8:1 (Overburden to Ore on tonnage basis) and beyond which it would be more economical to switch over the mining method from opencast to under ground.

The ore reserve (Approx. 75.73 Million Tonnes) beyond the ultimate limits will be mined by under ground method. With present reserve and resource status and at proposed rate of production, the mine will run up to the year 2039 -40.

The layout of the plant and mine is shown in **Figure-2.2.**

2.2.16 Method of Mining

Ore body has been proved down to 1065-m and upper part of ore body is being worked with open pit. Firming of open pit depth is dynamic, influenced by updated geotechnical and financial parameters. However, based on updated input parameters, present consideration for ultimate pit depth is 372-m containing 48.7 Million Tonnes ore and 528 Million Tonnes of waste as on 1.4.2009.

Further, exploration (Phase II) has proved that orebody extends up to a depth of 1065 m with mineralization still open at depth. Thus there is good potential to increase the mining capacity by open Pit as well as going underground to mine beyond Ultimate Pit Bottom. Presently mine has reached to a depth of 170 m (Current depth of Open Pit).

The method of mining & mineral processing operations:

Mechanised open cast by excavators & dumpers and underground operation by LHD and LPDT

Differential froth floatation

The final pit designing was done by using the DATAMINE software on the in-house workstation with ultimate viable incremental ratio of 1:14.

2.2.17 Opencast Working

The following operations are carried out in the opencast working:

- It is fully mechanized operation;

- In the opencast mining, the overburden and ore body is loosened by drilling and blasting the in-situ rock to enable excavation;

- For loading of ore and waste: Hydraulic excavators are used. Ore/waste are loaded into dumpers and transported to the primary crusher/earmarked dump locations;
- As per the design, the bench height in overburden is maintained at 10 m. To have a better grade control, the height of ore benches is kept at 5 m; and

- Mine discharge water is collected in the sump and pumped to reclaim water reservoir and then recycled to beneficiation plant.

2.2.18 Mining Plan

The mine parameters are given in **Table-2.7.**

TABLE-2.7
MINE PARAMETERS

Sr. No.	Details	Plan
1	Mining width at working bench level	50 m
2	Ultimate pit wall slopes H/W F/W	 42 ° 35 °
3	Berm width and bench angle	Berm Width of 6.5 meter with individual bench angle of 70° on F/W side and 80 ° on H/W side.
4	Ramps	Two ramps, one each in H/W & F/W of 25 m width and gradient of 1 in 12
5	Ultimate depth of pit	Full strike of ore body will be mined up to 155 mRL and southern portion of ore body will be mined further up to 120 mRL. The depth may increase in case it is feasible to adopt steeper slope parameters in future
6	Ultimate/overall stripping ratio (As on 01.04.2009)	10.8:1 (Overburden/Ore)
7	Waste Management	Waste generated by mining will be dumped at pre decided sites in ultimate dump configuration of 4 X 10 m lifts.

The mine pit plan as on 30.09.2008; Mine pit longitudinal sections; Surface Geological plan; Geological Sections N/S00 and Waste (OB) dump plan are is shown in **Figure-2.3, Figure-2.4, Figure-2.5, Figure-2.6** and **Figure-2.7** respectively**.**

2.2.19 Drilling and Blasting

At Rampura Agucha Mine the existing bench height in overburden is 10 m, while for ore benches it is 5 m as well as 10 m. The bulk of blast hole drilling is performed by the 6 track mounted diesel powered DTH (Down the Hole) machines in ore and waste benches, using 165-mm diameter bits and wet drilling with dust extraction system.

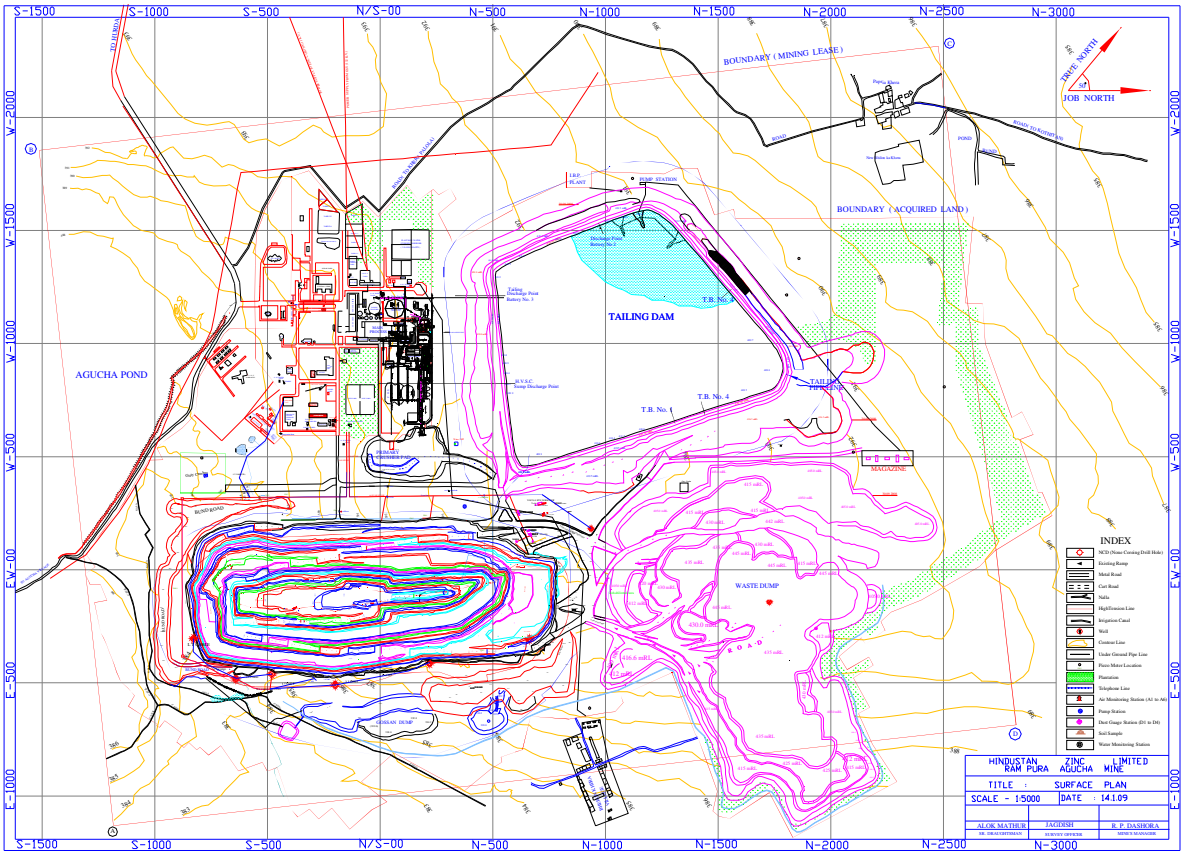


FIGURE-2.2
LAYOUT OF PLANT AND MINE

Site Mix Emulsion (SME) explosive along with booster charge is being used. For improved blast performance, reduced ground vibration and noise level, Non Electric Millisecond down the line delay detonators and Non Electric Trunk line detonators (Shock tube initiation) is used. The no. of blasts required in ore and waste clubbed together are approx. 8-10 per week, however by increasing the size of the blast; number of blasts required per week will be reduced.

Depending upon the strata condition, bench height and rock type, spacing and burden is being varied. A typical Drill & Blast design parameters are as given in **Table-2.8**.

TABLE-2.8
DRILL AND BLAST DESIGN PARAMETERS

Spacing and Burden	
Waste	5.0 x 3.5-m to 7.0 m x 4.5-m
Ore	3.0 x 2.75-m to 4.0 m x 3.5-m
Depth of Hole	11.0 to 12.0-m
Sub Grade	1.0-m to 1.25-m
Primary Charge	400-500 gm cast booster (Waste) 500 gm emulsion booster (Ore) 10-15% LD cartridge (toe blast)
Column Charge	Site Mixed Slurry (Bulk)
Charge Length	66-70% of hole depth
Charge per hole	135 to 160 kg
Drill Pattern	Mostly staggered
Blast Pattern	Reverse Echelen
Maximum Charge per Delay	500 Kg.
Powder Factor	Approx 4.3 T/Kg (Waste) Approx 2.7 T / Kg (Ore)
Holes per round	60-150 holes

2.2.20 Mine Drainage

- **Open Pit**

The ground water assessment studies carried out in core zone (lease area) indicates that there is surplus exploitable ground water potential of 0.389 mcm as there is hardly any ground water withdrawal in the lease area. The operating depth of the mine is about 170-m below land surface, there is a limited accumulation of 250 m^3/day in the mining pit. Limited quantity of rain water gets collected during the rainy season due to direct precipitation.

The rainfall collected in the mine pit during the monsoon season is being pumped out and used for green belt and the balance if any will be routed to the water reclamation pond for subsequent use in the plant. An adequate capacity of approx. 1,00,000 m^3 sump in hanging wall is available to collect the run off mine water.

Garlands have been provided to collect the run off water from mining area, waste dumps and the water is collected in common sump situated on south eastern side of the pit with arrangements to pump it back to tailing dam for reuse.

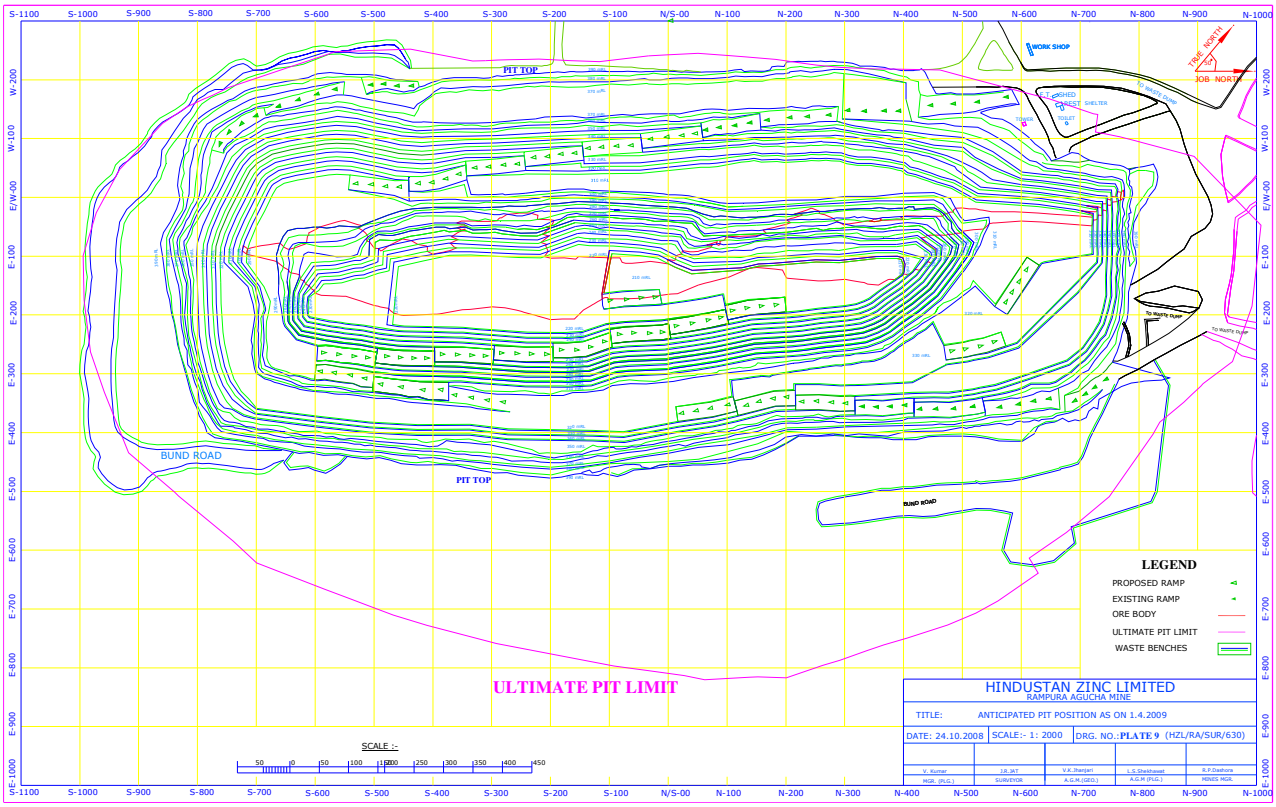


FIGURE-2.3
PIT PLAN AS ON 30.09.2008

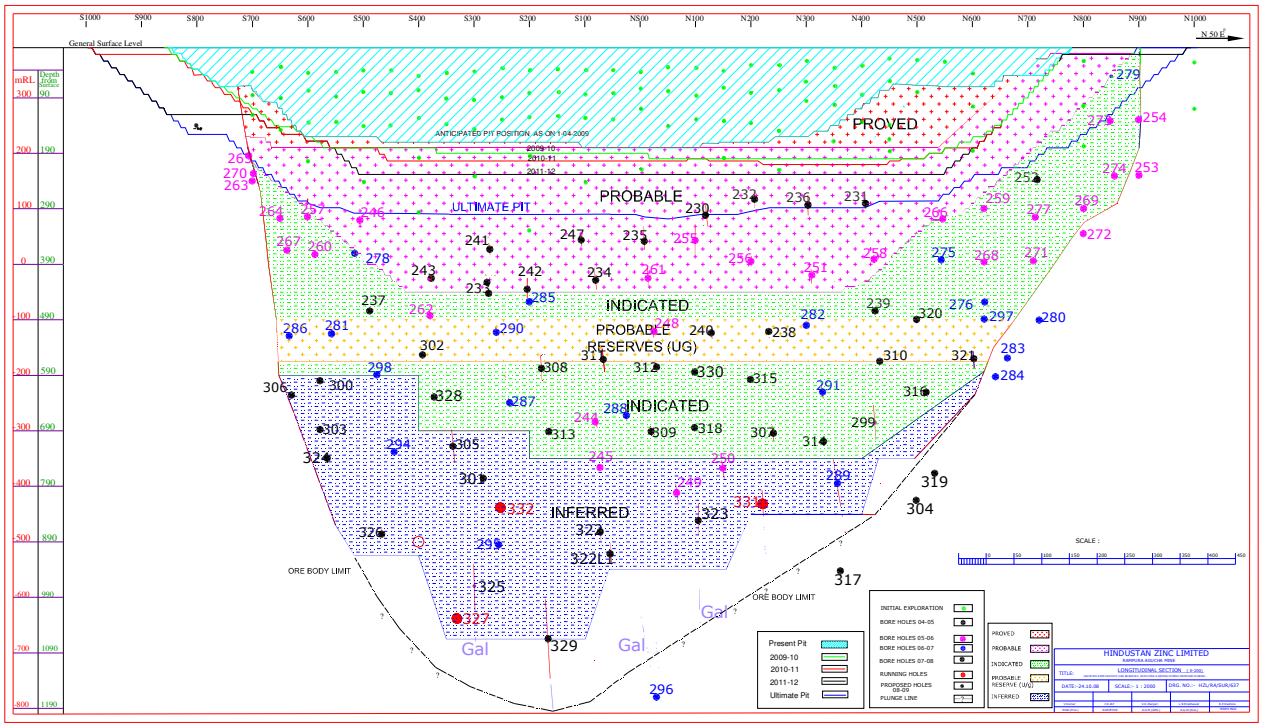


FIGURE-2.4
MINE PIT LONGITUDINAL SECTIONS

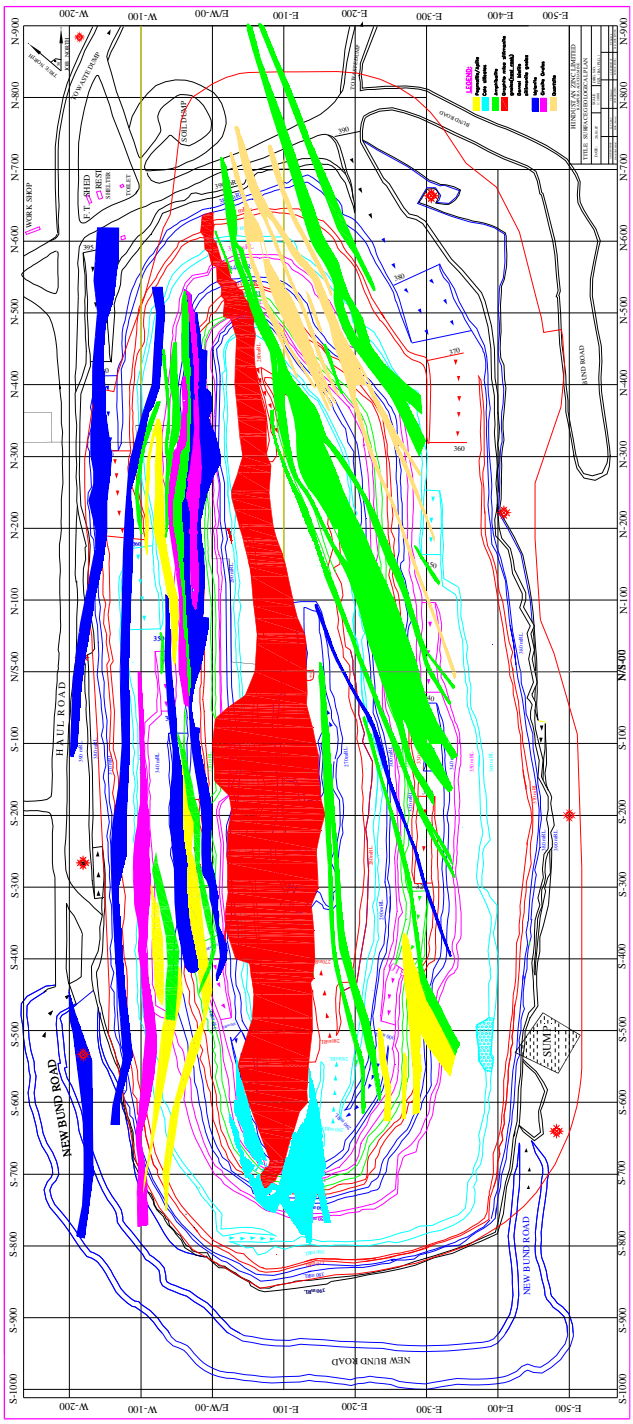


FIGURE-2.5
SURFACE GEOLOGICAL PLAN

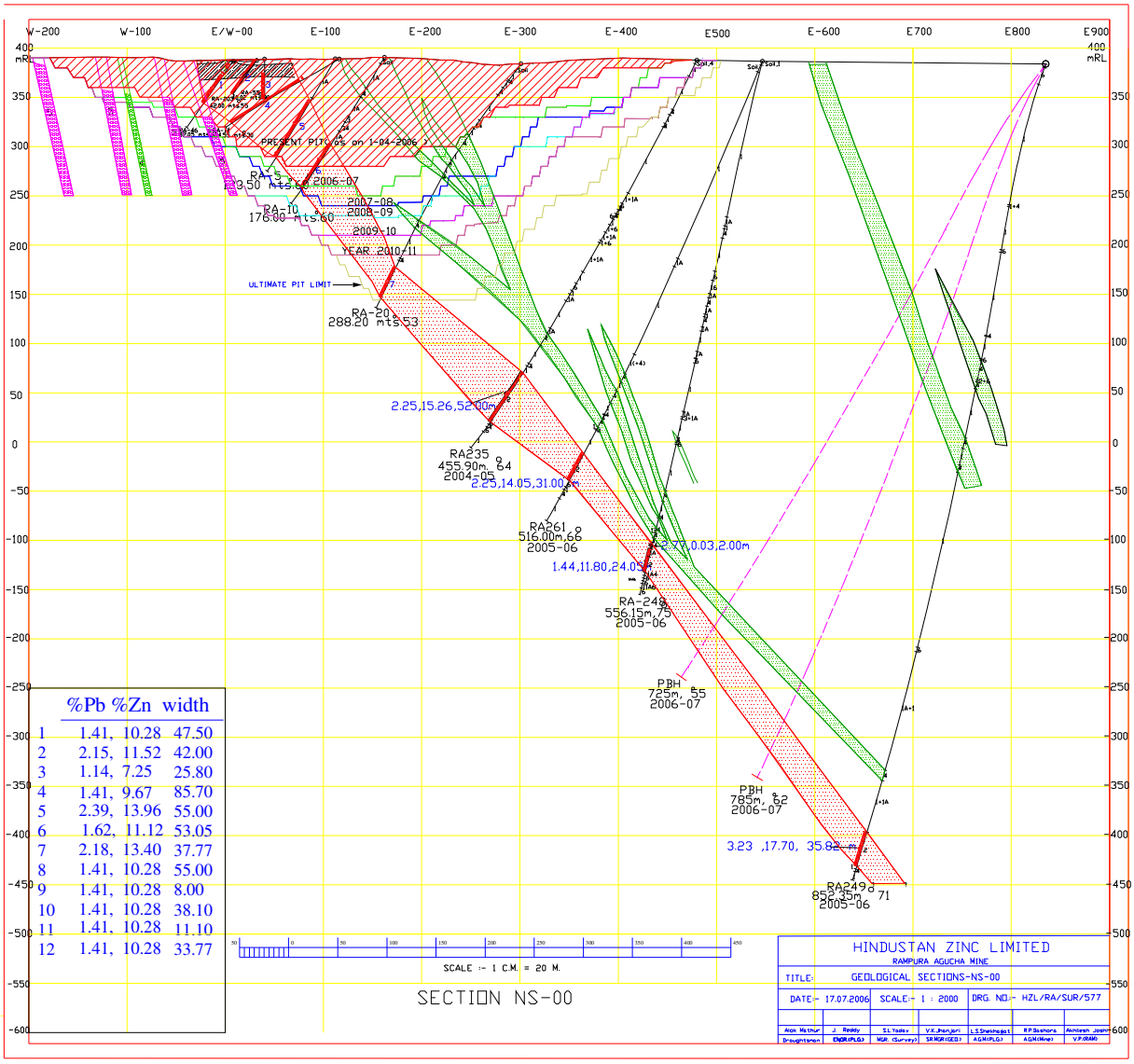


FIGURE-2.6
GEOLOGICAL SECTIONS N/S 00

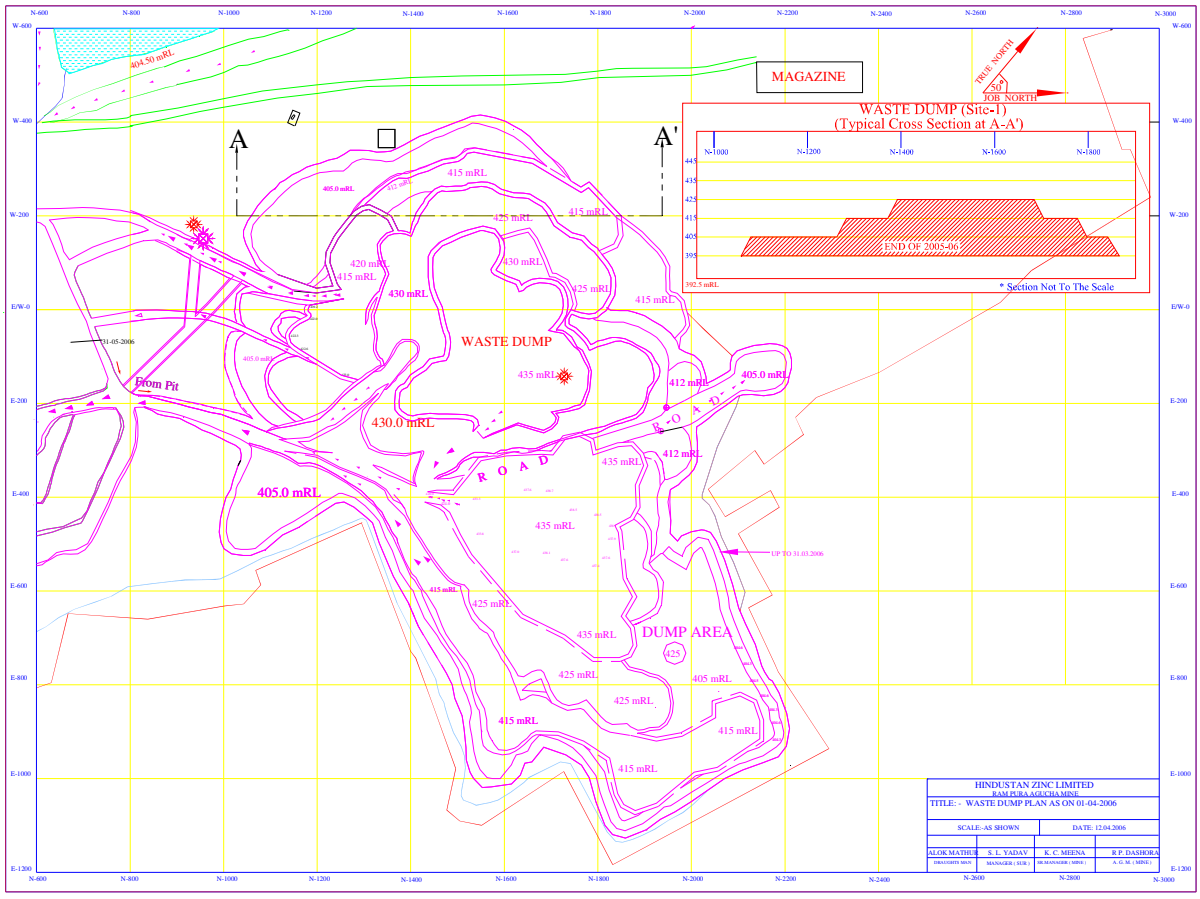


FIGURE-2.7
WASTE (OB) DUMP PLAN

2.2.21 Handling of Solid Waste

In the initial feasibility study, it was recommended that the height of waste dump should be kept 40-m, thereby reducing the area of land take and area available for run-off. Hence, presently waste dump Site-1 (**Figure-2.8**) is available with total capacity of 123.19 Million Tonnes (56 million m^3) in configuration of 4 x 10 m lift in ultimate position with top 435 mRL. The present dump (Site-1) is constructed with 4 x 10 m lift with 10 m benches between successive lifts. The final slope of 27° is essential to provide better stability to the dump. It also helps to minimize the surface air velocity and dust entrainment.

The following areas are presently available for accommodating waste:

- Current Dump Area;
- Tailing Dam Bund (Height to be raised up to 51-m in lifts);
- Bund / wall around pit of 5 to 10-m height & 30-40-m wide at top; and
- Main dump area (north of the pit)

These waste dumps are shown in **Figure-2.8.**

2.2.22 Generation and Stacking of Sub Grade Mineral

Ore containing material in excess of 15% non-sulfide Zinc are the sub-grade mineral which are to be segregated and stock piled separately as gossan. Out of total 1.6 million Tones of gossan, 1.490 million Tonnes of gossan has already been mined out and stacked at pre defined location. However, the existing gossan dump will be relocated at suitable appropriate location as the present area will be utilized for the proposed expanded pit. At present 110,000 Million Tonnes of sub-grade material (gossan) at the grade of 1.98% Pb (Total), 10.03% Zn (Total), 0.57% Pb (Non sulphide) and 8.80% Zn (Non sulphide) has been dumped within the mine. This material is expected to be excavated during the proposed plan period, which will be stacked separately at designated site of gossan.

2.2.23 Extent of Mechanization

The mine is fully mechanized. The available mining equipment is given in the **Table-2.9.**

2.2.24 Mineral Beneficiation

The lead zinc mineralization at Rampura-Agucha is associated with graphite sillimanite gneiss/schist. The major minerals affecting the beneficiation process are sphalerite, galena, pyrite, pyrrhotite and mica. Graphite represents major metallurgical problem due to its natural floatability.

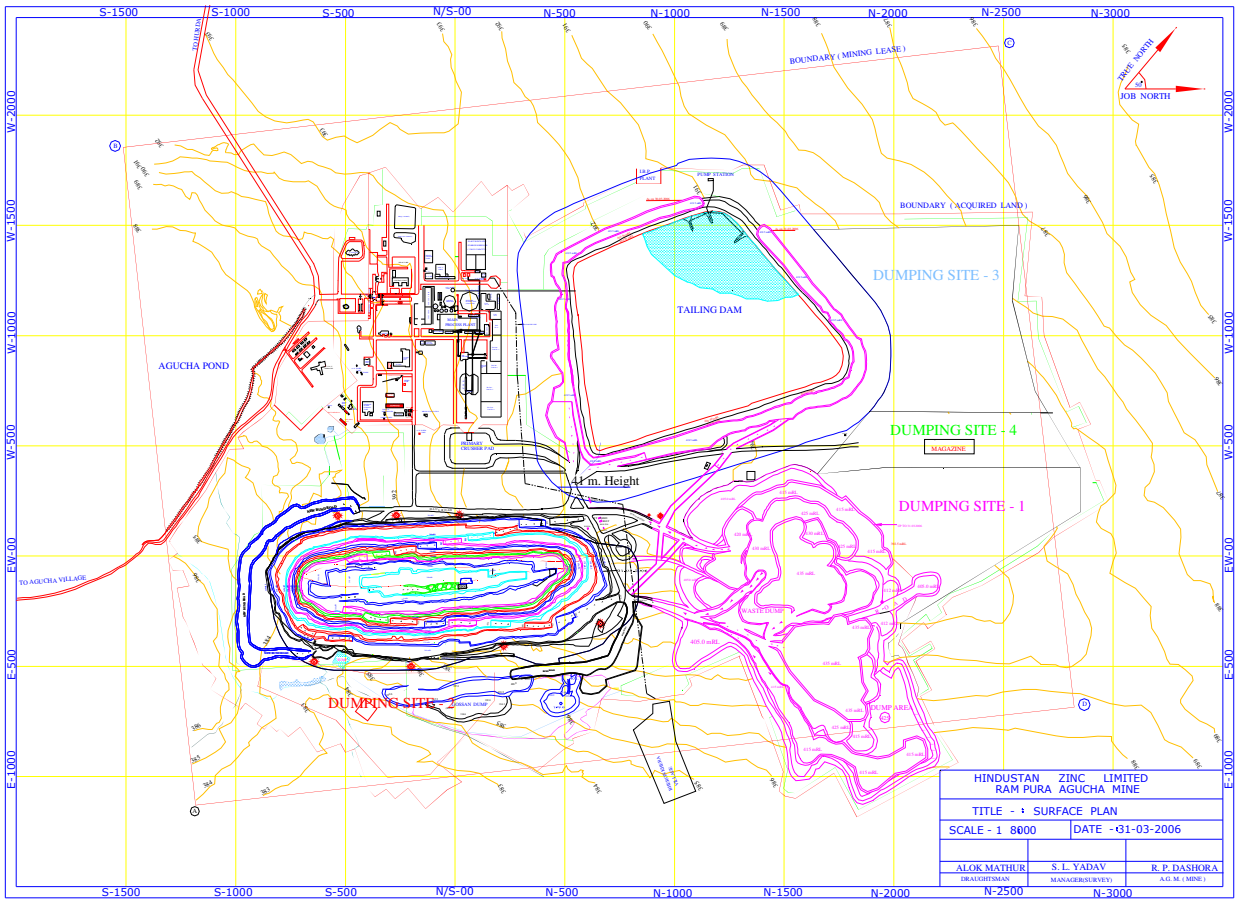


FIGURE-2.8
WASTE DUMP LOCATIONS

TABLE-2.9
AVAILABLE MINING EQUIPMENT

Equipment	Capacity	Existing (Nos.)
Excavator	6-m^3	1
	9-m^3	2
	15-m^3	2
Dumper	95 Tonnes	25
Drill	165-mm	7
	115-mm	2
Water Sprinkler	28 KL	2
	40 KL	2
Track Dozer	510 HP	5
Motor Grader	280 HP	2
RT Dozer	318 HP	1

2.2.25 Beneficiation Plant

The schematic flow diagram of the beneficiation plant is shown in **Figure-2.9.**

- ***Primary Crushing and Coarse Ore Stockpile***

There are two primary crusher house, one having the old 54 X 74 Gyratory Crusher supplied by Alllis Mineral System & another one 54 X 75 Gyratory Crusher has been recently added in last expansion. Run-of-mine ore is dumped into a hopper ahead of the primary gyratory crusher. The crusher reduces the ore to approximately minus 150-mm size and discharges to a 100 tonne live capacity hopper located over a 1.5m wide apron feeder provided with a variable speed drive. Crushed ore is transported from the apron feeder to the coarse ore stockpile of live capacity 7500 tonne (design) by 1.2m wide belt conveyors and tripper conveyor.

Each of the primary crusher house building is serviced by an overhead crane, 80/20 tonne capacity, which caters for maintenance requirements, including removal of the gyratory crusher head and shell assemblies. A wet scrubber type dust control system is provided in old primary crusher house to remove dust from apron feeder and conveyor transfer points. Dust slurry is pumped to the grinding circuit via dust collection system of secondary crushing plant. Water is also sprayed in the crusher feed hopper to suppress the dust.

The newly added primary crusher uses dust suppression system where water is added in mist form at different fall points to suppress dust. In the Stream 2, primary crushed ore from existing coarse ore conveyor is diverted to new COS having a live capacity of 7500 TPD through a transfer conveyor and a tripper conveyor after installing a flap gate mechanism. The existing COS continues to be fed through the existing conveyor system for production of fine ore with existing fine crushing plant, The primary crushed ore from new COS are reclaimed by five reciprocating feeders with variable speed AC drives and fed to SAG mill by a belt conveyor.
In the Stream 3, primary crushed ore is carried to new COS having a live capacity of 7500 TPD by two conveyors & a tripper conveyor. The primary crushed ore

from new COS are reclaimed by five reciprocating feeders with variable speed AC drives and fed to SAG mill by a belt conveyor. A conveyor is there to divert primary crusher for supplying ore to Stream 2.

2.2.25.1 Stream 1

Secondary and Tertiary Crushing: Crushed ore is fed to secondary crusher through feeders which are drawing ore from coarse ore stock pile. Secondary crusher product along with intermediate product from double deck screen and product from tertiary crushers goes to tertiary surge bin. From bin, the material is fed to deck screens. Oversize of the screens goes to tertiary crushers. There are two fine ore bins having a capacity of 4500 Tonnes each. They are provided with dust extraction systems.

Wet grinding and Classification: There are three identical grinding circuits, each comprising of one rod mill in open circuit and one ball mill in closed circuit. Products from rod and ball mill ore fed to two stage cyclones. Over flow from 2 stage cyclone from all three streams, after getting mixed is subjected to In stream Analyzer (ISA).

Lead Zinc Conditioning and Flotation: Lead conditioners will receive the 2nd stage cyclone overflow from grinding circuit. The material from conditioner flows to lead rougher scavenger OK 16 cells. There are 9 lead rougher cells and 10 lead scavenger cell. Pb middling is recirculated to Pb conditioner.
The tailing of lead rougher-scavenger cells bank will be sent to the first of two zinc conditioners each of capacity 65 M^3. then the material flows to Zinc rougher-scavenger cells. There are 10 Zinc rougher cells and 9 zinc scavenger cells. Zinc middling is recalculated back to zinc conditioner via a zinc regrinding. Flotation air is supplied by air blower in rougher and scavenger cells. Material from Roughers and scavengers fed to cleaners. There is 3- stage cleaning for Pb and 4 Stage cleaning process for Zn.

2.2.25.2 Stream 2

Stream 2 is installed with new semi autogenous grinding mill with ball mill combination. There are no requirements for secondary and tertiary grinding arrangements in stream 2.

Wet grinding and Classification: In the 1.45 Mtpa plant, primary crushed ore from coarse ore conveyor is diverted to new COS having a live capacity of 7,500 TPD. The existing COS continues to be fed through the existing conveyor system for production of fine ore with existing fine crushing plant. The primary crushed ore from new COS is reclaimed by five reciprocating feeders to SAG mill by a belt conveyor.

A new dedusting system comprising of either Venturi Scrubber & one dust slurry pump has been installed at coarse ore stockpile area.

A SAG mill of size 7.0-m dia x 3.5-m length receives coarse ore from new COS. Belt weigh scale located at conveyor monitors & controls the tonnage of ore fed to

SAG mill the belt scale located at another conveyor monitors the pebble rejects coming out of SAG mill. After 1st stage primary grinding in the SAG mill in closed circuit undersize is pumped to a two-stage classification system. SAG Mill & Ball Mill discharge are pumped to 1st stage cyclone The 1st stage cyclone overflow is pumped to the 2nd stage cyclones and both stage cyclone underflows at about 70% solids each is subjected to grinding in a ball mill.

The second stage cyclone overflow constitutes feed to flotation circuit.

Lead Zinc Conditioning and Flotation: A lead conditioner of 65 M^3 (4.5-m dia x 4.5-m ht) capacity receives 2nd stage cyclone overflow from grinding circuit. Lead rougher-scavenger OK 38 cells are arranged in 3+2+2 configuration, with three dedicated rougher & two dedicated scavenger cells with an option of conversion of intermediary two OK38 cells to either rougher or scavenger circuit. The tailing of lead rougher-scavenger cells bank will be sent to the first of two zinc conditioners each of capacity 65 M^3.

Zinc rougher-scavenger OK 100 TC cells are arranged in 2+1+2 configuration, with two dedicated rougher & two dedicated scavenger cells with an option of conversion of intermediary one tank cell to either rougher or scavenger circuit. Flotation air is supplied by air blower in rougher and scavenger cells. Material from Rougher and scavengers fed to cleaners. There is 3- stage cleaning for lead and 4 Stage cleaning process for Zinc.

Thickening, Filtering & Tailing Disposal: After froth flotation the products from the two streams i.e., stream I and II, Lead concentrate & Zinc concentrates are pumped to respective thickeners. There is 25-m dia high capacity thickener to meet dewatering requirements of Zinc concentrate. For Lead 16-m dia thickener is using. Tailing thickening for the entire tailings generated for 3.75 Million Tonnes ore treatment will be accomplished through one 55-m dia tailing thickeners. Tailing is disposed off to tailing dam via neutralization tank. The hydro cyclone separation system installed ahead of the thickener to reduce the load on tailing thickeners and recover more water.

Thickened slurry of lead & zinc thickener underflow is sent to respective concentrate holding tanks after which it is subjected to filtration. There are 1 No. PF-25 Larox Filter for lead & 1 Nos. of Larox PF-25 filters for zinc.

Filter cake discharges having a moisture content of 8-9% moisture are carried to respective stockpiles.

2.2.25.3 Stream 3

Wet Grinding & Classification: A SAG mill of size 6.1-m dia x 3.35-m length (Effective Grinding Length EGL)receives coarse ore from new COS via a series of conveyors. A cross-belt magnet picks up any tramp iron on the 1st conveyor. An in line magnetic separator for picking up further extraneous material is installed on pebble reject conveyor. A metal detector installed on 1st conveyor monitors for any metallic object entrained in the stream. While the belt weigh scale located at feed conveyor monitors & controls the tonnage of ore fed to SAG mill the belt

scale located at pebble reject conveyor monitors the pebble rejects coming out of SAG mill.

After 1st stage primary grinding in the SAG mill in closed circuit with a 6100-mm length X width 2130-mm (duty separation 6-mm) single deck wet PU vibrating screen, the wet screen undersize is pumped to a two-stage classification system Screen oversize (pebble reject) is returned to SAG Mill feed conveyor.

The 1st stage cyclone overflow at about 50-52% solids is pumped to the 2nd stage cyclones and both stage cyclone underflows at about 70% solids each is subjected to grinding in a ball mill of size 4.57-m dia X 7.60-m length(EGL). The ball mill discharge joins SAG mill discharge (wet screen undersize) for pumping to the 1st stage cyclones.

Max feed size to SAG Mill is 180-230-mm while the average F80 size is 150-mm. It produces a product of fineness 600-800 microns using 125-mm dia (top up size) hyper steel balls while hi-chrome balls of 40-mm dia (top up size) are used in ball mill. The SAG Mill is equipped with load cells to measure the weight of material inside it including grinding media.

The second stage cyclone overflow has a design fineness of 80% passing 63 microns which at 28-32% solids constitutes feed to flotation circuit.

Lead-Zinc Conditioning and Flotation: A lead conditioner of 50 M^3 (3.875-m dia x 4.820-m ht) capacity receives 2nd stage cyclone overflow from grinding circuit. There are seven(7) lead rougher-scavenger cells (40 M^3 each) with each cell having its own level & air flow measurement . There are four dedicated rougher & two dedicated scavenger cells while the fifth cell can be used as either rougher or scavenger circuit. Lead middling is recirculated back to lead Conditioner.

There are three stages of lead rougher concentrate cleaning, the first two stages each incorporating 2 (5 M^3 each) cells while third stage has one 5 M^3 cell.

There are two zinc conditioners each of 50 M^3 (3.875-m dia x 4.820-m ht) capacity receives lead scavenger tail. Zinc rougher-scavenger (50 M^3 each) cells are arranged in 2+1+2 configuration, with two dedicated rougher & two dedicated scavenger cells with an option of conversion of intermediary one tank cell to either rougher or scavenger circuit. Zinc middling is recirculated back to zinc conditioner via a zinc regrinding mill 2.74-m dia X 3.66-m length(EGL) which is in closed circuit with Krebs g-max 6 cyclones (8 op + 2 standby). P80 of zinc regrinding mill cyclone overflow is approx. 37 microns. Four stages of zinc rougher concentrate cleaning are provided, the first stage has 3 x 40 M^3 cells, second stage 3 cells (20 M^3 each), third stage 3 x 20 M^3 cells and the fourth stage 2 x 20 M^3 cells.

Reagents are added at various points throughout the circuit based on Multistream Analyzer (MSA) output and most are totally programmed & fed through APC control. The operation is controlled through Honeywell DCS system.

Thickening, Filtering & Tailing Disposal: After froth flotation the products, Lead concentrate & Zinc concentrates are pumped to respective thickeners. There is

16-m dia high capacity thickener to meet dewatering requirements of Zinc concentrate. For Lead 8-m dia thickener is using. Tailing thickening for the entire tailings generated will be accomplished through one 30-m dia tailing thickener. Tailing is disposed off to tailing dam via neutralization tank. The hydro cyclone separation system installed ahead of the thickener to reduce the load on tailing thickeners and recover more water.

Thickened slurry of lead & zinc thickener underflow is sent to respective concentrate holding tanks after which it is subjected to filtration. There are 1 No. PF-25 Larox Filter for lead & 1 No. of Larox PF-54-60 filters for zinc. Filter cake discharges having a moisture content of 8-9% moisture are carried to respective stockpiles. The list of the existing equipment is given in **Table-2.10.**

2.2.26 Details of Tailing Dam

2.2.26.1 Tailing Dam

The existing dam was constructed by aligning the embankment dam along its four sides almost on a plain ground. The material for construction of dam consists of mine muck. The bottom and side walls of the dam are made impervious by putting the impervious layer of clayey soil and raising the dam in phases. Stone pitching (riprap) has also been provided on inner face of dam embankment to prevent soil erosion.

The tailings are discharged along the periphery wall of the dam through a pipe line. In dam, the solid particles settle down and clean water accumulates at lower end of the impoundment. It is pumped out and recycled to plant. In reclaim water sump a level control switch has been provided to control the water level in the sump and prevent the overflow of the water. Thus, no water is allowed to go out of the mine premises and zero discharge status is maintained.

Besides tailings, mine pit water and run-off water from plant and waste rock dumps is also discharged into tailing dam. This facilitates to operate the entire premises on zero discharge.

TABLE-2.10
EXISTING EQUIPMENT OF BENEFICIATION PLANT

Sr. No.	Particulars	Existing
1	Primary Crusher	2
2	Secondary Crusher	1
3	Tertiary Crusher	3
4	Rod Mill	3
5	Ball Mill	5
6	SAG Mill	2
7	Zinc Regrind Mill	3
8	Lead Rogher/ Scavenger Cells	29
9	Lead Cleaner Cells	21
10	Zinc Rogher/ Scavenger Cells	32
11	Zinc Cleaner Cells	47
12	Pressure Filter	12
13	Air blower	10
14	Air Compressors	15

Sr. No.	Particulars	Existing
15	High rate thickners	7
16	Hydrocyclones	18

2.2.26.2 Design of Tailing Dam

Layout

The tailing dam was created by aligning the embankment dam along its four sides almost on a plain ground. Thus, the pond is confined on all the sides by its own embankment and the pond area itself is the catchment area. Clear water gets separated from the tailings and is collected in the lower portion of the impoundment. A garland drain was constructed along two sides of dam to collect seepage, if any, and discharges in reclaim water sump for recirculation to beneficiation plant.

Foundation Investigation

During foundation investigation, three bore holes were drilled near the dam axis. The log of bore holes indicate that

- The depth of the overburden soil is very shallow;
- Weathered rock is available at a depth varying from 1.2 m to 1.83 m;
- Hard granite gneiss is available below it, at a depth of 10 to 15m;
- The soil belongs to Clay loam, Sandy Clay and Sandy murrum group of soil classification; and
- Permeability value of the area ranged between 0.6 x 10^{-6} cm/sec to 4.8 x 10^{-6} cm/sec.

Section of the Dam

The dam section has been designed with mine overburden as shell material. The impervious layer is provided to prevent the percolation of the water into the ground. A zone of smaller fragments of selected overburden is provided between the impervious core and overburden to act as transition zone. Upstream riprap is provided for protection against erosion. The up stream and down stream slopes of 2:1 with suitable berms are provided based on the stability analysis results. The cross section of tailing dam is depicted in **Figure-2.10.**

Stability Analysis

The slope stability analysis was carried out by Swedish slip Circle Method by Central Water Commission (CWC). Analysis was carried out for the following conditions;

- Steady seepage condition without earthquake; and
- Steady seepage condition with earthquake

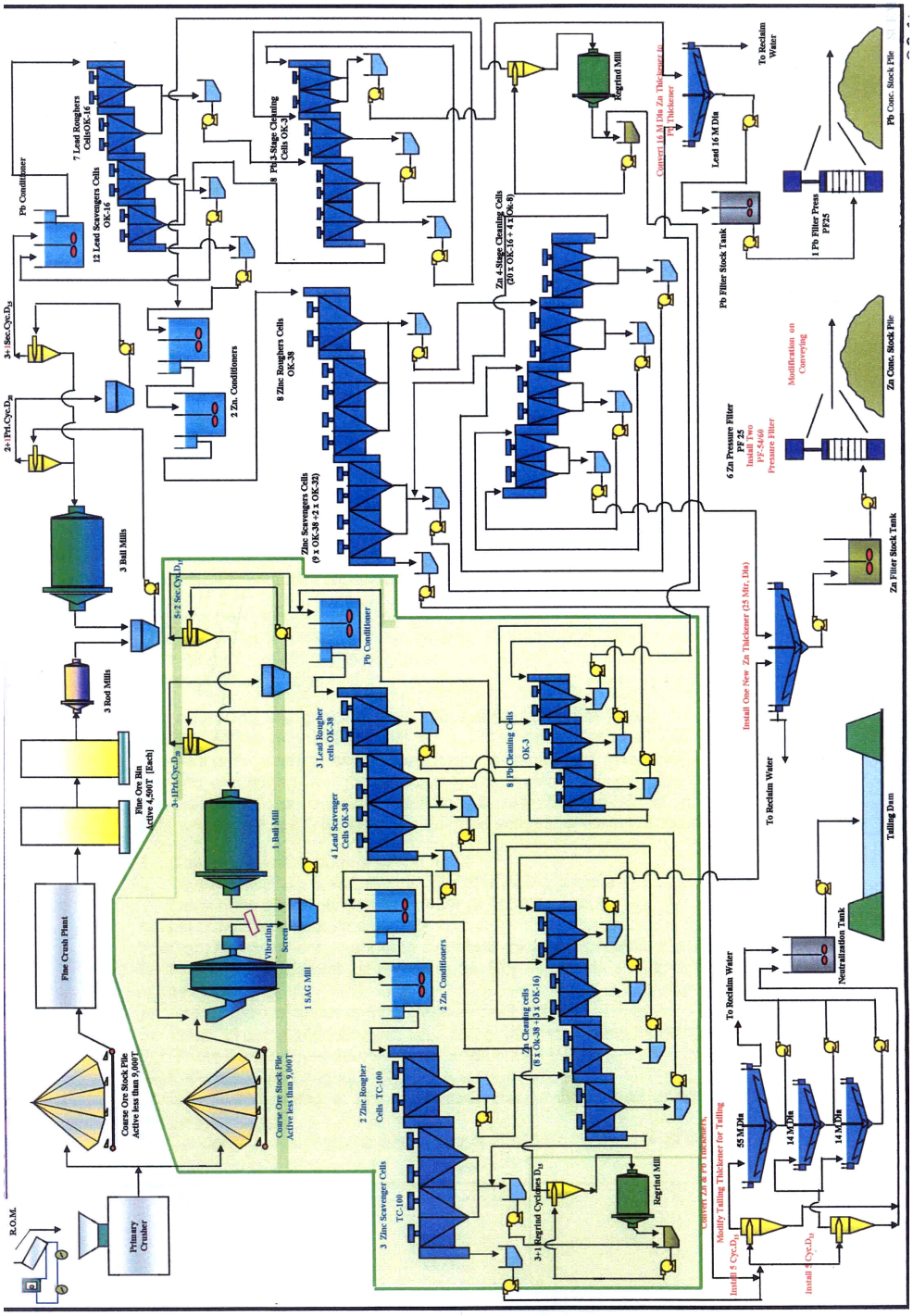


FIGURE-2.9
SCHEMATIC DIAGRAM OF BENEFICIATION PLANT

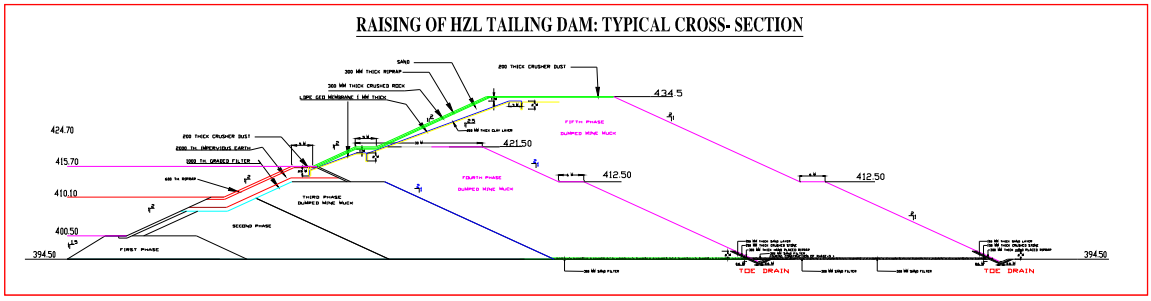


FIGURE-2.10
CROSS SECTION OF THE TAILING DAM

Based on the stability analysis results, a safe and economical design is adopted for the Tailing Dam.

The factor of safety attained for the final section adopted are given in **Table-2.11.**

TABLE-2.11
FACTOR OF SAFETY FOR THE TAILING DAM

Elevation (mRL)	Up stream steady seepage		Down stream steady seepage	
	Without Earthquake	With Earthquake	Without Earthquake	With Earthquake
Stage-II				
402.50	--	--	1.546	1.338
400.50	1.575	1.207	--	--
394.50	1.690	1.265	1.539	1.257
392.50	1.901	1.416	1.675	--
Stage-III				
410.50	1.551	1.221	--	--
409.50	--	--	1.524	1.314
402.50	--	--	1.763	1.496
400.50	1.636	1.232	--	--
394.50	1.673	1.246	1.689	1.433
392.50	1.770	1.304	1.727	1.435
Minimum Factor Safety required as per IS code	1.500	1.000	1.500	1.000

The same safety factors are strictly observed during every stage of height raising.

2.2.26.3 Stage wise Development of Tailing Dam

The initial ground level at the tailing dam was 392.5 mRL. In the first phase, tailing dam of 6m height was constructed from 392.5 to 398.5 mRL. In the IInd phase, tailing dam height was raised from 398.5 to 404.50 mRL. The third phase height raising of the tailing dam was completed from 404.50 to 410.50 mRL during 2002.The 4th Phase of height raising was completed from 410.50 mRL to 419.5 mRL during 2006-07. The 5th Phase of height raising is under progress from 419.5 to 425.5 mRL. The height of tailing dam can be raised upto 51m to accommodate the tailing till the mine life, the details of capacity of tailing dam are given in **Table-2.12**.

Present Status of the Tailing Dam

The existing tailing dam having surface area of 130ha. and height of 24-m with 3-m filter bed i.e. total height is 27-m from ground level (392.5 mRL to 419.5 mRL) and capacity of 15 million cubic meters.

TABLE-2.12
CAPACITY OF TAILING DAM

Phase	Description	Area (m^2)	Average area (m^2)	Average height (m)	Volume (mm^3)	Equivalent OT (Mmt)	Cummulative OT (Mmt)
1	Bottom area at 394.50	776504	787260	6	4.72356	7.8726	7.8726
	Top area at 400.50	798016					
2	Bottom area at 400.50	835920	857900	6	5.1474	8.579	16.4516
	Top area at 406.50	879880					
3	Bottom area at 406.50	897360	920370	6	5.52222	9.2037	25.6553
	Top area at 412.50	943380					
4	Bottom area at 412.50	955380	992280	9	8.93052	14.8842	40.5395
	Top area at 421.50	1029180					
5	Bottom area at 421.50	1054452	1079940	6	6.47964	10.7994	51.3389
	Top area at 427.50	1105428					
6	Bottom area at 427.50	1130988	1156908	6	6.941448	11.56908	62.90798
	Top area at 433.50	1182828					
7	Bottom area at 433.50	1208964	1235316	6	7.411896	12.35316	75.26114
	Top area at 439.50	1261668					
8	Bottom area at 439.50	1288236	1315020	6	7.89012	13.1502	88.41134
	Top area at 445.50	1341804					
Total				**51**	**53.0468**	**88.41134**	

2.2.26.4 Geological Stability of the Tailing Dam

Geological studies were conducted to assess the stability of the tailing dam. The studies were conducted by Mohanlal Sukhadia University, Udaipur in 1999 and National Institute of Rock Mechanics, Kolar Gold Fields, Kolar in 2000. The study has been concluded as follows;

1) Natural seismicity in the region of Rampura Agucha mine is very low and there are no records of any damage to the structures on account of earth quakes;

2) Induced seismicity is also unlikely in view of very small quantity of water stored in the tailing dam;

3) The thin soil cover in tailing dam area is very dry indicating no leakages/seepages from the tailing dam;

4) Hydrogeology of the area indicates very little ground water movement in the region;

5) An impervious layer was laid at the base of the dam. Tailing settles and water is reclaimed and recycled to process plant; and

6) Tailing dam site has solid bedrock of different lithologies due to rock formation under high pressure-temperature conditions prevailing at depth, the rocks have turned into a highly compacted solid mass with very few joints.

Even the mylonites, which constitute very thin layers are also different from a fault breccia forming under subsurface condition, in the sense that even the most minute grains are interlocked between themselves without any trace of matrix

cement. Scanning photographs taken under Electron Microscope reveal that fluid induced chemical activities have completely sealed even the few micro-fractures, which developed in the rocks.

The soil cover is very thin and the soil bedrock contact is irregular. This makes the foundation quite sustainable for tailing dam with its enhanced capacity.

Considering the possibility of groundwater contamination due to disposal of tailings in tailing dam. HZL sponsored a study on assessment of aquifer vulnerability due to tailing disposal operations at Rampura Agucha Mine. The major conclusions and recommendations of the study area as follows:

The assessment of present practice of tailing disposal at Rampura Agucha Mine revealed that, layers of impervious earth have been provided to the bottom of the tailing dam during various phases of construction. Further, about 50 to 60% water from the tailing dam is collected and recycled back to the process while major potion of the remaining waste gets evaporated due to arid climatic conditions.

The assessment of geological and hydro-geological information at the Rampura Agucha Mine site and its surrounding indicate that the principal aquifer of the area is banded gneissic complex (BGC) located about 8 to 10 m below ground level. Due to the impervious nature of the BGC the hydraulic conductivity of the aquifer is very low indicating poor groundwater potential in the area.

The assessment of aquifer vulnerability at Rampura Agucha Mine area using DRASTIC model indicates that the Rampura Agucha Mine area falls under low to moderate category of aquifer vulnerability.

The assessment of groundwater quality around the tailing dam indicates that high concentrations of certain parameters in the groundwater viz. TDS, sulphates, cadmium and iron irrespective of their location (upstream and downstream of tailing dam) could be due to the hydrogeological setup of the area. Further, no direct correlation could be established between the tailing dam and the groundwater quality.

Thus, an overall conclusion could be drawn from the study that the tailing dam at Rampura Agucha Mine had been constructed at a site which has low to moderate groundwater pollution potential. The present practice of tailing management at Rampura Agucha Mine does not pose significant danger to the existing groundwater resources in the area.

However, keeping in view the long-term operation of the tailing dam, it is recommended that Rampura Agucha Mine should continue to monitor the groundwater quality around the tailing dam regularly. Besides the existing groundwater monitoring locations, additional piezometers, especially in the downstream of the tailing dam may be installed by Rampura Agucha Mine.

2.2.27 Details of Raw Material and Products

The chemicals and fuels are the main consumables. The consumption and storage capacities are given in **Table-2.13.**

TABLE-2.13
RAW MATERIAL REQUIREMENT AND STORAGES

Sr. No.	Description	Requirement (Tonnes/Day)	Storage Capacity in Tonnes
1	Raw Material (lead-zinc ore)	20,000	27000
2	Products Zinc concentrate Lead concentrate	 3400 300	60000
3	Potassium Ethyl Xanthate	0.988	200
4	Sodium Iso Propyl Xanthate	0.28	200
5	MIBC	0.76	25
6	Sodium Cynaide	0.532	18
7	Copper Sulphate	13.68	150
8	Nigrosine	3.04	100
9	Hydrated Lime	17.48	-
10	Grinding Media (Balls)	12.16	-
11	Grinding Media (Rods)	2.89	-
12	HSD for HEMM Equipment	41 KL	165.5 KL
13	HSD for DG set	43 KL	500 KL

2.2.28 Site Services

2.2.28.1 Surface Transport

The lead and zinc concentrates are transported by trucks/dumpers to the smelters located at Chittorgarh and Udaipur by road and to Visakhapatnam by rail.

2.2.28.2 Workshop

Rampura-Agucha mine is having a central workshop capable to cater all services to all departments of the mine. The list of equipment in the central workshop is given in **Table-2.14.**

TABLE-2.14
LIST OF EQUIPMENT

Sr. No.	Description	No. of Equipment
1	Lathes	4
2	Radial drill	1
3	Column drill	3
4	Milling	1
5	Shaper	1
6	Reciprocating Hacksaw	1
7	Tool and cutter grinder	1
8	Bench grinder	1
9	Hydraulic press	1
10	Plate bending machine	1
11	Crane	1
12	Welding transformer	1

2.2.28.3 Safe Storage of Explosive

Three magazines having total license capacity of

3 X 30 tonnes = 90 tonnes of Explosive

3 X 25000 mtrs = 75000 mtrs Detonating fuse

3 X 10000 nos = 30000 nos Detonators

3 X 20000 coils = 60000 coils safety fuse.

2.2.28.4 Man Power

The mine has presently employed 614 workmen and 180 Executives and approximately 200 contract labourers.

2.2.28.5 Township

HZL has constructed a township for the employees at a distance of 7-km from the mine in NW direction in a total area of 74 ha. The township is well equipped with all the facilities like school, club, playing ground, Children Park, shopping center and hospital. Total 493 numbers of staff quarters are constructed besides one Guest house. The types of quarters are given in **Table-2.15.**

TABLE-2.15
DETAILS OF QUARTERS IN TOWNSHIP

Type	Present
D	7
C	66
2B	48
1B	92
A	216
SH	40
WH	24
Total	**493**

2.2.29 Power Requirement

The power requirement is 30 MW, which is met from the Captive Power Plant of HZL at Chanderiya Lead Zinc Smelter at Chittorgarh by wheeling through state grid of Ajmer Vidyut Vitran Nigam Limited (AVVNL). The sanctioned power from Ajmer Vidyut Vitran Nigam Limited (AVVNL) is a stand by arrangement and two DG sets of 5 MW each capacity are used during emergency.

2.2.30 Fresh Water Requirement

Fresh Water is being transported from radial wells in Banas riverbed through 60-km pipeline up to reservoir by two-stage pumping. Daily fresh water requirement for the mining, beneficiation and colony is 8500 m^3/day.

2.2.31 Land Requirement

Mining lease area is 1200-ha of which the land acquired for mining and industrial use is 869.5-ha. Land use pattern of acquired land prior to mining lease is as given in **Table-2.16**. The acquisition status of the mine lease area is given in **Table-2.17.**

TABLE-2.16
LAND USE PATTERN OF ACQUIRED LAND

Landuse	Area (ha)
Grazing land	70
Waste land (Govt. land)	81.97
Private Land (including agricultural)	692.53 (approx.)
Private land (outside mining lease)	25 (approx.)
Total	**869.5**

TABLE-2.17
ACQUISITION STATUS OF LAND IN MINING LEASE

	Village	Govt. Land (ha)	Pvt. Land (ha)	Total (ha)
Land Acquired	Agucha	138.30	325.00	463.30
	Kothiyan	51.67	354.53	406.20
	Sub total	**189.97**	**679.53**	**869.50**
Land Acquired outside ML area for township	Hurda (7 km from Mines)	74.00	-	74.00

Land use pattern of acquired land of mining lease at present is as given in **Table-2.18**. To accommodate pit expansion 20-ha additional land will be acquired within the mining lease during the plan period.

TABLE-2.18
EXISTING LAND USE PATTERN OF ACQUIRED LAND

Break up of Land use	Existing operations			Total
	Degraded	Rehabilitated	Undisturbed	
Pit & Waste Dump	286.37	12.3	54.49	353.16
Concentrator	39	-	-	39
Tailing dam	148.93	0	3.07	152
Infrastructure	47.64	0	22.86	70.5
Land put in use for mining & allied activities	**521.94**	**12.3**	**80.42**	**614.66**
Green belt development	258.6	-		258.6
			Total	**873.26**

2.3 Measures Adopted for Controlling Pollution

2.3.1 Measures Adopted for Controlling the Air Pollution

Various mitigation measures have been adopted in the existing mining and beneficiation plant to control the air pollution:

- Track mounted DTH drills with wet drilling system are being used for drilling;
- The production of blast fumes containing noxious gases are reduced by the following methods;
  - Proper mixing of Site Mixed Slurry (SMS) to ensure complete detonation.
  - Use of adequate booster/primer.
  - Proper stemming of the blast holes.
  - Use of electrical/non-electrical initiation system.
- A well-equipped workshop is set up for the regular maintenance of vehicles and machineries in order to control emissions. Air Conditioned Cabins are provided to shovel and dumpers to protect the operator from the direct exposure to dust and gaseous emissions.
- Water spray nozzles are provided at crusher, and the locations where enclosure and fugitive dust collection is difficult,
- The primary, secondary and tertiary crushers are provided with wet venturi scrubber to collect the dust while crushing the ore. The scrubbed slurry is pumped to grinding for disposal within the process. Sampling ports are provided for source emission monitoring purpose;

  The dust on the haul road is suppressed by automatic water sprinklers system installed at permanent haul roads and by three water sprinklers of 28-m^3 and two 40 KL capacity each. The haul road is maintained by two motor graders. In addition, an automatic water sprinkling system has been installed on permanent haul roads. The frequency of water sprinkling is once every hour during summer and once every two hours during other seasons like winter and post-monsoon season. The frequency has been increased and will be extended as per the mine development.
- The exhaust of all the earth moving machinery is directed upwards to prevent dust entrapment;
- Truck tyre washing system is installed near the weigh bridge to wash out the concentrates attached to wheels of the truck;
- Cleaning of Industrial roads by Mechanical Road Sweeper;
- The conveyor belts are covered to prevent dust losses into atmosphere;
- The moisture content of 7 % to 8% in the concentrates is maintained to prevent dust generation during loading and transportation. The concentrate carrying trucks are covered with tarpaulins from top and sides;

- Ambient Air quality monitoring is regularly conducted at three locations within the mine area and three locations in nearby villages. Stack emissions are also regularly monitored; and

- The Eco-Plan was prepared in the year 1988-89 for the Greenbelt development and the same is meticulously implemented covering 260 ha of land out of 869.5 ha. Till date more than 2,72,000 saplings have been planted in the existing mine and colony with survival rate of more than 80%.

The above-mentioned mitigation measures are implemented under air pollution management to mitigate any adverse impacts on surrounding and work zone area. Additional plantation is planned to be done on the solid waste dump and other vacant places.

Regular monitoring of stacks, dustfall rates and ambient air quality is carried out which indicates that the air quality is well within acceptable limits, and indicates the adequacy of the pollution control measures.

The baseline ambient air quality within and outside the mine lease area indicates that the concentrations of pollutants like RPM, SO_2, NOx, CO and lead are within the permissible limits applicable for residential zone. The SPM concentrations in the rural/residential areas have been observed to be slightly exceeding the respective permissible limits. This could be attributed to the typical dry climate and open fields and unpaved roads of the study area. However, the SPM concentrations within the mine area are observed to be within the permissible limit of 500 $\mu g/m^3$.

2.3.2 Measures adopted to prevent Water Pollution

All the wastewater generated in the mine and plant are routed to water reclamation tank and then recycled back to beneficiation plant for further use.

➢ ***Existing Mitigation Measures***

- Plant tailings are discharged in tailing dam, tailing water is collected and pumped back to beneficiation plant for reuse in process;

- Mine water is pumped to reclaim water reservoir and gets recycled;

- All spillages, overflows and other wash streams from the industrial area are collected and pumped to reclaim water reservoir for recycling;

- Run-off water from waste dump area is collected during monsoon and pumped to reclaim water reservoir;

- Oil and grease trap is used for collecting oil & grease from Heavy Vehicle Service Center (HVSC) effluents;

- Sewage Treatment Plant having capacity of 425 KL/day is being installed in HZL township and 300 KL/day at mine to treat domestic wastewater; and

- A reservoir of 50000 m^3 was constructed near beneficiation plant to collect and recycle water from tailing dam, mine and other areas for reduction of evaporation losses in tailing dam.

- Improved dumper cleaning system at Heavy Vehicle Service Center (HVSC) including oil trap;

- Sewage Treatment Plants in the industrial area with provision for recycling of treated effluent to increase the water recovery and reduce the fresh water consumption;

- High rate thickeners to improve the water recovery from tailing and concentrates; and

- Flocculants in the thickeners to improve water recovery.

As a result of these measures, an effective zero discharge is maintained from the mine premises. As a part of the improvement measures, recently, a system for tailing dewatering through hydro-cyclones has been commissioned to increase the water recovery from tailings before disposal to tailing dam.

Water quality is being monitored at various locations within and outside the mine area and is observed to be unaffected by mining activities.

2.3.3 Mitigation Measure to control Noise Levels

Adopted mitigation measures for noise and ground vibrations are of following types:

- Well equipped workshop is set up for the regular maintenance of vehicles and machineries in order to reduce noise generation;

- All dumpers and excavators are provided with A. C. enclosures;

- Blasting is performed strictly as per the DGMS guidelines such as blasting during day hours between 2 PM to 3 PM when temperature inversions are unlikely and blasting is avoided during high wind conditions;

- Excavators & dumpers supplier has to demonstrate the noise level below 85 dB (A) inside the cabin and they have to maintain the equipment in good health for 5 years; and

- Air over pressure is controlled effectively in each and every round of blast by planned charging

The charge per delay and total charge is minimized and preferably more number of delays are used per blast;

- Steel liners in Ball mill are replaced by Rubber liners;
- Boundary walls (Baffle walls), waste banks and dense belt of trees are erected as acoustic barriers;
- Noise is abated at source by suitable mounting of equipment and ventilation systems and by providing noise enclosures or padding wherever necessary; and
- Greenbelt is developed in and around the mine area to intercept noise transmission. A 30-40 m wide belt of trees of different heights are useful to act as noise attenuator in the mining areas.

- ***Vibration Abatement***

Blasting operations cause ground vibrations and noise. Vibration may cause structural damages, due to high intensity. High intensity of Air Over Pressure can damage structurally unsound buildings and cause window shattering.

The details of blasting, vibration monitoring and methods adopted in blasting in order to control the vibrations are given in **Annexure-IX.**

2.3.4 Solid Waste Generation

Hazardous waste generation from the mine/mill is in the form of used lube oil, discarded containers of Sodium cyanide and tailings. The overburden waste generated during mining is non-hazardous in nature. The solid waste generation from the beneficiation plant and mine is presented in **Table-2.19.**

TABLE-2.19
SOLID WASTE GENERATION

Sr. No.	Waste	Quantity	Source	Schedule under Hazardous waste Rules	Disposal
A	**Hazardous Waste**				
1	Used / Burnt Lube Oil (Ltrs/day)	500	Used lube oil from vehicles and machinery	Schedule I Category 5.1	Sold to authorized refiners
2	Discarded Containers (Nos/day)	8-10	Decontaminated Discarded containers of Sodium Cyanide	Schedule I Category 33.3	De-contamination and sold as scrap
3	Tailings (Million Tonnes/day)	11860	Tailing generated from beneficiation plant	Schedule II A2, A4, B4, C14.	Disposed in Tailing pond
B	**Non Hazardous**				
1	Waste Rock (m^3)	62650	From Mining Operation	--	Stacked in overburden dumps

The chemical analysis of tailings and Waste rocks is given in **Table-2.20** and **Table-2.21** respectively.

TABLE-2.20
CHEMICAL ANALYSIS OF TAILINGS

Sr. No.	Parameter	Range
1	Pb	0.40 – 0.50 %
2	Zn	1.2 - 1.8 %
3	Fe	9.41 - 10.29 %
4	Cu	146 - 158 ppm
5	Ca	48 - 69 ppm
6	Ag	25 - 27 ppm
7	ISM (Acid Insoluble)	63.52 - 63.44 %
8	C	4.97 – 6.09 %
9	Ni	101 - 105 ppm
10	CO	39 - 45 ppm
11	Mn	311 - 315 ppm

TABLE-2.21
CHEMICAL ANALYSIS OF OVER BURDEN ROCK WASTE

.

Composition	Range
SiO_2 (%)	55.60 - 58.70
Al_2O_3 (%)	15.20 - 21.00
CaO (%)	0.57-2.15
Bi (ppm)	2-14
Ni (ppm)	2 - 70
Co (ppm)	2-30
Cu (ppm)	8-240
Pb (ppm)	2-192
Zn (ppm)	95-1050
Fe (%)	2.4 – 4.0
Cd (ppm)	4 – 30

2.3.4.1 Measures adopted for Storage and Disposal of Hazardous Waste

Discarded containers and used Lube oil are stored in the specific earmarked area in store yard for disposal. The disposal method adopted presently is given below:

- **Used / Burnt Lube Oil**

Used lube oil is generated from vehicles, machineries and mine equipment. The used oil is collected in drums and stored in an ear-marked area in the store. The used oil is sold to re-refiners registered with MoEF/CPCB.

- **Sodium Cyanide**

Sodium Cyanide pellets are received in MS drums with inside polythene liner. Each drum has a capacity of holding 50/100 kg of material.

Collection: Empty drums are collected from the plant and are made unusable by perforating sides, top lid and bottom and then decontaminated before disposal.

Method of Decontamination of Drums and Liners

The punctured drums, lids and clips are immersed in 5-7 % Sodium Hypochlorite solution for 24 hours and then rinsed with water.

2.4 Disposal of Mine Waste/Overburden and Reclamation

There are four earmarked sites to store the overburden i.e. Site-1, Site-2, Site-3 and Site-4. Existing active dump area is located on northern side of the mine. Top elevation of current dump area is 435 mRL. Waste generated by mining is being dumped at pre decided sites in ultimate dump configuration of 4*10-m lifts for minimum land degradation. Each lift has angle of 45^0 and overall final slope of approximately 27^0. This overall slope angle is kept to limit the increase in surface air velocity and dust entrainment and to aid stability.

The following areas are presently available for accommodating waste:

- Current Dump Area;
- Tailing Dam Bund (Height to be raised up to 51-m in lifts);
- Bund / wall around pit of 5 to 10-m height & 30-40-m wide at top; and
- Main dump area north of the pit

Due care is taken in all respect for its confinement like the provision of dump stabilization by vegetation on ultimate non-moving ends. Till end of March 08, 12.3 ha. of non-active area of waste dump have been stabilized by covering with top soil & plantation.

Mitigation Measures adopted in Overburden Dump

- Overall slope of 27^o and maximum height of 40-m is maintained to give proper stability to the dump;
- Waste is stacked systematically in layers and leveled by dozer;
- After reaching the benches to their ultimate location, plantation is being done;
- Construction of garland drains around the dump so that surface run off from the dump is collected in a sump and pumped to tailing dam; and
- Regular maintenance of the garland drains constructed around the solid waste dump to collect the surface run off.

2.5 Green Belt Development

HZL initiated the greenbelt development program in the year 1988-89 on a very large scale. The lease hold area was totally barren land prior to the establishment of the mine. The intensive plantation by HZL has changed the look of the area. The total 1200 ha of mining lease area consists of non-forestland with semi-arid climatic conditions. The acquired land for mining activities is 869.5 ha.

The greenbelt development program started by planting 5000 numbers of saplings covering an area of 4.5 ha in the year 1988-89. So far about 260 ha of land has been brought under green cover and about 2,72,000 number of plants have been planted. Plantation is done along the roads, on the periphery of mining pit, near waste dump, near beneficiation plant and near administration building. In addition to this about 35,000 number of plants are planted in township covering an area of 33.5 ha of land.

The wide varieties of plant species were selected on the basis of climatic conditions and its suitability to serve the objectives. The list of plants along with their botanical names is given in **Table-2.22.**

TABLE-2.22
LIST OF SPECIES

Sr. No.	Local Name/Hindi	Botanical Name
1	Shisham	*Dalbergia sissoo*
2	Gulmohar	*Poinciana Regia*
3	Bamboo	*Bambusa Arundinacea*
4	Cassia Siamea	*Cassia Siama*
5	Gadhapalas	*Butea frondosa*
6	Karanj	*Pongamia Glabra*
7	Peltaferrum	*Peltoforrum ferrusinum*
8	Arjuna	*Terminalia Arjuna*
9	China Rose	*Hibiscus Spp*
10	Kaner	*Nerium indica*
11	Bilpatra	*Aegle marmelos*
12	Sejana	*Moringa Pterygosperma*
13	Subbabool	*Leucena leucophloe*
14	Siras	*Albizzia Lebbek*
15	Eucalyptus	*Euclayptus Spp*
16	Bakain	*Melia Azederach*
17	Kanui Churhel	*Sesbania suevalens*
18	Bouganvillea	*Bouganvillea Spp*
19	Neem	*Aeardichta Indica*
20	Amaltas	*Cassia Fistula*
21	Kiker	*Prosopis spicegera*
22	Parkinsonia	*Parkinsonia*
23	Cassia javanica	*Cassia Javanica*
24	Ashoka	*Polyalthia longifolia*
25	Bottlepalm	*Orodoxia regia*
26	Pipal	*Ficus Religiosa*
27	Bad Banvan	*Ficus Bengalensis*
28	Paras Pipal	*Thespesia Populeama*
29	Casurina	*Casuarinas equisetifolia*
30	Dalmoth	*Thevetia peruviana*
31	Juliflora	*Prosopis Julifora*
32	Babool	*Acacia arabica*
33	Bottle Brush	*Callistemon Lanceolatus*
34	Cess Suloa	*Pedalium sp*
35	Castor	*Ricinus communicus*
36	Khejra	*Prosopis cineraria*
37	Kachnar	*Delonix regia*
38	Dhak/Dhakara	*Butea Frondosa*
39	Acacia	*Acaca nilotica*
40	Akashneem	*Millingtonia neem*
41	Saptparni	*Alstonia scholaris*
42	Lemon	*Citrus Lemon*

Sr. No.	Local Name/Hindi	Botanical Name
f43	Karonda	*Carissa carandus*
44	Imali	*Tamarindus Indica*
45	Amla	*Euphorbia officinalis*
46	Papaya	*Carica ppaya*
47	Ber	*Zyphus Mauritiana*
48	Jamun	*Euginea Jambolana*
49	Mulberry	*Morus Alba*
50	Pomegranate	*Punica Granatum*
51	Guava	*Psidium guava*
52	Gonda	*Cordia Rothi*
53	Mango	*Mangifera indica*

*This is common list of plants species for industrial area and colony.

The plantation and maintenance is looked after by a qualified and experienced horticulturist under the overall guidance of environment manager. This has ensured very good survival rate of plants, which is more than 80%. For the implementation of greenbelt development program, HZL has made separate budgetary allocations.

3.0 PROJECT DETAILS AND SOURCES OF POLLUTION: PROPOSED EXPANSION

3.1 Introduction

In the proposed capacity expansion at this mine involves addition of larger mining equipment so as to handle increased tonnages and installation of a parallel stream of grinding and flotation equipment. The final ore production capacity, after expansion, shall be annual production of 6.5 million tonnes of ore.

3.2 Exploration Details in Expansion Phase

Preliminary exploration was initiated by DMG. Government of Rajasthan in 1978 – 79. In November 1979 Hindustan Zinc Limited prepared a detailed exploration scheme. The exploration completed in four stages with sequential evaluation of data.

Further to assess the resource potential at depth, 10000-m of drilling at depth is proposed during the year 2008-09. Based on the results, further exploration scheme will be devised and taken up. Till October 2008, approx 9021-m drilling has been completed against the drilling target of 10000-m. The category wise ore reserves are given in **Table-3.1.**

TABLE-3.1
STATUS OF ORE RESERVES & RESOURCES
(As on 01/04/2008)

Sr. No.	Category (UNFC)	Million Tonnes	Zn (%)	Pb (%)
1	Proved (111)	11.71	13.52	2.11
2	Probable (121)	51.85	12.84	1.90
3	Total Reserve	63.56	13.0	1.94
4	Indicated (122)	22.77	15.66	2.21
5	Inferred (222)	21.0	14.92	1.85
6	Total Resource	43.77	15.3	2.04
	TOTAL	**107.3**	**13.92**	**1.98**

3.3 Conceptual Mine Plan

3.3.1 Extent of Deposit

The deposit is a plunging isoclinal synform with rock units showing NE – SW strike with steep dips (75^0–80^0) in hanging wall & moderate dips (60^0–65^0) in footwall towards SE. The host rock occupies the core of the synform and plunge in southwestern limit is 65^0 – 70^0 due NE. The strike length of deposit is 1580 m and average width is 58m.

3.3.2 Present Open Pit

Mine is being worked with shovel dumper combination and as per the working permission granted by DGMS. Operation is being carried out with bench height of 10-m, berm width of 6.5-m with batter angle of 70º and 80º on F/W and H/W respectively. Two access ramps of 25-m wide each in F/W and H/W, with gradient of 1 in 12, provides the entry to the pit.

As per the bench height and strata condition, 165-mm dia holes are drilled at specified drill pattern and bulk emulsion explosive and NONEL initiation system are used for blasting for required fragmentation. Excavators from 9 to 15-m^3 bucket capacity with dumper of 95 Million Tonnes class are used for loading and hauling of ore and waste material. Mine is being worked on ultimate pit depth design of 372-m and with present depth of 170-m from surface.

3.3.3 Pit Optimization and Design

In the proposed expansion, mining will continue with shovel dumpers combination, utilizing the capacity of existing equipment and addition of required numbers of equipment. (Excavators in 30-34 m^3 capacity with 177 to 218 metric tonne capacity dumpers)

With the proposed higher capacity mining equipments and supported by geo-technical investigations, bench height of 12-m has been proposed. Considering these parameters, modification in working permission has been granted by DGMS. Both access ramps are designed with gradient of 1 in 10 and 30-m width

The present open pit mine operation is planned on three shifts of 8h duration basis. The mine is scheduled to work for 342 days/ year after keeping margin for public holidays and days lost due to seasonal effects like rain & storm.

In the opencast mining operation, the in-situ overburden and ore body is loosened by drilling and blasting to enable excavation. In the process, box cut is opened at central part of the H/W contact and advancing the waste bench in either directions of the strike i.e., North & South. After sufficient development and advancement of the H/W, ore is extracted. Benches in waste are kept sufficiently advanced compare to ore benches so as during the ore excavation dilution can be minimized. Same practice of development and ore extraction will be followed in the proposed plan period.

To develop geotechnical mine design criteria for open pit and underground mine, geo-technical study was conducted (SRK Consultings-UK). The study involved the development of open pit slope design parameters for ultimate open pit together with detailed batter and berm configurations for stage and ultimate engineered pit design.

Detailed geotechnical investigations were carried out using limit equilibrium method, kinematic stability analysis and check analysis method, derived the slope angles and bench design parameters. These parameters were utilized in the pit optimization.

Analysis of data generated from these bore holes were utilized in determination of the design parameters for the open pit as well underground mine.

In light of updated geological information's, ore body model has been updated and re-optimisation has been carried out. Open pit mining has been envisaged down to a depth of 372-m and beyond which underground mining will be done. Lersch Grossman (LG) pit optimization was performed using the Whittle 4X software over the ore body model in determining the optimal depth of the open

pit. Considerations made were geo-technical bench slope parameters, operating cost projection for open pit, operational efficiency of the mine etc.

The ultimate pit has been designed in DATAMINE software using slope angles of 35º & 42º in F/W and H/W respectively as outcome of the geo-technical study. After optimization and pit design, detailed scheduling of ore and waste has been done by considering the annual ore requirement and machinery operating parameters.

As on April-08, Pit contains estimated ore reserves of 48.70 Million Tonnes and waste quantity of 528 Million Tonnes.

3.3.4 Bench Parameters

The design parameters considered in preparation of ultimate pit design are given in **Table-3.2** and **Table-3.3**.

TABLE-3.2
BENCH PARAMETERS FOR FOOTWALL

	Below 300 mRL	Above 300 mRL
Bench height	12m	
Bench Angle	60^0	
Bench Width	7.6m	9.6m

TABLE-3.3
BENCH PARAMETERS FOR HANGWALL

	Below 300 mRL	Above 300 mRL
Bench height	12m	
Bench Angle	70^0	60^0
Bench Width	7.5m	6m

3.3.5 Underground Mining

The conceptual underground study has been carried out by M/s SRK, UK and AMC Australia independently. The deposit has potential of producing 2.0-2.4 Mtpa as well as it is possible to carry out concurrent mining in open pit as well as underground. Accordingly the infrastructures will be developed. The mining will be "Stoping with backfilling" and will be a Trackless mining system. The proposed underground layout is conceptualized for:

- Approach to the deposit below Ultimate Pit by a Decline and a Shaft from surface.
- Footwall drives at safe distance (about 30-40m) from ore body. Footwall drives to be connected to Decline and Shaft.
- A production Shaft equipped with Winder.
- Two ventilation shafts one each at south & north ends of orebody..
- First block of 200m vertical depth below Ultimate Pit bottom, proposed for commencement of production. Subsequent blocks to be developed as the mining advances.

3.3.6 Mineable Reserves and Anticipated Life of the Mine

By the recent exploration activities the ore body up to -675 mRL has been established. The total ore reserves up to this depth are 118.76 Million Tonnes with 13.9 % Zn and 2.0 % Pb (as on 01.04.2008). Looking to the enhanced ore production requirements, the life of mine(open pit and underground) for Rampura Agucha Mine will be approx. 30 years.

In the present economic scenario (which is subjected to review based on dynamic design parameters) open cast mining is considered up to 372-m depth from the surface i.e., up to 18 mRL. The ore reserves within the ultimate open cast mine are 48.7 Million Tonnes (as on 01.04.08) and these reserves are adequate to sustain the open cast mine for approximately 10 years at proposed annual ore production rate. The overall strip ratio at ultimate pit depth is 10.8:1 (Overburden to Ore on tonnage basis) and beyond which it would be more economical to switch over the mining method from opencast to under ground.

The ore reserve (Approx. 58.6 Million Tonnes) beyond the ultimate limits will be mined by under ground method. With present reserve and resource status and at proposed rate of production, the mine will run up to the year 2039 -40.

3.3.7 Proposed Rate of Production when the mine is fully Developed

- **Open Pit**

The mine is presently producing 5 Million Tonnes of lead zinc ore annually. As beneficiation plant will be fully commissioned for expanded capacity by the end of 2009-10, only 5.0 Million Tonnes of ore production is planned during first two years. Further after full commissioning of the expanded capacity of the mill, the rate of ore production from the mine (Openpit and Underground) will be 6.15 Million Tonnes. from the year 2010-11. Accordingly mine plan is prepared, flexible enough to incorporate ore requirement in respective years.

- **Underground**

Initially production is conceptualized from 2011 -12 , which will gradually ramp up to 1.5 Million Tonnes and finally 2.0 Million Tonnes. Rated capacity (2 Mtpa) will be achieved in fifth year (2013-14) on completion of shaft & hoisting system.

3.3.8 Mining

The extent, size and shape of ore body at Rampura Agucha Mine, ideally suited to workout upper part by open pit technique up to techno-economic pit bottom depth and below it by underground mining.

Ore body has been proved down to 1065-m and upper part of ore body is being worked with open pit. Firming of open pit depth is dynamic, influenced by updated geotechnical and financial parameters. However, based on updated input parameters, present consideration for ultimate pit depth is 372-m containing 43.03 Million Tonnes ore and 528 Million Tonnes of waste as on 1.4.2008.

In the proposed expansion, open pit will be continued with shovel dumper combination delivering maximum ore production of 6.15 Million Tonnes in initial year and would be supplemented by underground from 2011-12. Underground will deliver ore production of 2 - 2.4 Million Tonnes/year. In total, opencast and underground mine will deliver 6.15 Million Tonnes ore / year.

The reserves falling within ultimate pit depth of open pit mine are 48.7 Million Tonnes and these reserves are adequate to sustain open pit mine for approx. 10 years at the proposed annual ore production rate. The open pit depth and reserves are subject to further review based on up dated geotechnical information's and other dynamic input parameters. The overall strip ratio at ultimate pit depth is 10.8:1 (Overburden to Ore on tonnage basis) and beyond which it would be more economical to switch over the mining method from opencast to under ground.

Reserves and resource potential for the U/G mining is 75.73 Million Tonnes, (including reserves of 7.01 Million Tonnes with 12.20% Zn and 1.54% Pb from level -100 mRL to -175 mRL).

In the proposed expanded ore production scenario, life of the mine(including underground) will be approx. 30 years, which may get extended depending upon addition of ore reserves at depth and level of ore production from underground mine, beyond the economic depth of open pit. The combined open pit and underground ore production schedule for the next three years is as given in **Table-3.4**.

TABLE-3.4
THREE YEAR ORE PRODUCTION SCHEDULE (OPENPIT AND UNDERGROUND)

	2009-10	2010-11	2011-12
Open pit (Million Tonnes)	5	6.15	6.05
Underground (Million Tonnes)	0	0	0.1
Total (Million Tonnes)	5	6.15	6.15

Yearwise production details since 1994 onwards is as given in **Table-3.5**

TABLE-3.5
YEARWISE PRODUCTION DETAILS SINCE 1994 ONWARDS

Year	Ore Production (Mtpa)	Environmental clearance granted (Mtpa)
1994-1995	1.004	0.90
1995-1996	1.079	
1996-1997	1.012	
1997-1998	1.001	
1998-1999	1.290	
1999-2000	1.425	1.35
2000-2001	1.485	
2001-2002	1.516	
2002-2003	1.810*	
2003-2004	2.172	
2004-2005	2.470	3.75
2005-2006	3.512	

2006-2007	3.749	
2007-2008	4.075	5.00

- Submitted the application under ex-post facto environmental clearance for the enhancement of capacity to 2.15 Mtpa by debottlenecking.

3.3.9 Year Wise Development for the Next Three Years

- **Open Pit**

The plan and sections show that proposed mining is planned from the anticipated pit position at the end of 2008-09. The mining will be distributed from the surface to 150 mRL down. For the proposed three year period mining will be done on 10-m benches in both waste and ore for existing cut backs and new cut backs will be started with 12-m benches both in ore and waste.

Two separate ramp developments in FW and HW are planned. With in next five years almost the entire strike length of the ore body will be exposed in N-S direction. The plan enables a large amount of mining flexibility with in the constraints of the overall mining limits. This allows maximum utilization of the mineable resources. Numerous ore faces can be exposed so that blending of ore can be accomplished.

The plan shows development of sump in hanging wall every year. The pit water collected in the sump away from the ore body which would allow mining above this water level during rainy season. South side of the pit is generally higher than the north side, this will also allow ore mining from south side in rainy season in worst possible situation.

- **Underground**

The access and ventilation infrastructures etc, will be developed in next five years. Decline outside Pit will be developed to reach to bottom of first mining block i.e. below Ultimate Pit Bottom. Intermediate levels will be opened to develop footwall drives. Underground mining will commence from North ore body, which will be developed through ramp. The shaft outside pit will be excavated and connected to bottom of first block. It will be equipped for crushing & hoisting of ore of the first block.

At ends of the ore body, ventilation shafts will be excavated and connected to footwall drives. With completion of ventilation circuit and main access of mine, commence production from north block. Till the shaft gets commissioned, the initial production will be hauled out through decline. Mining will continue down below first block. Shaft, decline, ventilation system etc will be extended. The isometric view system is shown in **Figure-3.1.**

The schedule of quantities for overburden and total excavation in BCM and Million Tonnes within the plan period from open pit and underground are shown in the **Table-3.6**.

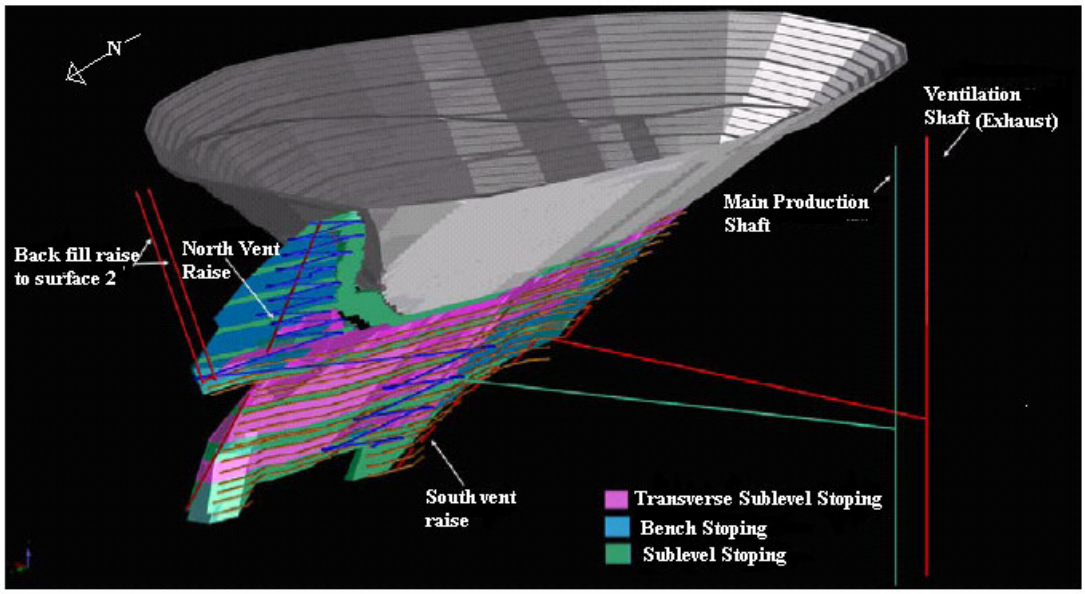


FIGURE-3.1
ISOMETRIC VIEW

TABLE-3.6
EXCAVATION SCHEDULE FOR OPENPIT AND UNDERGROUND

Year	Overburden/Waste Excavation		Ore Production		Total Excavation	
	Million Tonnes	BCM	Million Tonnes	BCM	Million Tonnes	BCM
2009-10	83041100	30417985	5000000	1666667	88041100	32084652
2010-11	101727700	37262894	6150000	2050000	107877700	39312894
2011-12	87491900	32048315	6150000	2050000	93641900	34098315
Total	272260700	99729194	17300000	5766667	289560700	105495861

3.3.10 Year wise Mining

The yearwise mine development is shown in **Table-3.7.**

TABLE-3.7
YEARWISE MINE DEVELOPMENT

Year	Decline	Shaft, Winzes etc	Footwall drive, essential development etc.	Development in waste	Waste generation	Stope development	Total development
	(m)	(m)	(m)	(m)	Million Tonnes	(m)	(m)
2009-2010	2200	400	900	3900	241100	0	3900
2010-2011	2200	1000	1800	6000	327700	500	6000
2011-2012	400	590	1800	3380	165090	1800	5000

3.3.11 Year wise Production for the Next Three Years

The quantum of ore production with expected in situ grade and quantity of overburden removal/waste removal and total excavation year wise is indicated in **Table-3.8**.

TABLE.-3.8
EXCAVATION SCHEDULE FOR OPENPIT

Year	Overburden/Waste Excavation	Ore production	Grade		Total Excavation
	Tonnes	Tonnes	Pb%	Zn%	Tonnes
2009-10	82800000	5000000	2.10	13.32	87800000
2010-11	101400000	6150000	2.17	12.91	107550000
2011-12	87340000	6050000	1.83	11.84	93390000
Total	**27154000**	**17200000**	**2.03**	**12.65**	**288740000**

- **Underground Mining**

All principal development will be in footwall side. Incidental developmental ore will be available from third year onwards. Production from North end will commence with a limited potential of 0.1 Million Tonnes a year. Production from central block will commence in end of forth year. Production will ramp up in fifth year, the details are given in **Table-3.9**. The longitudinal vertical and transverse section are shown in **Figure-3.2** and **Figure-3.3**. The isometric views are shown in **Figure-3.4** and **Figure-3.5**.

TABLE-3.9
EXCAVATION SCHEDULE FOR UNDERGROUND MINING

Year	Overburden/Waste Excavation	Ore production	Grade		Total Excavation
	Tonnes	Tonnes	Pb%	Zn%	Tonnes
2009-10	241100	-	-	-	241100
2010-11	327700	-	-	-	327700
2011-12	151900	100000	2.30	12.75	151900
Total	**720700**	**100000**	**2.30**	**12.75**	**720700**

3.3.12 Conceptual Method of Mining

Rampura Agucha deposit lying at comparatively shallow depth with an average width of 58-m over a strike length of 1550 m which is ideally suited for open pit mining with conventional mining equipment up to a depth of 372-m from surface (Up to 18 mRL).The ore reserves beyond the ultimate pit are economical to mine by under ground mining method.

- **Open Cast Mining**

a) Mechanized open pit operation**:** In the proposed expansion, mining will continue with shovel dumpers combination, utilizing the capacity of existing equipment and addition of required numbers of equipment (Excavators in 30-34-m^3 capacity with 177 to 218 metric tonne capacity dumpers)

Looking to the higher capacity mining equipments and supported by geo-technical investigations, bench height of 12-m has been proposed. Both access ramps are designed with gradient of 1 in 10 and 30-m width.

b) Complete layout of the open pit has been shown in the mine plan. It is envisaged that bench height in overburden and ore shall be 12 m with individual bench angles of 60^0 in FW and 60^0 & 70^0 in HW. The position of waste and tailing disposal has been shown in surface plan.

c) Geotechnical studies were conducted in the area by various experts in the field like, SNC (1982), GCCE (1993), CMRS (1994), NIRM (2002), SRK (2007-08) and CMRI (2003 and 2008) for open pit slope design and stability of rocks. Based on study of CMRI, Dhanbad and SRK, UK and subject to working permission granted by DGMS, proposed open pit mining parameters at Rampura Agucha Mine will be incorporated in workings. These geotechnical studies further recommended for conceptualizing and opening of the under ground mine concurrently with open pit mine.

Mine is having a full fledged work shop equipped with lathe machine, drill machine, shipping, milling, grinding, hydraulic press, plate and pipe bending machine and overhead crane etc. for repair and maintenance of heavy earth moving machinery and beneficiation plant. The mine is having heavy vehicle service centre and repaired shop equipped with required facilities. The conceptual plan is shown in **Figure-3.6.**

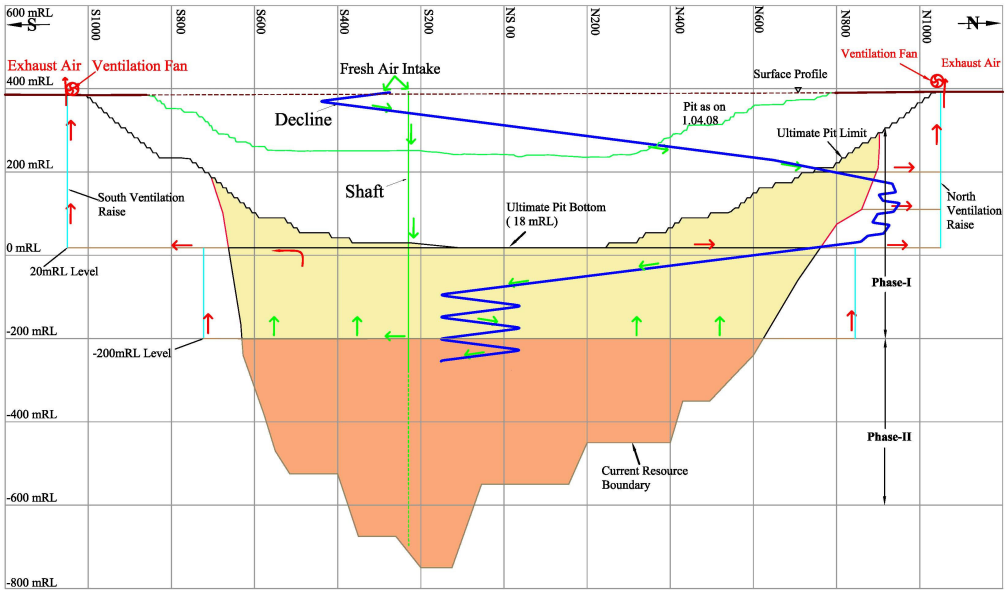


FIGURE-3.2
LONGITUDINAL SECTION SHOWING ULTIMATE PIT AND PROPOSED APPROACH TO UNDERGROUND

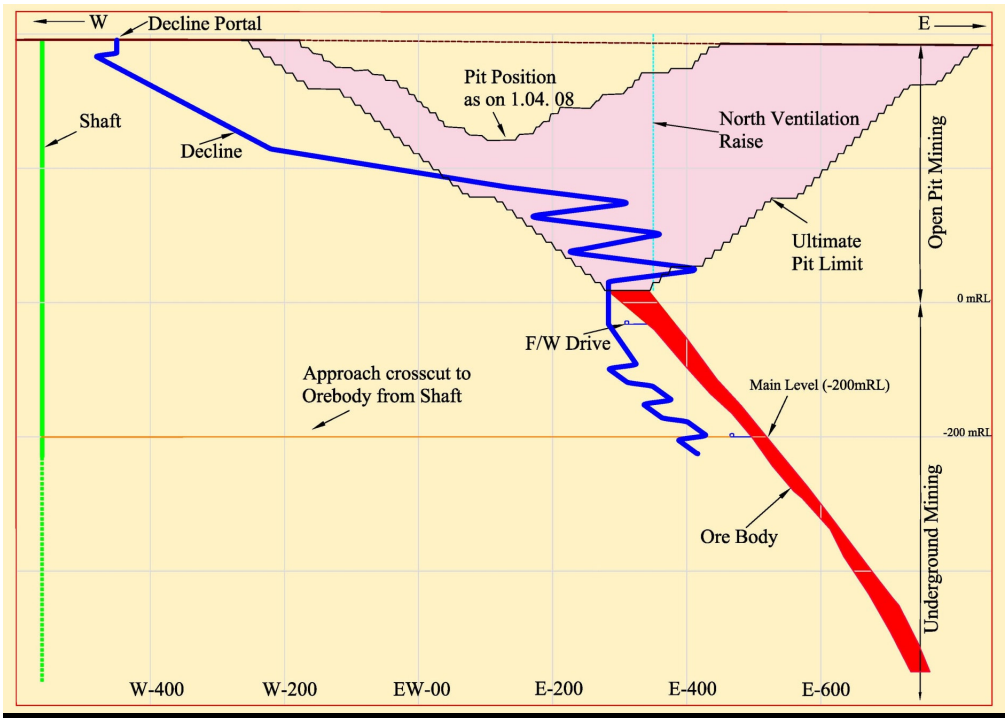


FIGURE-3.3
TRANSVERSE SECTION SHOWING ULTIMATE PIT AND PROPOSED APPROACH TO UNDERGROUND

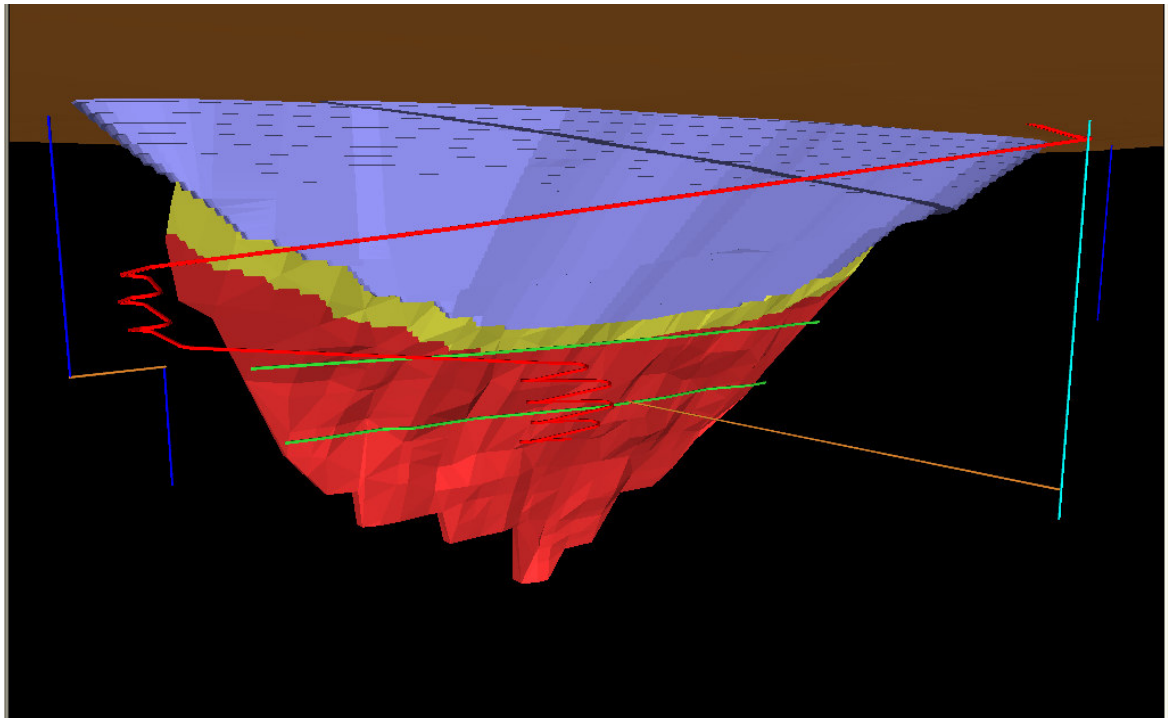


FIGURE- 3.4
ISOMETRIC VIEW

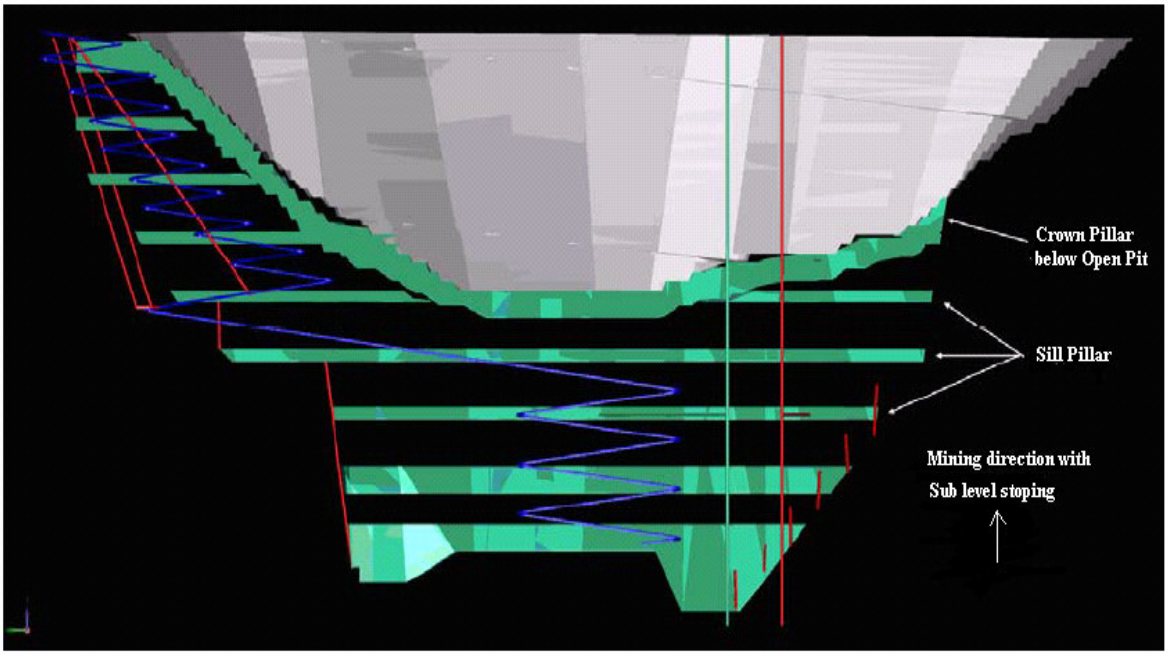


FIGURE-3.5
ISOMETRIC VIEW

- **Under Ground Mining**

After Conceptual study it is proposed to mine the deposit by Sublevel Open Stoping with back filling. Based on the geotechnical parameters, ore body physicals, available technology, equipments etc, two concepts of Open stoping are proposed.

a) Sub Level Open Stoping (SLOS) in area having ore body thickness >12-15m.
b) Benching/ AVOCA stoping in extremities having ore body thickness <12-15m

SLOS will be used to mine about 80-85% of the underground resources. The Stoping would advance from the bottom upwards and center outwards to the ends of the first mining block. The front of stoping would be an inverted "V". The method would be without interim pillars i.e. "continuous advance".

Sub-Level Open Stoping (SLOS)

Transverse stopes are formed. Competent hanging wall will allow the stope to remain open for a 25-30m length during mining and prior to back filling. The method is successfully used in Cannigton, Mount Isa Copper, Rosebery, etc.

It has two drill drives. Blast holes are done parallel to HW to minimize blast damage to HW. The rings are blasted against slot raise. The sublevels are at 25-30m level interval. The blasted ore is mucked using remote operated load haul and dump (LHD) machine and loaded into Trucks/ ore pass. Once the block gets extracted, it is backfilled up to hanging wall.

A footwall drive at 60 – 100-m level interval is located at safe distance (25 – 30-m) away from ore body and all along the strike length for drawing ore, access drill drives and ventilation, as shown in **Figure- 3.7**.

Bench Stoping

It is also a variant of AVOCA stoping method. It is proposed for mining narrow and down dip resources mostly towards the ends of ore body. A centrally located drill drive or two parallel drill drive are developed to drill the entire width of ore body. The drill levels are located at 15m vertical interval. The stoping advances from center strike-length toward the ends. At the levels of SLOS and interim rib pillar would be retained until the stoping at those SL has completed. The ore is mucked using LHD's (remote mucking). As the extraction proceeds, backfill is commenced from the center, as shown in **Figure-3.8**.

AVOCA Method

In general the Avoca method consists of developing three 20-25m levels starting at the lower level and progressing upwards. The lower level lies upon a sill pillar. Mining of the three levels using the Avoca method is continued at depth leaving the sill pillars in place. A slot to act as free face is developed above the level to be mined. Slot development and ring drilling has the flexibility to be carried out from the lower or upper drive of the stope depending on the equipment, as shown in **Figure-3.9**.

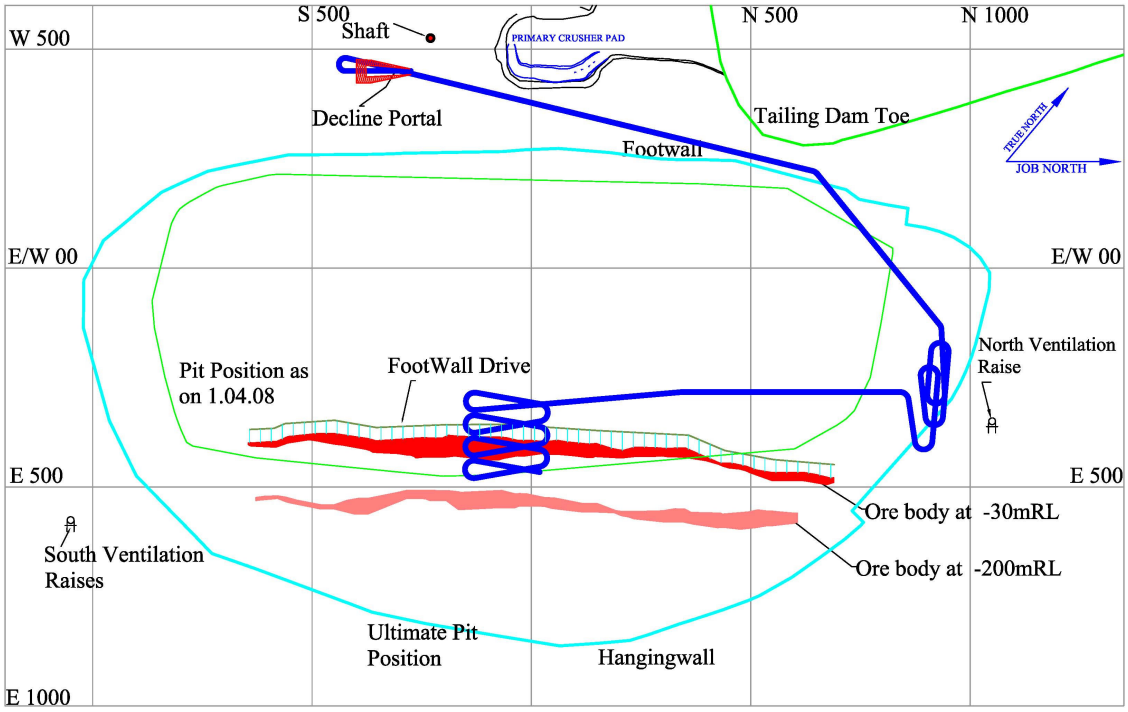


FIGURE-3.6
CONCEPTUAL PLAN

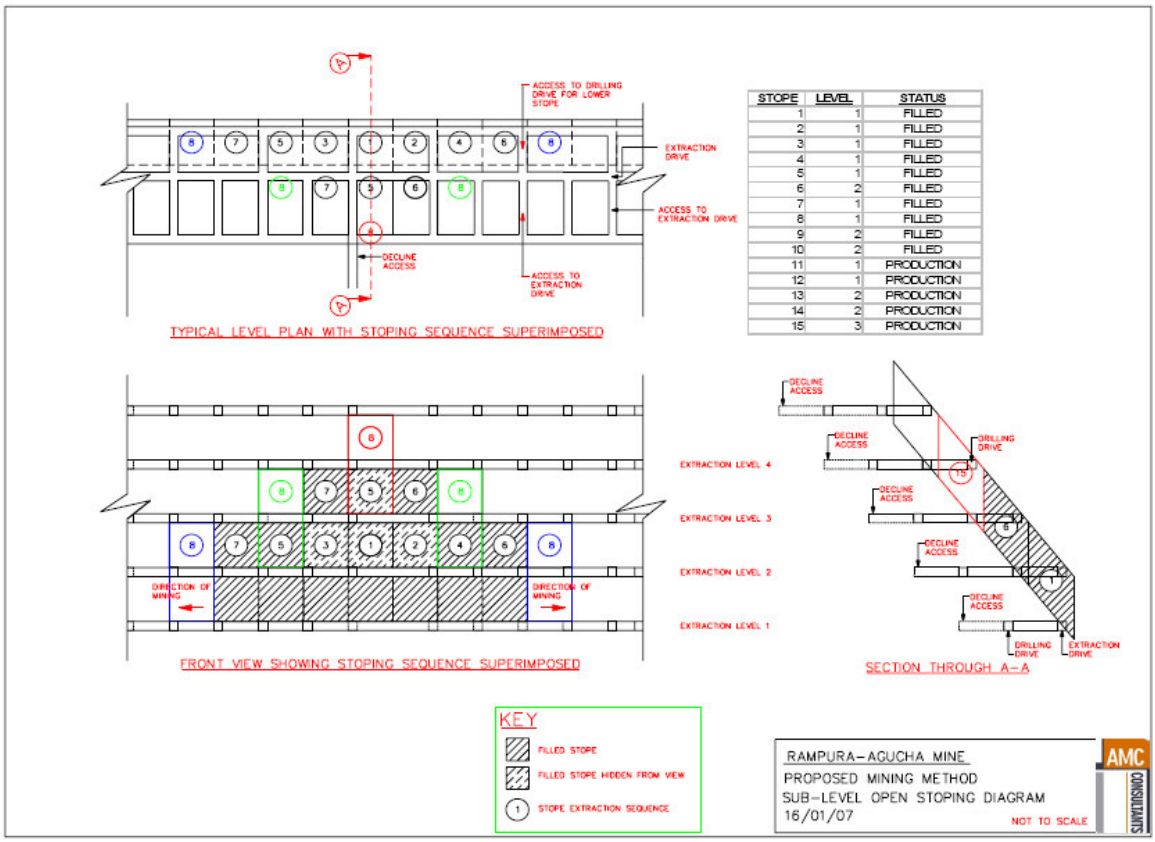


FIGURE-3.7
SUB LEVEL STOPING WITH FILLING

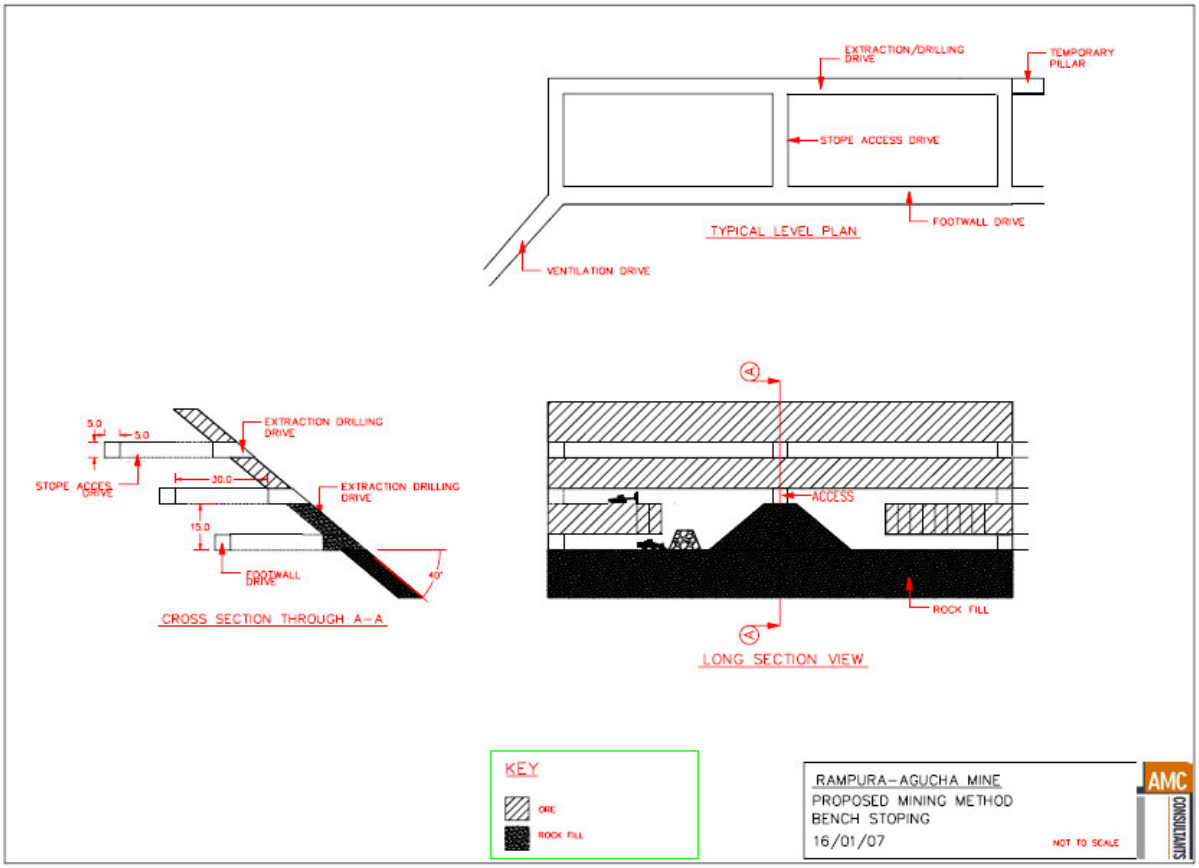


FIGURE-3.8
BENCH STOPING

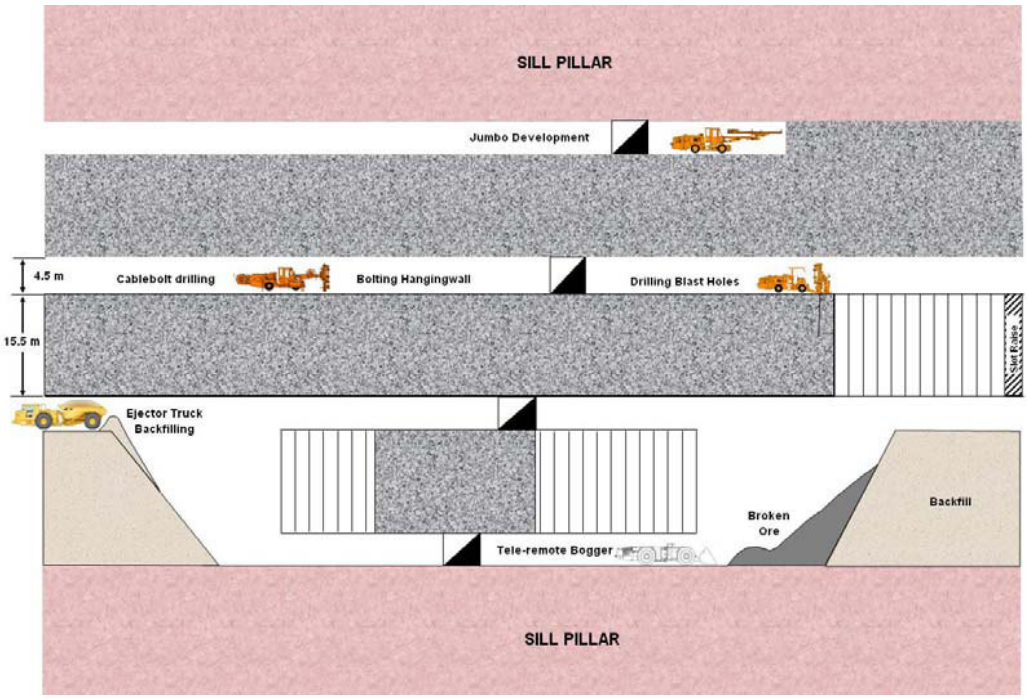


FIGURE- 3.9
AVOCA METHOD

Mine Access

Access to the underground workings will be via shaft about 850-m. A Level drive will be driven approximately 1-Km to connect to the footwall drive and ore body. The drives will act as the fresh air intake and exhaust.

The second access will be via decline from the surface, acting as a fresh air intake and haul way for ore production from the upper levels at the northern end as well as in early stage of underground mining.

The specifications of shaft, level drives, drill drives etc will be available during Feasibility & detail engineering study. However Decline is planned at 1 in 8 gradient and of 5.5-m wide & 5.5-m height. RCC portal will be constructed for about 160-m to cross the weathered zone near surface.

Ventilation

Mine will have exhaust ventilation system. The main returns will be located at ends of workings in South and North. The main intake routets will be ramp and shaft. The air will be distributed to each stope from lower footwall drive and coursed through stopes to upper level and return to main circuit.

Two ventilation return shaft of 4 m dia. will be equipped with adequate capacity fans. The development heading will be ventilated by auxiliary ventilation arrangements.

Power supply will be extended for underground workings through cables from the existing power reticulation system.

Conceptual mine parameters are as given in **Table-3.10.**

TABLE-3.10
CONCEPTUAL MINE PARAMETERS

Sr. No.	Details	Plan
1	Mining width at working bench level	50 m
2	Ultimate pit wall slopes H/W F/W	 42 ° 35 °
3	Berm width and bench angle	Berm Width of 7.6 & 9.6 meter with individual bench angle of 60° on F/W side and berm width of 6 & 7.5 m with 60° & 70° on H/W side.
4	Ramps	Two ramps, one each in H/W & F/W of 25 m width and gradient of 1 in 12
5	Ultimate depth of pit	Full strike of ore body will be mined up to 155 mRL and southern portion of ore body will be mined further up to 120 mRL. The depth may increase in case it is feasible to adopt steeper slope parameters in future
6	Ultimate/overall stripping ratio (As on 01.04.2008)	10.8:1 (Overburden/Ore)
7	Waste Management	Waste generated by mining will be dumped at pre decided sites in ultimate dump configuration of 4 X 10

Sr. No.	Details	Plan
		m lifts. In the proposed expansion, the ultimate height is proposed to be raised upto 100m with individual benches of 20m and overall slope angle of 27 degrees.

3.4 Drilling and Blasting

- **Open Pit**

At Rampura Agucha Mine the existing bench height in overburden is 10 m, while for ore benches it is 5 m as well as 10 m. The bulk of blast hole drilling is performed by the 6 track mounted diesel powered DTH (Down the Hole) machines in ore and waste benches, using 165-mm diameter bits and wet drilling with dust extraction system.

Site Mix Emulsion (SME) explosive along with booster charge is being used. For improved blast performance, reduced ground vibration and noise level, Non Electric Millisecond down the line delay detonators and Non Electric Trunk line detonators (Shock tube initiation) is used. The no. of blasts required in ore and waste clubbed together are approx. 8-10 per week, however by increasing the size of the blast; number of blasts required per week will be reduced.

Depending upon the strata condition, bench height and rock type, spacing and burden is being varied. A typical Drill & Blast design parameters are as given in **Table-3.11**.

TABLE-3.11
DRILL AND BLAST DESIGN PARAMETERS

Spacing and Burden	
Waste	5.0 x 3.5-m to 7.0 m x 4.5-m
Ore	3.0 x 2.75-m to 4.0 m x 3.5-m
Depth of Hole	11.0 to 12.0-m
Sub Grade	1.0-m to 1.25-m
Primary Charge	400-500 gm cast booster (Waste) 500 gm emulsion booster (Ore) 10-15% LD cartridge (toe blast)
Column Charge	Site Mixed Slurry (Bulk)
Charge Length	66-70% of hole depth
Charge per hole	135 to 160 kg
Drill Pattern	Mostly staggered
Blast Pattern	Reverse Echelen
Maximum Charge per Delay	500 Kg.
Powder Factor	Approx 4.3 T/Kg (Waste) Approx 2.7 T / Kg (Ore)
Holes per round	60-150 holes

With the change in Bench Height for proposed open pit expansion, there will be nominal changes in the blast design parameters. These changes will be incorporated into the design at the time of actual execution.

Safe Storage of Explosive

Three magazines having total license capacity of

3 X 30 Tonnes = 90 Tonnes of Explosive
3 X 25000-m = 75000-m Detonating fuse
3 X 10000 Nos = 30000 Nos Detonators
3 X 20000 coils = 60000 coils safety fuse.

Underground mine blasting is being divided into two parts.

1.Development
2.Production.

Development headings of 4.5 m X 4.5 m shall be drilled with horizontal jumbo drill having a hole dia of 42 mm to 48 mm. The length of each hole shall be kept 4 meters(Charging length 3 meters), having 45 to 55 holes per round and having charge density 1.2 kg/ meters (average as the perimeter hole shall be lightly charged) the explosives required will be 125 to 130 kg per round.

1. Production drilling shall be done by using DTH or similar type of drills to make 89 mm dia holes. These holes shall be charged with site mix slurry or emulsion explosives and to keep the vibration within limit the charge per delay shall be confined to 400 to 500kg / delay.

- **Secondary Breaking**

Open Pit

To deal with the oversize ore boulders, rock breaker mounted on PC 220 is being deployed. For additional boulders, secondary blasting is being performed. For the purpose of secondary blasting, 34-mm dia holes with the help of jack hammer are drilled of 2.5-ft length. These holes are charged with 25-mm dia slurry explosive cartridges tied with detonating cord and are fired with electric detonator. In a round approx. 50 boulders are blasted.

To further reduce the secondary blasting in proposed expansion, 1 no of rock breaker of appropriate size will be purchased.

3.5 Extent of Mechanization

- **Open Pit**

In present open cast mining operations the extent of mechanization is given below. However in the proposed expansion additional equipments will be added to fulfill the production. The following are the major mining machinery presently deployed at Rampura Agucha Mines.

Excavators

Different types of excavators available at Rampura Agucha mine:

a. 2 No. O & K RH-120 E Front end shovel of 15-m^3 bucket capacity, which is of twin motor with cumulative horse power of 1350 HP.
b. 2 No. of O&K RH-90c Front end shovel of 9.1-m^3 bucket capacity, which is of twin motor with cumulative horse power of 1050 HP.
c. 1 No. Komatsu make PC-1250 back hoe of 6-m^3 bucket capacity is deployed for ore production. In the expanded scenario, this equipment will be utilized for ancillary work only.

Hauling Equipments

25 Nos Caterpillar manufactured CAT-777D dumpers of 938 HP engine with a carrying capacity of 95 Million Tonnes

Drilling Machinery

Total 7 Nos of 165-mm dia DTH drills are deployed for drilling of holes on bench of 10 meter. Out of these drills four number of RECP make C-650-D model drilling machinery of 530 HP engine, one no. of Atlas Copco make ROC L-8 model drill machine and two nos. Sandvik make DI-600 drill machine . These machinery are having capacity to drill up to 165-mm dia holes and up to 30-m Depth and are utilized for production drilling.

Besides these, there are, one no. of Atlas Copco make ROC L-6 and one no. Sandvik make DI-300, small dia.(115-mm) drill machine utilized exclusively for pre-split drilling to minimize damage to the pit wall and achieve desired wall slope angle.

Ancillary Equipments

List of ancillary equipments available at Rampura Agucha are

a. Track Dozer: 5 numbers BEML make BD355A-3 of 40Tons capacity and one KOMATSU make D-375 of 61.5 Tons capacity

b. Motor Graders: 2 numbers of BEML make with 280 HP engine and one no CAT make with 259 HP engine.

c. Water Sprinklers: Two numbers, 28000 liters carrying capacity of BEML make with 355 HP engine and two 40,000 liters carrying capacity of CAT make..

d. Rock Breaker: One no. mounted on PC 220 of BEML make with 148 HP engine.

e. Wheel Loader: One number, wheel loader of BEML manufactured with 185 HP engine and 2m^3 bucket capacity and one number LETOURNEAU make L-950 model 13.5 m^3 bucket capacity loader for ore feeding at primary crusher

f. Tyre Handler: One Tyre handler of BEML make with 130 Hp engine

g. R T Dozer: One CAT make G-824, 35 Tons capacity.

In the proposed expansion, mining will continue with shovel dumpers combination, utilising the capacity of existing equipments and addition of required numbers of equipment (Excavators in 30-34-m^3 bucket capacity with 177 to 218 metric tonne capacity dumpers)

To optimize the concentrator plant efficiency, constant feed grade is to be maintained and to achieve, it is proposed to always deploy two nos. of existing 165 Tonnes class excavators exclusively for ore feeding. Annual capacity of 2 nos. of 165 Tonnes class excavators is well above the desired ore production of 6.15 Mtpa. Other existing equipments and proposed under expansion will be deployed for the waste stripping.

Wet drilling will be continued with 165-mm dia DTH drill and deployment of required numbers of other ancillary equipment like track dozer, water sprinklers and motor graders etc.

For enhancement of the mine production, additional major mining equipments will be required as given in **Table—3.12**.

TABLE-3.12
OPEN PIT MINING EQUIPMENT (EXISTING AND PROPOSED)

Equipment	Capacity	Existing (Nos.)	Addition (Nos.)	Total (Nos.)
Excavator	6-m^3	1	0	1
	9-m^3	2	0	2
	15-m^3	2	1	3
	30-34-m^3	0	3	3
Dumper	95 Tonnes	23	2	25
	177-218 Tonnes	0	24	24
Drill	165-mm	7	0	7
	165-200 mm	-	7	7
	115-mm	2	2	4
Water Sprinkler	28/40 KL	2	1	3
Track Dozer	510 HP	5	3	8
Motor Grader	280 HP	2	2	4
RT Dozer	318 HP	1	2	3

- **Under ground**

It is proposed to mechanize the operations to all possible extent. Accordingly Trackless mining is proposed and take the advantage of decline connecting all sublevels. The trackless equipments (drill jumbo, drilling, mucking, transport, wall support, etc.) will be deployed as given in **Table-3.13.**

TABLE-3.13
PROPOSED UNDERGROUND MINING EQUIPMENT

Sr. No.	Equipment	No.
	Development	
1	Drill Jumbo	2
2	Loaders (LHD-8 m^3)	2
3	Trucks (LPDT-45-50T)	2
	Production	
4	Long hole drills (57-165-mm)	3
5	Loaders (LHD-3.5-8 m^3)	6
6	Mining type Trucks (LPDT-50/60 T)	5
	Service Equipment	
7	Winder	1
8	Ventilation Fan	2
9	Crusher & feeder	1
10	Pumps	6
11	Personal carrier	2
12	Backfill Activities	
	Electric Loader (8 m^3)	2
	Ejector Truck 45T	4

3.6 Handling of Waste/Sub-Grade Material

3.6.1 Current Position and Proposal for Expanded Capacity

- **Waste Dumping**

Open Pit

The Rampura Agucha mine has almost a flat topography with a general surface elevation of 390 mRL. There are four earmarked sites to store the overburden i.e. Site-1, Site-2, Site-3 and Site-4. Existing active dump area is located on northern side of the mine. Top elevation of current dump area is 435 mRL. Waste generated by mining is being dumped at pre decided sites in ultimate dump configuration of 4*10-m lifts for minimum land degradation. Each lift has angle of 45^0 and overall final slope of approximately 27^0. This overall slope angle is kept to limit the increase in surface air velocity and dust entrainment and to aid stability.

In the proposed expansion dumping area will expand towards north & northwest as well as in height with the progress of mine-life. Looking to the expanded open pit and substantial increase in generation of waste, a waste dump of height 100-m has been proposed with following parameters, subject to approval.

- Individual Lift: 20 m
- Overall slope angle: 27^0
- Individual bench angle: 40^0
- Berm Width:19.3-m

The waste rock generated from the mining will be dumped in the earmarked overburden dump yards with proper stabilization and plantation. The physico-

chemical analysis of the waste rock indicates that the waste is non-hazardous in nature and not likely to cause any adverse impacts.

The following areas are presently available for accommodating waste:

- Current Dump Area;
- Tailing Dam Bund (Height to be raised up to 51-m in lifts);
- Bund / wall around pit of 5 to 10-m height & 30-40-m wide at top; and
- Main dump area (north of the pit)

To accommodate the balance waste quantity (and pit expansion) over the life of the mine, additional land of approx. 155 ha is required, which will be acquired from the land falling within lease boundary.

Due care is taken in all respect for its confinement like the provision of dump stabilization by vegetation on ultimate non-moving ends. Till end of March 08, 12.3 ha. of non-active area of waste dump have been stabilized by covering with top soil & plantation.

Use of higher capacity dump trucks in waste handling, more compaction over the year is anticipated, which will further enhance the waste dumping capacity. The proposed dumping sites site for sub grade mineral dump. Density of waste in-situ is 2.73 t/m^3 whereas the density of waste in waste dump after compaction becomes 2.201 t/m^3. In the proposed plan period, waste will be dumped at main waste dump, outer periphery of the tailing dam and safety bund around pit. Year wise dumping plan for the plan period is given in **Table-3.14**. These sites are sufficient to take care of waste disposal during the plan period. Due care is taken in all respect for its confinement like the provision of dump stabilization by vegetation on ultimate non-moving ends.

TABLE-3.14
YEAR WISE SCHEDULE OF OVER BURDEN DUMPING
All figures are in Million Tonnes

Plan Period	Particular	Waste Dump	Tailing Dam	Bund Preparation	Total
	Area to be occupied (ha)	250.40	189.60	-	440.00
	Total Capacity	443.08	73.43	7.14	523.65
	Capacity until (31.03.09)	112.79	49.38	5.12	167.29
	Capacity anticipated as on 01.04.09	330.29	24.05	2.02	356.36
Year 1	Year 2009-10	73.01	9.79	-	82.80
Year 2	Year 2010-11	87.14	14.26	-	101.40
Year 3	Year 2011-12	85.32	-	2.02	87.34
	Grand Total	**245.47**	**24.05**	**2.02**	**271.54**

- **Underground**

Very small quantity of waste rock will be generated from underground as compared to open pit mining. All the initial developmental waste rock generated in initial years upto 2011-12 (about 1 Million Tonnes) for developing the Decline, shaft, footwall drives, ventilation shafts etc, will be accommodated in the existing

waste dump at surface. Subsequent developmental waste rock will be disposed off in stoped out areas in underground itself as shown in **Figure-3.10**.

Generation and Stacking of Sub grade Mineral

Ore containing material in excess of 15% non-sulfide Zinc are the sub-grade mineral which are to be segregated and stock piled separately as gossan. Out of total 1.6 million Tones of gossan, 1.490 million Tonnes of gossan has already been mined out and stacked at pre defined location. However, the existing gossan dump will be relocated at suitable appropriate location as the present area will be utilized for the proposed expanded pit. At present 110,000 Tonnes of sub-grade material (gossan) at the grade of 1.98% Pb (Total), 10.03% Zn (Total), 0.57% Pb (Non sulphide) and 8.80% Zn (Non sulphide) has been dumped within the mine. This material is expected to be excavated during the proposed plan period, which will be stacked separately at designated site of gossan.

Generation and Stacking of Top Soil

The soil cover in the mining area varies from 0.3 to 0.8 m with an average of 0.55 depth. As on 01.04.2008 total 549565.5 m^3 of top soil was generated by mining activities. All the topsoil generated till date has been used for the lining of tailing dam and vegetation on matured ends of waste dump. The topsoil, which generated in initially development phase was stored properly in 2.0-ha land on north side of the mine pit and used for green belt development particularly on waste dump and also in tailing dam embankment whenever raising of tailing dam was done. The mine will continue to preserve topsoil whenever encountered and utilize it for revegetation and other useful activities. The fresh breakage of ground takes place only at a very slow rate since strike length of ore body is limited and majority of which has already opened. Development / production of ore body mostly take place in depths. The rate of yearly generation of the top soil for proposed plan years will be as given in **Table-3.15**.

TABLE-3.15
YEARLY GENERATION OF TOPSOIL FOR PROPOSED PLAN YEARS

Year	Quantity Generated (M^3)
2009-10	0
2010-11	126088
2011-12	56434
Total	**182522**

The topsoil will be utilized for stabilization of waste dump, slopes of tailing dam and to generate the green belt in surroundings of waste dump and mine area.

3.6.2 Use of Mineral

The ore is being treated in beneficiation plant to produce lead & zinc concentrates. The concentrate is sent to the Chanderiya Zinc smelter, situated at a distance of 120-Km to produce lead & zinc metal & its by-products.

3.6.3 Mineral Processing

Rampura Agucha Beneficiation Plant treats Pb-Zn ore. Ore mineralization consists of sphalerite with subordinate pyrite, pyrrhotite and galena.

The ROM ore having a maximum size of 1.2-m is fed to primary gyratory crusher having a size 54-74. Primary Crusher product (-150-mm) is conveyed to coarse ore stockpile via apron feeder and a series of transfer conveyors.

3.7 Proposed Expansion of Beneficiation Plant

- **Process Description**

There will be capacity enhancement from 5.00 Mtpa to 6.50 Mtpa for Rampura Agucha Beneficiation Plant.

a) In the proposed 1.50 Mtpa operation, the Primary Crusher product will be taken to a new C.O.S. via a series of Conveyors from either of the existing Primary Crushers. There will be a tripper driven by VFD (with bypass option) above new Coarse Ore stockpile, which should be designed to carry -150-mm product (max boulder size: 180-230-mm). There will be electrically operated flap-gate system by which the primary crushed product from new primary crusher will be diverted to COSP feeding to SAG Mill- Ball Mill section.

b) Secondary & Tertiary Crushing & Fine Ore Bin: The pre-expansion & post-expansion schedule is the same for the existing secondary & tertiary crushing section. The existing fine crushing plant will continue to operate as per its existing operation.

c) Additional Coarse Ore – Stockpile & reclaim system requirements.

A second stockpile of equal capacity i.e. 9,000 Tonnes will be required in order to feed the new semi-autogeneous grinding (SAG) millstream. The list of the existing and additional equipment is given in **Table-3.16.**

Primary Grinding & Classification

A SAG mill of suitable size will receive coarse ore from new COS. The SAG Mill will have variable frequency drive. After 1st stage primary grinding in the SAG mill in closed circuit with a 6.3-mm wet screen, the wet screen undersize will be pumped to a two-stage classification system. The screen rejects will be returned by conveyor(s) to the SAG mill. There will be one vibrating screen. The panel of vibrating screen will be of PU make. The 1st stage cyclone overflow will be pumped to the 2nd stage cyclones and both stage cyclone underflows will be subjected to grinding in a ball mill of size (SAG Testwork Grinding data is available to spec the motor & mill size). The ball mill discharge will join SAG mill discharge (wet screen undersize) for pumping to the 1st stage cyclones. The flotation feed will be the 2nd stage cyclone overflow. There shall be approachable sampling points for Ball Mill discharge, 1st stage cyclone feed & 2nd stage cyclone feed which will be equipped with 3 inch pinch valves.

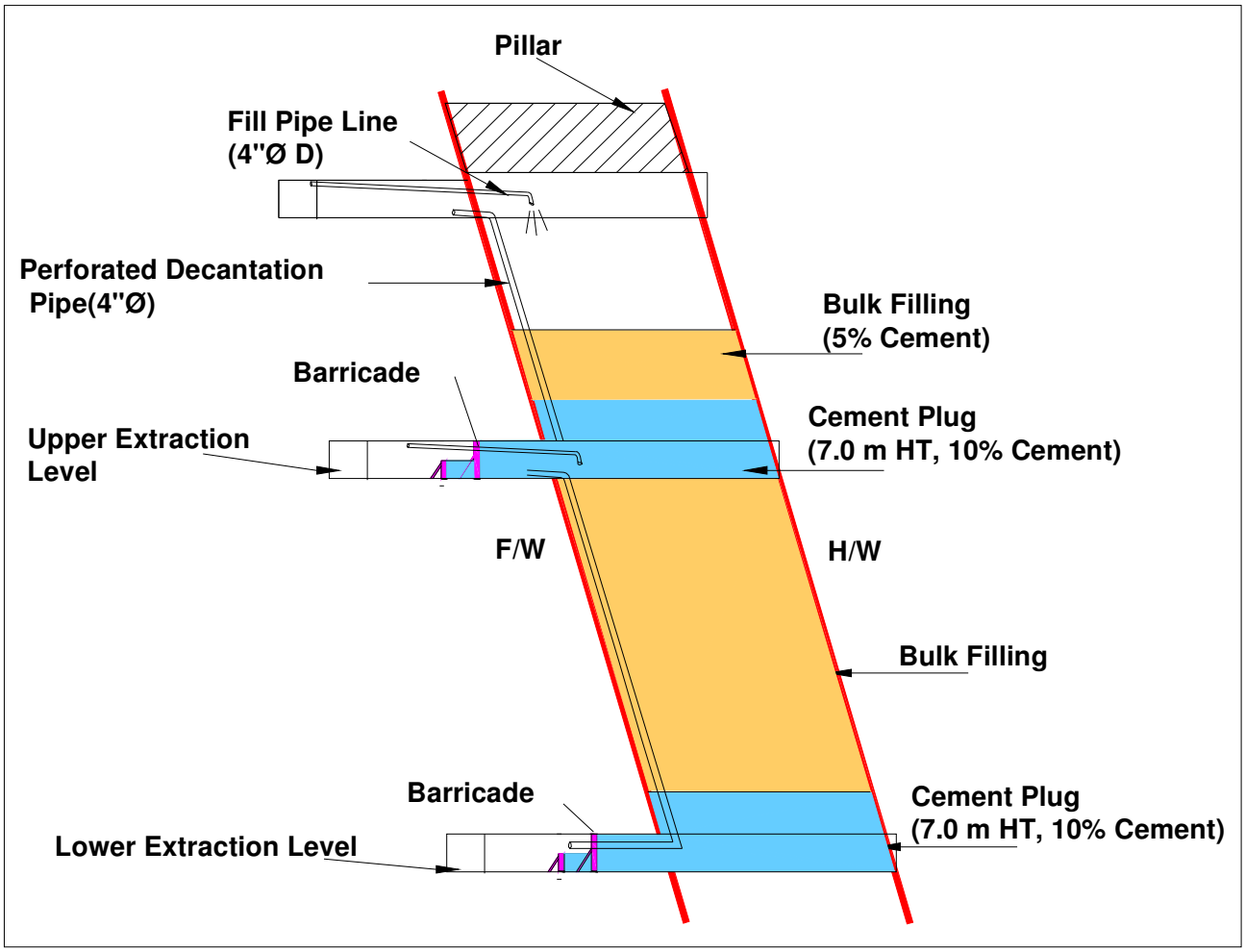


FIGURE-3.10
STOPE FILLING SYSTEM

TABLE-3.16
EXISTING AND ADDITIONAL EQUIPMENT OF BENEFICIATION PLANT

Sr. No.	Particulars	Existing	Additional
1	Primary Crusher	2	0
2	Secondary Crusher	1	0
3	Tertiary Crusher	3	0
4	Rod Mill	3	0
5	Ball Mill	5	1
6	SAG Mill	2	1
7	Zinc Regrind Mill	3	1
8	Lead Rogher/ Scavenger Cells	29	7
9	Lead Cleaner Cells	21	8
10	Zinc Rogher/ Scavenger Cells	32	8
11	Zinc Cleaner Cells	47	12
12	Pressure Filter	12	4
13	Air blower	10	2
14	Air Compressors	15	4
15	High rate thickners	7	3
16	Hydrocyclones	18	10

Lead & Zinc Flotation

The second stage of cyclone overflow will go to the lead conditioner. There will be lead rougher-scavenger cells comprising of small cells. The lead middling will be recirculated back to lead conditioner. Material after lead flotation will go to conditioner. In zinc rougher-scavenger circuit there will be smaller volume cells.

Flotation circuit will have 3-stages cleaning for lead & 4-stages cleaning for zinc.

Concentrate Thickening & Tailing Disposal

a) Lead – there will be separate high rate thickener for lead concentrate
b) Zinc - there will be separate high rate thickener for zinc concentrate
c) Tailing - there will be separate high rate thickener for tailing

The plant tailing will be fed to cluster of declining cyclone comprising of declining cyclones. Overflow of declining cyclone (at about 65 % solid spilt) at 10-15 % solids will be fed to new HRT for tailing. New tailing thickener underflow (at 40-55 % solids) along with desliming cyclone underflow (40—45 % solids) will be fed to a new neutralization tank from where it will be pumped to tailing dam via the pumps installed at new tailing dam pump house.

Lead & Zinc Concentrate Filtering

There will be pressure filters each, one for lead & two for zinc concentrate produced from new plant. There will be dedicated auxiliaries for these filters.

Lead & Zinc Concentrate Load Out

There will be separate stockpile each for lead & zinc concentrate. Suitable conveying system will be installed to transport Lead Filter discharge to new stockyard. Suitable conveyor and tripper system will transport the zinc concentrate from the new filters to new stockyard. The flow sheet is given in **Figure-3.11**.

3.7.1 Tailing Disposal

The tailing is the only waste emanating from the mine due to mining and beneficiation of the lead-zinc ore. The tailing is stored in a specially constructed Tailing Impoundment Area. The material for construction of the tailing dam consists of mine waste. Thickened tailing is pumped through a tailing line and discharged into the tailing dam, after neutralization with lime. The pipeline for tailing disposal is on all the four sides of the dam. A pumping station has been built in the Northwest corner of the dam and water is reclaimed through wells provided in this area of the dam.

With the expanded capacity of the mine, the tailing dam height is proposed to be raised up to 51m height to accommodate all the tailings generated during the life of the mine. The initial ground level at the tailing dam was 392.5 mRL. In the first phase, tailing dam of 6m height was constructed from 392.5 to 398.5 mRL. In the IInd phase, tailing dam height was raised from 398.5 to 404.50 mRL. The third phase height raising of the tailing dam was completed from 404.50 to 410.50 mRL during 2002.The 4th Phase of height raising was completed from 410.50 mRL to 419.5 mRL during 2006-07. The 5th Phase of height raising is under progress from 419.5 to 425.5 mRL.

Water in the tailing dam is allowed to settle down, then it is reclaimed on continuous basis and pumped to reclaim water reservoir for re-use in the process. No water is allowed to escape outside the dam. The quality of the water in the piezometer wells around the impoundment area is regularly monitored.

Measures taken to ensure the stability of the Tailing dam

The existing tailing dam having surface area of 130ha. and height of 24-m with 3-m filter bed i.e. total height is 27-m from ground level (392.5 mRL to 419.5 mRL) The tailing dam was made of waste rocks with soil lining and rip – rap of stone. There is provision of raising the sidewalls for future capacity enhancement. While designing the dam many parameters were taken into account like rainfall in the area, earthquake history etc. The present dam is very stable with adequate capacity.

To ensure the stability of the tailing dam, following proactive measures are taken.

1. Inspection of the tailing dam for seepage etc.

2. IISc- Bangalore has approved the construction design of the tailing dam upto the height of 41 m and approval for final design for 51-m height tailing dam will be taken before actual construction.

3. To further ensure the stability of the tailing dam, various Scientific studies had been carried out, which are as under.

a. To review the geological stability of the tailing dam, a study was conducted by Dr. A.B. Roy in April 2000. The study reveals that foundation of the tailing dam is quite sustainable for its enhance capacity.

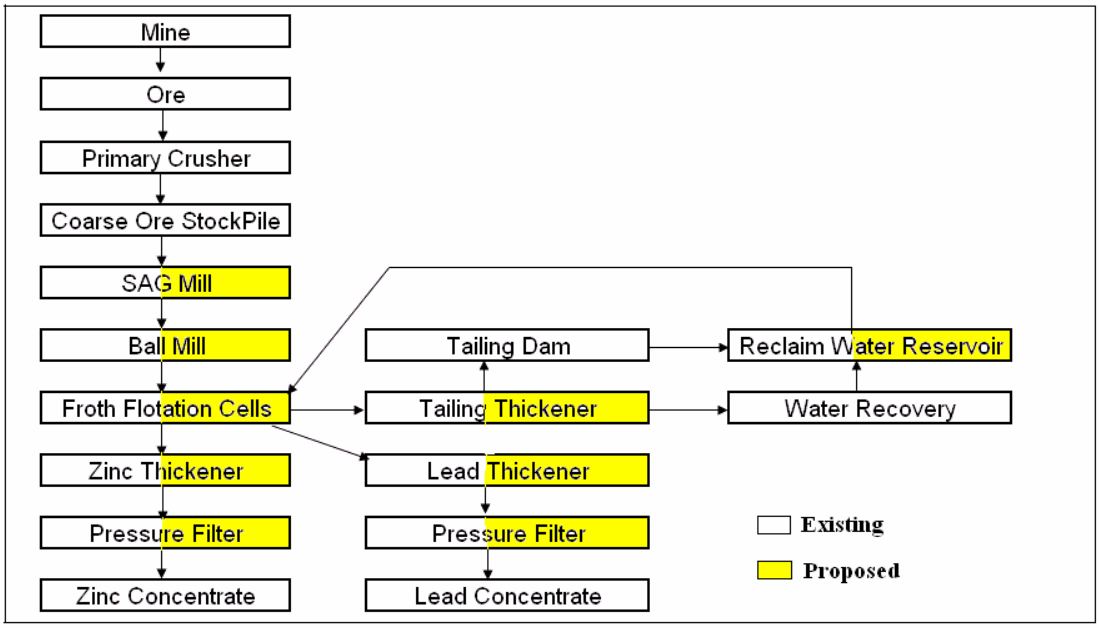


FIGURE-3.11
BENEFICIATION PLANT: FLOW SHEET

b. To review the structural stability of the tailing dam, in year 2000 a study was conducted by National Institute of Rock Mechanics KGF Karnataka by using "ground Penetrating Radar and seismic Exploration Methods '' and the survey did not find any threat to the stability of the tailing dam in the wake of future expansion plan.

c. To review the structural safety aspect of the tailing dam and also examine the impact of blasting on it, a study was conducted from M/s. Central Water and Power Research Station (CWPRS), Pune in the year 2003. The study reveals that the tailing dam is stable against the blast vibrations generated due to the blasting.

d. To assess the aquifer vulnerability at Rampura Agucha mine a study was conducted by National Environmental Engineering Institute (NEERI), Nagpur in the year 2006. The study reveals that the surface soil cover all along the traverses around the tailing pond show very low resistivity values mostly around 10 ohm meters.

4. Additional measures, disaster management plan & emergency plan are in place.

In the proposed expansion, there will be a separate tailing disposal system. Although disposal of tailing will be done at the same tailing pond mentioned above.

- ***Filling***

In the mines for filling stopes, + 32 microns fraction of tailing is used as fill material. Mill tailing will be classified to separate fine below 32 microns. Coarse material of above 32 micron size will be used for filling after cement addition. Cement ratio of 10% will be used for base plug formation and 5 % cement ratio will be used for remaining stope filling A perforated pipe will be placed in the stope to decant the water from the stope. The fill material (pulp) is pumped at 65% solid through 4 inch dia pipelines to fill change room from where it will pass from surface to underground through lined bore-holes as shown in **Figure-3.12**.

Fill Plant will have an arrangement for automatic handling and addition of cement in the desired quantity. Monitoring of various quality control parameters such as particle size analysis, pulp density, cement ratio of 10% and 5% will be maintained depending on filling requirement.

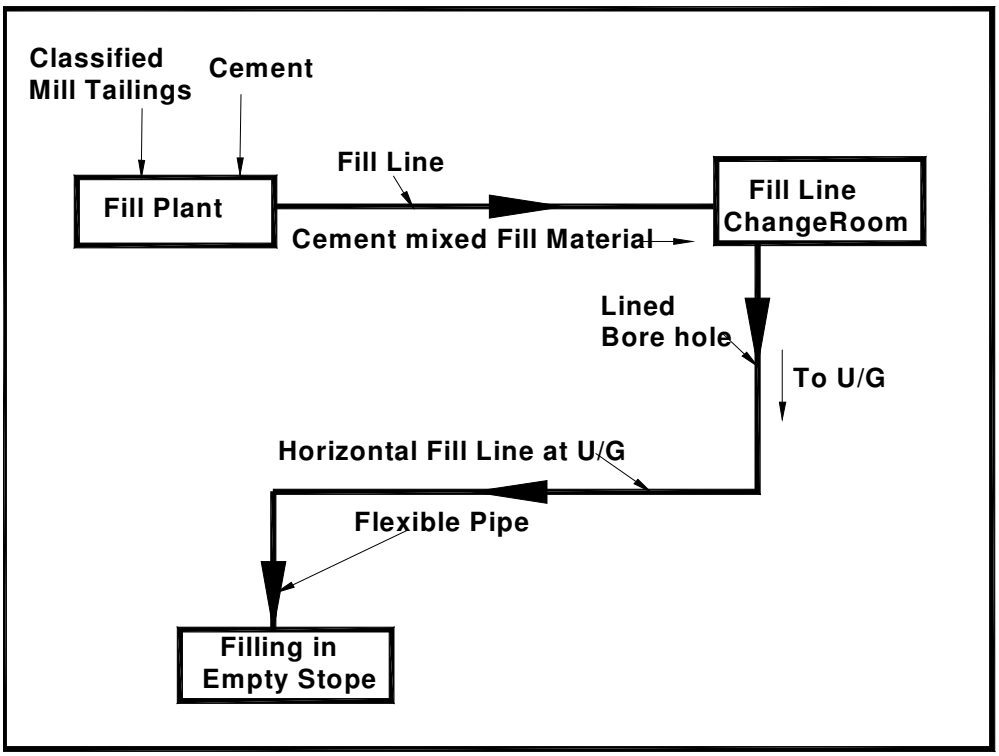


FIGURE-3.12
FILL RETICULATION

3.7.2 Process Instrumentation and Automation

A highly automated/instrumented process control has been envisaged in the beneficiation plant design. Salient features of the process instrumentation are discussed below:

- **On-line Stream Analysis System** for measurement of elements concentration in slurries;
- **Suitable operating system** is designed to optimize, stabilize and control individual unit operations as well as the entire plant;
- **Froth Camera System** makes use of machine vision technologies to measure the speed of the froth; and
- **Particle Size Analyser** is a sizing system for mineral slurries. It takes automatic samples from one to three process streams and measures their particle size distribution in the range of 1-500 microns.

3.7.3 Land Requirement

Mining lease area is 1200-ha of which the land acquired for mining and industrial use is 869.5-ha.The pre-operational Land use pattern of acquired land mining lease is as given in **Table-3.17**.

TABLE-3.17
PRE-OPERATIONAL LAND USE PATTERN

Landuse	Area (ha)
Grazing land	70.
Waste land (Govt. land)	81.97
Private Land (including agricultural)	692.53 (approx.)
Private land (outside mining lease)	25 (approx.)
Total	**869.5**

Total 155-ha of additional land is proposed to be acquired under Phase-III expansion (12.96-ha outside mining lease and 142.04-ha is within mining lease). Of the proposed acquisition 20-ha of land is to be acquired within plan period. The acquisition status and additional acquisition proposed of the mine lease area is given in **Table-3.18.**

Land use pattern of acquired land of mining lease at present and at the end of mine life is as given in **Table-3.19**. To accommodate pit expansion 20-ha additional land will be acquired within the mining lease during the plan period.

TABLE-3.18
STATUS AND ADDITIONAL ACQUISITION PROPOSED DETAILS OF LAND IN MINING LEASE

	Village	Govt. Land (ha)	Pvt. Land (ha)	Total (ha)
Land Acquired	Agucha	138.30	325.00	463.30
	Kothiyan	51.67	354.53	406.20
	Sub total	**189.97**	**679.53**	**869.50**
Additional Acquisition Proposed	Agucha*	8.86	62.59	71.45
	Kothiyan	0.97	82.58	83.55
	Sub total	**9.83**	**145.17**	**155.00**
	Grand Total	**199.80**	**824.70**	**1024.50**
Land Acquired outside ML area for township	Hurda (7 km from Mines)	74.00	-	74.00

TABLE-3.19
OPERATIONAL AND POST-OPERATIONAL LAND USE PATTERN OF ACQUIRED LAND

Break up of Land Use	**Beginning of Plan Period**		**End of Plan Period**		**End of mine life**
	Area put in use for Mining and allied activities	Area fully Reclaimed /Rehabilitated	Area put in use for Mining and allied activities	Area fully Reclaimed /Rehabilitated	Area put in use for Mining and allied activities
Pit & Waste Dump	348.52		447.08	9.5	596.84
Concentrator	39		45		45
Tailing dam	163.51		189.69		189.69
Infrastructure	47.64		47.64		47.64
Land put in use for mining & allied activities	**598.67**		**729.41**	**9.5**	**879.17**
Green belt development	255.04		158.07		145.33
Rest (Future green belt & other works)	15.79		2.02		0
Total	**869.5**	**0**	**889.5**	**9.5**	**1024.5**

3.7.4 Water Requirement

The mine is situated in the semi-arid region of Rajasthan with scanty rainfall of 450-mm. The availability of ground and surface water in the vicinity is not adequate to meet the requirements of our mine and beneficiation plant and domestic use. Presently, water is withdrawn from the radial well situated at Banas river bed through 400-mm dia MS pipeline, 60-km long with two boosting pumping stations at Banas & Shahpura. Existing system will be used to pump 11700-m^3/day. **No additional water withdrawal will be required.** The water balance for expansion project is shown in **Figure-3.13**.

With the present water conservation plans, pumping capacity for drawl of water from radial well will meet the requirement of the proposed mine and beneficiation plant expansion. All the process water is recycled back to plant for reuse and maintaining zero discharge.

The major conservation initiatives includes retrofitting of all the concentrator and tailing thickeners, measures taken to maximize the recovery of water from tailing dam, construction of 20000-m^3 capacity reservoir for storage of water drawl from tailing dam, collection of run of water and reuse it in process, mine run of water was stored in reservoir and used it for beneficiation process.

The CGWA has given permission for drawl of 11700-m^3/day.The water allocation letters are enclosed as **Annexure-VI**. The details of fresh water requirement after expansion is given in **Table-3.20**.

TABLE-3.20
PROPOSED FRESH WATER CONSUMPTION

Sr. No.	Particulars of Water Requirement	m^3/day
1	Dust suppression and DG set	1000
2	Drinking (Colony and office)	800
3	Beneficiation plant	9900
	Total	**11700**

3.7.5 Power Requirement

Present power requirement of 30 MW is met from 154 MW captive thermal power plant at Chanderiya Lead Zinc Smelter (CLZS), power is wheeled through Ajmer Vidyut Vitran Nigam Limited (AVVNL) grid system. The same source and methodology will be followed for the proposed expansion requirement (underground mine 10-12 MW and Mill 8 MW) of 20 MW. The total power requirement after expansion is 50 MW.

3.7.6 Other Facilities

- **Workshop**

The existing workshop is well equipped and does not need any changes.

- **Heavy Vehicle Service Center (HVSC)**

The existing HVSC is well equipped, however, it will be augmented to meet the services required for the new mining equipment.

- **Magazine**

The existing Magazine has sufficient capacity and does not require any change.

3.7.7 Details of Raw Material and Products

The chemicals and fuel are the main consumables required in mining and beneficiation plant. The list of consumables is given in **Table-3.21.** The existing storage facility is adequate and no additional storage is envisaged. However, to store increased quantity of lead-zinc ore, additional coarse ore stockpile of 9000 Million Tonnes capacity and concentrate storage yard of 20,000 Million Tonnes will be constructed.

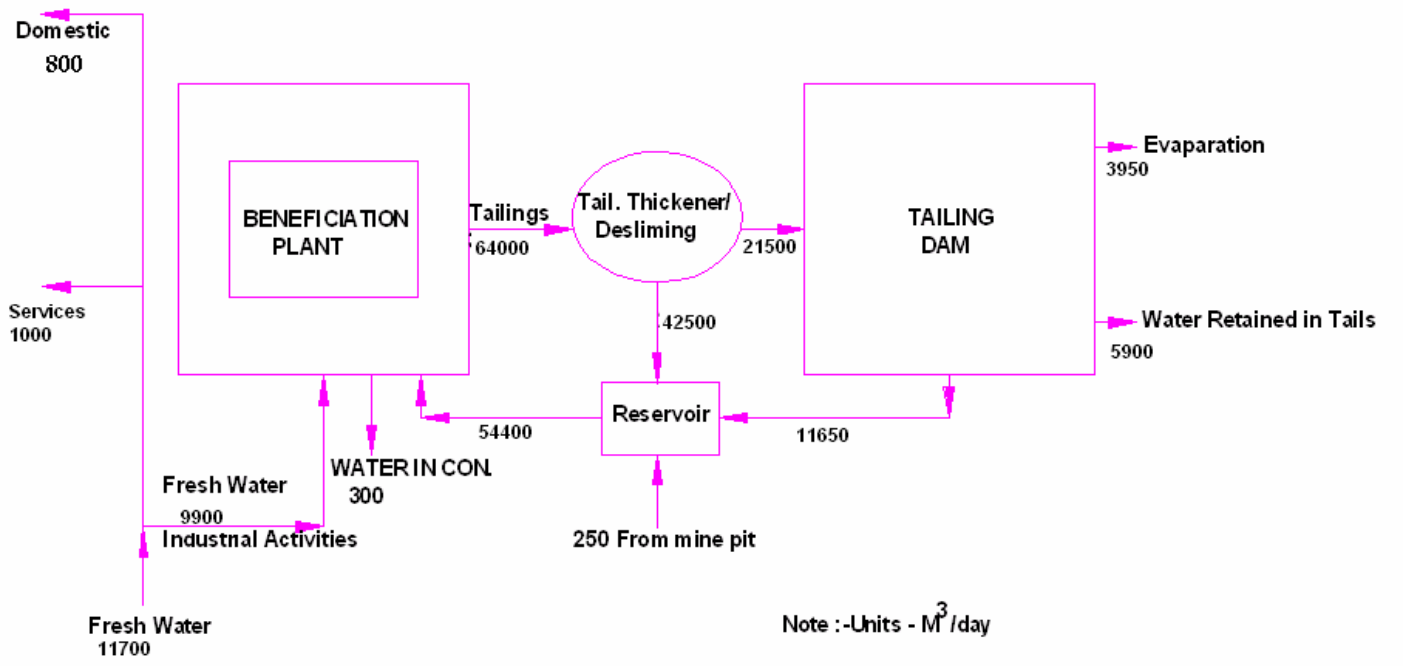


FIGURE-3.13
WATER BALANCE FOR THE EXPANSION PROJECT

TABLE-3.21
REQUIREMENT OF CONSUMABLES, PRODUCTS AND STORAGE CAPACITY

Sr. No.	Description	Requirement (Tonnes/day)	Storage Capacity, Tonnes
1	Raw Material (Lead & Zinc concentrate)	2000	Coarse ore 27000 + additional 9000
2	Products Zinc concentrate Lead concentrate	 4200 400	60000 + additional 20000
3	Potassium Ethyl Xanthate	0.988	200
4	Sodium Iso propyl Xanthate	2.28	200
5	MIBC	0.76	25
6	Sodium Cyanide	0.532	18
7	Copper Sulphate	13.68	150
8	Nigrosine	3.04	100
9	Hydrated Lime	17.48	-
10	Grinding Media (Balls)	12.16	-
11	Grinding Media (Rods)	2.89	-
12	HSD	70.0 KL	136.5 Kl
13	HSD	43.2 KL	500 KL

3.7.8 Man Power

The mine has presently employed 614 workmen and 180 executives. Proposed expansion of present open pit and opening of underground operations will require about 250-300 workmen.

3.7.9 Surface Transport

The lead and zinc concentrates will be transported by trucks covered with tarpaulin to the various smelters and Kandla Port for export. The concentrates are also transported by rail to Visakhapatnam zinc smelter.

3.8 Improvements in Efficiency Parameters

The various management and control measures implemented in the existing capacity enhancement programme have resulted in conservation of resources such as water, energy and chemicals and also improved the metal recovery efficiency. The details are discussed below:

Energy Conservation

On account of higher throughput and various other energy conservation measures, the specific energy consumption has been reduced from 41.6 KWH/Million Tonnes ore (2003-04) to 39.1 KWH/Tonnes of ore (2008-09). The energy consumption is expected to reduce further upto 38.5 KWH/Tonnes after expansion.

Water Requirement

The specific water consumption has been reduced from a level of 1.2 m^3 per tonne of ore treated to approximately 0.52 m^3 per tonne of ore treated due to

various conservation measures. This is further expected to come down marginally after expansion.

Chemicals

Specific consumption of chemicals and other reagents has been reduced significantly over the years through various conservation measures including higher throughput and process optimization. This trend is likely to improve further during the operation of this expansion programme.

Metal Recovery

The improved version of control tools in expansion plant is expected to produce lead with 60 % recovery and zinc with 92.3 % recovery.

3.9 Sources of Pollution

The major environmental impacts due to open cast and under ground mining and mineral beneficiation plant, in general, could be broadly classified into the following categories:

- Air Pollution;
- Despoliation of Land;
- Water Pollution;
- Noise Pollution; and
- Solid Waste Disposal.

3.9.1 Air Pollution

Mining operations contribute towards air pollution in two ways - addition of gaseous pollutants to the atmosphere and emission of dust particles. The gaseous pollutants include NO_x, SO_2 and hydrocarbons etc. The gaseous air pollutants are emitted from operation of heavy earth moving equipment, which are mostly run on diesel and blasting operations.

SPM/dust particles are emitted during drilling, blasting, excavation, loading and unloading of the ore and overburden, hauling and crushing and stockpiles etc.

Similarly, the gaseous pollutants near beneficiation plant include DG sets (emergency source of power) and the dust is generated from fine ore bins, concentrate handling and concentrate transportation etc.

In the proposed expansion project, one additional Primary crusher and one Coarse Ore Stock (COS) will be added to the existing system. One stack each for primary crusher and COS will be attached to control the emission of particulate matter emission and these stacks will not contribute to gaseous emissions.

However, in mining additional heavy earth moving equipment will be added which will be operated on low Sulphur HSD and may contribute to emissions of NOx and CO.

The sources of air pollutants from the opencast mining can be categorized as area sources, point sources and line sources.

- **Area Sources (Mining Activity)**

The mining pit constitutes the area source. There will not be any lateral increase in the mine pit size. The expansion capacity will be achieved by going vertically deep into the existing mine pit. Thus, the area source emissions in terms of dust will be comparatively less.

There will be a marginal increase in the blasting frequency during the expansion. The blast size will be appropriately enhanced to match the production. However, the dust generated due to blasting is instantaneous and prevails only in the quarry area and has been observed to dissipate within half an hour after the blasting.

The overburden dumping and grading is also another source of dust generation. However, overburden will be dumped by giving less aerial lift and grading will be done by dozing. This will help in reduction of dust generation.

The drilling activities will increase to enhance the production. If no control measures are applied, this activity will increase the dust generation. However, the drilling will be carried out by wet drilling method. Hence, the possibility of dust generation during drilling operations will be greatly reduced.

Similarly, the excavator operations, loading and unloading operations will cause dust generation. During the expansion programme, one more excavator of 15-m^3 capacity will be added to match the expansion. However, the bucket size will be big (15-m^3) requiring less no. of buckets for filling the dumpers. This will inturn reduce the dust generation.

- **Line Sources (Mining Activity)**

Transportation of ore from the mine pit to the primary crusher and overburden from mine pit to dump will be covered under line source. In the proposed expansion project 5 dumpers will be added to the existing fleet of dumpers. The width of the haul road within the mine pit will remain same as before expansion. The length of the haul road will be increasing at a rate of about 250-m every year. The open cast mining activities will continue upto 2013-14. Hence the haul road is likely to increase for about 2500-m during the life of the mine.

The dumper movement is likely to contribute to dust, Oxides of Nitrogen and carbon monoxide. However, these emissions are likely to be confined to the mine pit only.

The dust generation along the haul roads will be suppressed by continuous sprinkling on the haul roads at regular frequency. There are 3x28 KL capacity sprinklers for this purpose in addition to the automatic water sprinkling system for

permanent haul roads. Additional one water sprinkler will be added to increase the frequency of sprinkling.

- **Point Sources (Beneficiation Plant)**

There will be no additional stacks during the expansion. Thus, the connected stack will be emitting dust. There will not be any change in the emissions of secondary crusher stack and Fine Ore Bin stacks.

The DG sets will normally be operated during emergency requirements. However, during the proposed expansion, the power will be sourced from Captive Power Plant of HZL located at CLZS, Chittorgarh. The power generated by CPP is being wheeled through state grid. Thus the existing DG sets are non operational.

The secondary and tertiary crushing system will remain same and hence there will not be any additional dust generation.

Concentrate handling will be another source of dust generation. However, this will be contained by mechanized handling of concentrate. The concentrate carrying trucks, which is another source of dust, will be covered by tarpaulin to arrest the dust. Further, the concentrate will be having about 8-9% of moisture, which will be in a semi-dry condition.

Further, the truck wheels are likely to cause pollution in terms of dust. However, with the proposed additional truck washing system, this is going to be minimized.

3.9.1.1 Additional Control Measures Proposed

In addition to the existing air pollution control measures will be taken up in order to control the dust emissions from the proposed expansion programme. The detailed recommendations are given in Chapter-6.

3.9.2 Despoliation of Land

Since the capacity expansion of the mine and allied facilities are being carried out within the existing acquired mining lease area and no further land despoliation is involved.

3.9.3 Water Pollution

The fresh water requirement in the proposed capacity expansion project will remain same and there is no increase in fresh water requirement. The present water requirement of the mine and plant activities is 11,700 m^3/day.

The total wastewater will be increased from existing 16,350 to 21,500 m^3/day within the plant and mine. Similarly, the total domestic waste from mine will be about 150 m^3/day. The details of wastewater generation are presented in **Table-3.22**.

TABLE-3.22
WASTEWATER GENERATION

Sr. No.	Units	Quantity (m^3/day)
1	Process (Tailings)	21500
2	Domestic (Canteen, toilets and sanitary in mine)	150
Total		**21,650**

3.9.3.1 Wastewater Treatment

The wastewater in the form of tailing slurry generated in the beneficiation plant is routed to the tailing dam. After the settlement of tailings in the tailing dam, clear water is recycled to water reclamation pond and then routed to beneficiation plant for reuse. This practice will continue in the expansion project also.

All the run-off water from over burden dumps and mining area is collected in mining sump through garland drains and pumped to water reclamation pond. The wastewater generated in the plant and mine is being recycled in the process and no wastewater is discharged out side the mine lease area, thus, facilitating the plant to be operated on 'zero discharge' condition. In future also, after the proposed expansion, the mine and plant will be operated on 'zero discharge' condition.

3.9.3.2 Water Pollution Control Measures

- ***Proposed Mitigation Measures***

The existing measures adopted in the mine will be continued in the proposed capacity expansion project. The additional measures recommended are;

- Improvements in dumper cleaning system at HVSC including oil trap;
- A reservoir of 20,000 m^3 was constructed near beneficiation plant to collect and recycle water from tailing dam and other areas for reduction of evaporation losses in tailing dam;
- High rate thickeners will be installed to improve the water recovery from tailing and concentrates; and
- Use of flocculants in the tailing thickeners to improve water recovery.

These measures while reducing the pollution will result in further reduction of fresh water consumption. The detailed additional measures are given in Chapter-6.

3.9.4 Noise Pollution

- ***Noise Pollution due to Mining Equipment***

In the proposed capacity expansion project, few mining equipments will be added to achieve the expanded capacity. The list of equipments along with source noise levels is given in **Table-3.23**.

TABLE-3.23
LIST OF ADDITIONAL MINING EQUIPMENT AND NOISE LEVELS

Sr. No.	Name of Equipment	Proposed [additional]		Noise Levels
		No.	Capacity	dB(A)
1	Dumper	18	177-218 T	<85
2	Drill for pre-splitting	2	115 mm	<85
3	Track Dozer	2	318 HP	<85
4	Excavator F/E	3	30-40 m^3	<85
5	Track Dozer	2	>510 HP	<85

- ***Blast Induced Noise & Vibrations***

Blasting contributes to noise pollution and vibration. The intensity of the vibration and noise depends upon the maximum charge per delay during blasting. Blasting causes ground vibrations that travel through the ground in the form of energy waves away from the blast or point of initiation of the charge.

To meet out the expanded excavation quantities blast size will be increased. However, blasting frequency will be increased by 10-15%. There is no increase in the charge per delay, which is restricted to 500 kgs.

The details of blasting and vibration studies being undertaken at Rampura-Agucha mine is given in **Annexure-IX.**

- ***Noise Pollution due to Beneficiation Plant***

In the proposed capacity expansion project, few types of equipment will be added in the beneficiation plant to match the beneficiation capacity. The proposed additional equipments are listed in **Table-3.24** along with the expected source noise levels.

3.9.5 Solid Waste Generation

Hazardous and non-hazardous waste generation from the beneficiation plant is in the form of used lube oil, discarded containers of sodium cyanide, tailings in the beneficiation plant and waste rock, which is non-hazardous in the mining. The solid waste generation from the beneficiation plant and mine is presented in **Table-3.25.**

TABLE-3.24
NOISE LEVEL - BENEFICIATION PLANT

Sr. No.	Particulars	Existing	Additional	Noise Level dB(A)
1	Primary Crusher	2	0	<85.0
2	SAG mill	2	1	<85.0
3	Ball Mill	5	1	<85.0
4	Lead rougher/Sca.Cells	29	7	<85.0
5	Lead cleaner cells	21	8	<85.0
6	Zinc Rougher/ Sca. Cells	32	8	<85.0
7	Zinc Cleaner cells	47	12	<85.0
8	Pressure Filter	12	4	90.0
9	Air Blower	10	2	90.0
10	Air compressors	15	4	<85.0

TABLE-3.25
SOLID WASTE GENERATION

Sr. No.	Waste Generated	Physical form	Quantity	Schedule under Hazardous waste rules	Analysis	Disposal
	Hazardous Waste					
1	Tailing	Solid	15600 TPD	A2, A4, B4 C14 of Schedule 2	Given in **Table-3.14**	Disposed in Tailing Pond.
2	Empty discarded containers of NaCN	Solid	12 no. per day	Category no.33.1 of schedule 1	De-contaminated containers of NaCN	De-contamination
3	Waste oil	Liquid (Oil)	1000 liters per day	Category no 5.1 of Schedule 1	Oil & Grease	This is sold to re-refiners approved by CPCB & MoEF.
	Non-Hazardous Waste					
1	Overburden Waste	Solid	2 lakh Tonnes/day	From mining operation	Rock/soil waste and inorganic and non-toxic. The analysis is given in Chapter-2	Dumped in the OB dump yards and part of it is used for tailing dam construction

3.9.5.1 Storage and Disposal Of Hazardous Waste

The Hazardous waste generated in expansion project will be disposed off as per the existing practice. The typical analysis of tailings is given in **Table-3.26.**

In the proposed expansion programme, because of the better metal recovery due to process automation, the metal content in the tailings is going to decrease. The Lead concentration in tailings will be reduced from 0.62 to 0.50%. Similarly, the zinc content in the tailings will reduce from 1.42% to 1.2%. Further, Ag will reduce from 25 ppm to 22 ppm.

TABLE-3.26
CHEMICAL ANALYSIS OF TAILINGS-EXISTING STATUS

Sr. No.	Parameter	Range
1	Pb	0.40-0.50 %
2	Zn	1.2-1.8 %
3	Fe	9.41-10.29 %
4	Cu	146-158 ppm
5	Ca	48-69 ppm
6	Ag	25-27 ppm
7	ISM (Acid insoluble)	63.52-63.44 %
8	Graphitic C	4.97-6.09 %
9	Ni	101-105 ppm
10	CO	39-45 ppm
11	Mn	311-315 ppm

Source: HZL, Rampura Agucha

3.9.5.2 Overburden Storage

Waste rock will be systematically stacked at the existing earmarked sites as outlined in Chapter-3. The vegetation cover will be developed on the non-moving ends of the dumps under reclamation program. No reclamation is possible till matured area is available. In the present case no non-mining area is available. The overburden dumps are being planted with green belt.

3.10 Greenbelt Development

The existing greenbelt will be strengthened further by planting more trees in the vacant areas and on the overburden dumps. The detailed plan of greenbelt development on the overburden dump is presented in Chapter-6 (Environment Management Plan).

4.0 BASELINE ENVIRONMENTAL STATUS

4.1 Introduction

This chapter provides a description of the existing environmental status of the study area with reference to the different environmental attributes. For this purpose, the core zone covers an area of 1200 ha and buffer zone covers an area of 10 km radius around the mine lease boundary. The enhancement of production and capacity expansion is proposed within existing mine lease area.

The existing environmental setting is considered to adjudge the baseline environmental conditions, which are described with respect to climate, hydro geological aspects, atmospheric conditions, water quality, soil quality, vegetation pattern, ecology, socio-economic profile, traffic study, land use and places of archaeological importance.

A regional background to the baseline data is being presented at the very outset, which will help in better appreciation of micro-level field data generated on several environmental and ecological attributes. The background information is based on Bhilwara and Ajmer District Gazetteers and district geo-hydrology reports. The secondary data on the impact of mining on water regime is based on the Hydrology & Hydrogeology study of core and buffer zones of Rampura-Agucha Mine conducted by Hydro-Geosurvey Consultants Private Limited, Jodhpur. This secondary information forms the first section of this baseline chapter. The second part contains primary data generated for micro-meteorology, ambient air quality, water quality, soil quality, noise levels and aquatic and terrestrial ecology in the core zone and buffer zone around the mine lease of the Rampura-Agucha Mine, during winter season (1st December 2008 to 28th February 2009). The third part of this section contains the land use pattern and the socioeconomic aspects in the buffer zone. HZL also carries out environmental monitoring and HZL data has been referred for comparison of the data generated during study period and to understand the impacts due to the present mining activity on the environment.

4.2 Hydrology and Hydrogeology

4.2.1 Hydrology

4.2.1.1Physiography of Banas River Basin

The Hydrogeological studies were carried out during 2006. The area forms the part of elevated plateau, cluster hills on either sides and is located within Aravali ranges trending NE-SW. It is mainly undulating landscape formed due to fluvial activity developed due to river systems. The alluvial thickness in general is limited with moderate thickness along the river courses. The area is drained by ephemeral rivers like Mansi, Sameilya Nadi and Khari which are tributaries of river Banas. Mansi river originates in hills western part of the district and after flowing for 50 km in northeast, it meets Khari river near village Phuliya in Bhilwara district. Khari river originates in the hills near Deogarh in Rajsamand district. It flows northeast for 192 km through Rajsamand, Bhilwara and Ajmer districts before joining Banas river near village Chosla in

Ajmer district. Sameliya Nadi, just flowing parallel to Mansi river, originates in Raila area and after flowing for 42 km, joins Khari river near village Bisundi in Bhilwara district.

All these rivers are tributaries of river Banas which originates in the eastern slopes of the Aravali ranges near Kumbhalgarh and after flowing eastwards for about 512 km through districts of Rajsamand, Chittorgarh, Bhilwara, Tonk, and Sawai Madhopur meets Chambal river near Rameshar village in Sawai Madhopur district. The Banas river basin covers an area of 47,052 sq.km.

The area in general has alluvial soils of fluvial origin with varying depths from shallow to moderate with weathered rock in the sub-stratum.

4.2.1.2 Mansi and Khari river sub-basins

Rampura- Agucha mines area is drained by river Mansi, which flows on its southern side. Northern area is drained by river Khari and both the rivers meet near village Phuliya about 25 km down stream from Rampura - Agucha mines. The catchment area of Mansi river is around 1750 sq.km before joining Khari river while the catchment area of Khari river is around 1845 sq.km. Both these rivers have been harnessed by minor and medium irrigation projects. Two dams, Sareri and Arwar have been constructed on Mansi river while Nahar Sagar has been constructed on Sameliya Nadi. Agucha pond gets water from local catchment area. Arwar dam and Agucha ponds are located in the buffer zone while Sareri and Nahar Sagar dams are located outside the buffer zone. However, a part of the command area of Sareri dam is located in the buffer zone while entire command area of Agucha dam lies in the buffer zone. The salient features of these dams are presented in **Table-4.2.1**.

TABLE-4.2.1
SALIENT FEATURES OF EXISTING SURFACE WATER PROJECTS IN MANSI-KHARI RIVER SUB-BASINS

Sr. No.	Project Name	DSB No.	Catchment Area (km^2)			Live Storage Mm^3	CCA Ha.
			Total	Intercepted	Free		
1	Agucha	4	89.3	36.3	53.1	4.5	633
2	Arwar	4	1145	565	580	47.8	7391
3	Nahar Sagar	4	539	195	344	24.5	3310
4	Sareri	4	1652	603	1049	83.5	9712

DSB - Differential Sub-basin ***Source: Irrigation Department 1996***
CCA - Culturable Command Area

4.2.1.3 Drainage Pattern

There is a well-defined drainage system having dendritic drainage pattern in the buffer zone. A major part of drainage has been harnessed by constructing medium and minor irrigation projects. Whatever runoff is produced by the annual rainfall of 400 mm in the buffer zone, major part goes as surface runoff after meeting the evapo-transpiration losses and a part percolates to the zone of saturation.

4.2.1.4 Runoff

Average annual rainfall in the catchment area of Mansi – Khari river sub- basin is 557 mm (IMD- Ajmer) out of which 516 mm happens to be during monsoon period from June to September. Winter monsoon is low, hardly contributing to surface runoff. The rainfall during the year 2006 was recorded as 472 at the mines by HZL, which is above average rainfall of 430 mm. The surface runoff in the river sub- basin has been computed as 15 to 18% based on the storage of medium irrigation dams.

4.2.2 Hydrogeology

4.2.2.1Regional Geology

The geology of the area is mainly composed of thin alluvial cover, belonging to Sub-Recent to Recent period of Quaternary Era followed by Banded Gneissic Complex (BGC) of Bhilwara Group of Lower Proterozoic Era. The geological succession can be summarized as under:

Era	***Age***	***Super Group***	***Group/Formations***	***Rock Types***
Quartemary	*Sub-Recent to Recent*	*Fluvial & Colluvium*	*Alluvium*	*Sand, Silt, Clays gravel etc.*
----------Unformity----------				
Proterozoic		*Aravali*	*Devda*	*Quarzites, phyllites, dolomites etc.*
Lower Archaeans Proterozoics		*Bhilwara*	*Banded Gneissic*	*Granites, Gneisses, Schists, migmatites*

Of all the rocks exposed in the area, only banded gneissic complex forms very poor aquifer while alluvium generally thin, remains above water table. It is only during the post monsoon period that basal part of alluvium gets saturated in the area along river courses. Hydro-geological Map of core and buffer zone of Rampura-Agucha Mine is shown in **Figure-4.2.1**.

4.2.2.2 Nature of Occurrence of Ground Water

Ground water occurs under water table conditions and is transmitted through fractures, joints and foliations. Banded Gneissic Complex (BGC) rocks are impervious in nature and have developed secondary porosity only due to joints and fractures. There is very limited thickness of weathered BGC rocks and generally it lies above the zone of saturation.

The depth to water in BGC rocks ranges from 8 to 10-m below the land surface near the river courses, surface water reservoirs and ponds during post-monsoon period while it is deeper in the area from 10 to 20-m below the land surface. The fluctuations due to rainfall and ground water withdrawal are significant as the rocks have very low fracture porosity and hydraulic conductivity.

4.2.2.3 Movement of Ground Water

The ground water movement is controlled mainly by the hydraulic conductivity of the crystalline metamorphics and hydraulic gradient. The ground water movement mainly takes place through the fractures and joints of the crystallines.

A review of the topography, and drainage pattern in the buffer zone reveals that the general slope of the area is towards East and is 0.6 m/km. The ground water flow is also towards Northeast and East with hydraulic gradient of 2.58 to 2.66 m/km as calculated from the monitoring of wells of the area.

4.2.2.4 Nature of Hydraulic Conductivity

As the principal aquifer of the area is banded gneissic complex, mostly gneisses, the hydraulic conductivity is mainly developed due to fractures and joints. The hydraulic conductivity is very low. The depth of productive hydraulic conductivity has been observed up to maximum depth of 90 m in the metamorphics beyond which there are hardly any secondary openings making the metamorphics completely barren.

There are very few tube wells and mostly open dug wells have been constructed for irrigation in the buffer zone. No pump tests have been carried to find out hydraulic conductivity. However, the pump tests carried out in similar formations elsewhere have indicated hydraulic conductivity (K) as varying from 0.02 to 0.5 cum/day /m^2.

Corresponding to these values of K, the specific capacity of open wells ranges between 0.2 cum/ day/m and 5 cum/day/m of the aquifer tapped respectively. These are very low values for hydraulic conductivity and specific capacity of wells indicating very poor capability of wells. This is also confirmed by the results of few exploratory tube wells drilled in the area between Agucha dam and mines, which yielded very low discharges indicating very low hydraulic conductivity. It appears that fractures and joints present in the gneisses are not extensive and are not connected to each other.

4.2.2.5 Yield of Wells

There are a few open wells working in the mines area, which were earlier operated but are now occasionally pumped. These wells yield meager discharge ranging from 50 to 100 cum/day of potable quality of water. These wells do not sustain pumping more than few hours and go dry and recoup after 12 to 16 hours further confirming very low hydraulic conductivity. Wells are mostly operated by centrifugal pumps either by electrical motors of 5 HP or diesel engines of 8 HP.

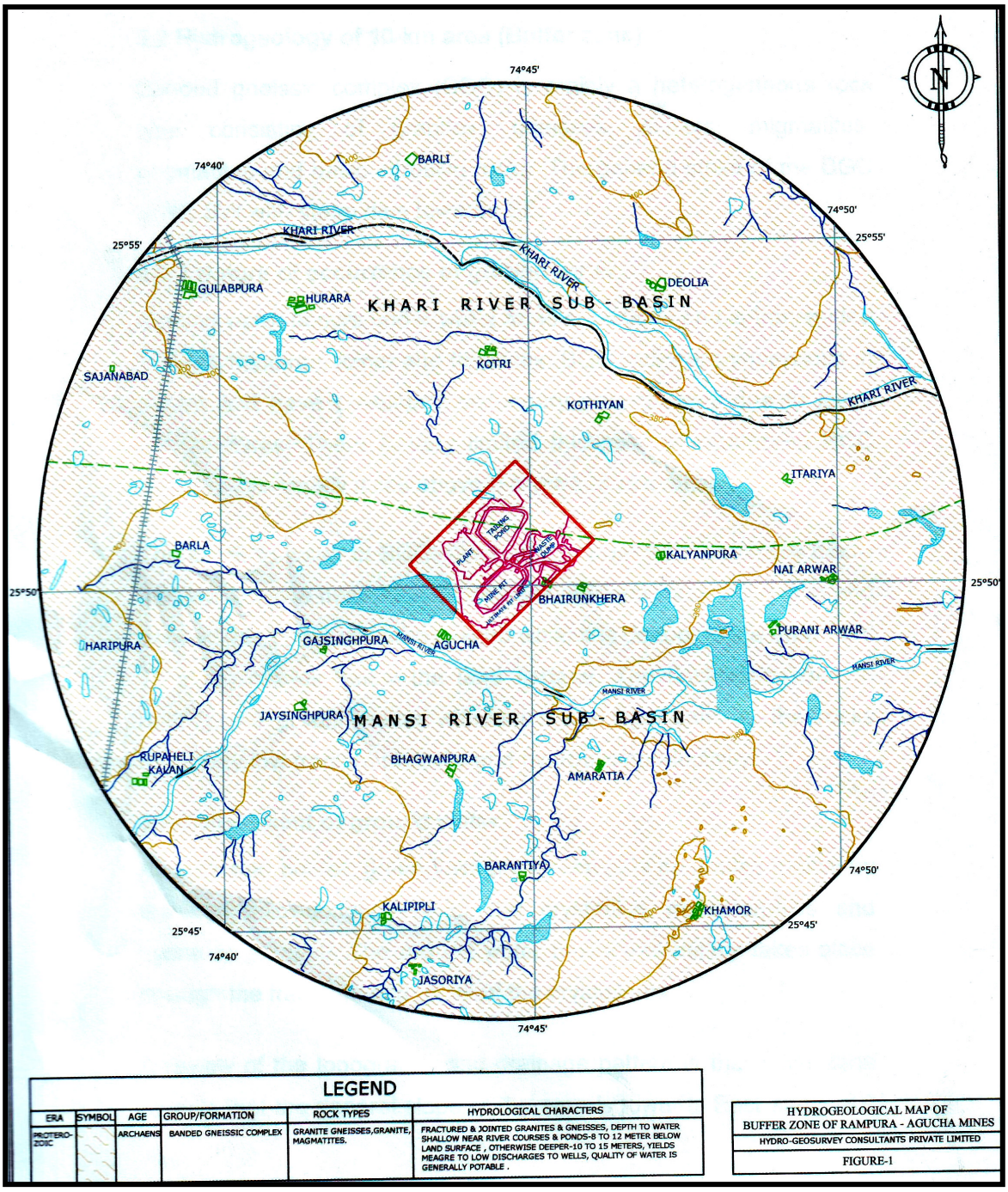


FIGURE-4.2.1
HYDRO-GEOLOGICAL MAP OF CORE AND BUFFER ZONE OF RAMPURA-AGUCHA MINE

4.2.2.6 Ground Water Recharge

The ground water is recharged mainly through the rainfall by direct percolation to the zone of saturation. There is well developed drainage in the area due to loamy soils. A significant part of the rainfall is lost as runoff from the area due to thin loamy soils. A limited percentage of rainfall therefore reaches zone of saturation and becomes a part of ground water storage after meeting the evaporation and evapo -transpiration losses. There is also ground water recharge from the return flow of irrigation water pumped from dug wells operated by the cultivators and also from canals of Sareri dam and Agucha pond. The other dams have command area just outside the buffer zone. The command area in buffer zone from irrigation dams is 3410 hectares. The ground water recharge from return flow of irrigation is normally taken as 30 % of the total water applied for irrigation. This percentage has been suggested by the Ground Water Estimation Committee for ground water assessment for this part of the state.

Ground water recharge from rainfall for the year 2006, which was above the average annual rainfall (792 mm against average annual rainfall of 430.87 mm), has been calculated by measuring the rise of water levels in the key wells of the buffer zone. The water levels in the month of first week of June 2006 were recorded and were again measured in the first week of October, 2006. The rise of water levels indicates the quantity of water percolated to zone of saturation due to recharge from rainfall. The average rise of water table has been noted as 5.15 m in granitic gneisses. Taking specific yield of 1.5 % for granitic gneisses, the ground water recharge has been calculated for core and buffer zones.

4.2.2.7 Ground Water Recharge of Mines Area (Core Zone)

The mining lease covers an area of 1200 hectares. At present there is hardly any ground water withdrawal from this area as the water requirement of the mine and plant is met from radial collector wells located in Banas river, about 57 km from the mines. The rise of water table due to rainfall for the year 2006 has been determined from two existing open wells by recording water table during pre and post-monsoon periods, which was observed as 5.45 m for the gneisses. The ground water recharge is calculated for the core zone as under;

*Area of core zone * Rise of water level * specific yield = Recharge*

$$12 \; x \; 1000 \; x \; 1000 \; x \; 5.45 \; x \; 0.015 = \quad 0.98 \; mcm$$

The ground water recharge for the core zone therefore amounts to 0.98 mcm and when adjusted to normalized rainfall year, amounts to 0.51 mcm.

- ***Rainfall Infiltration***

The Ground Water Resource Estimate Committee, formed by Government of India has proposed rainfall infiltration factor to be used for estimation of ground water recharge for the areas where monitoring of wells has not been done. The committee has suggested 10 % to 15 % as the rainfall infiltration factor for metamorphics area having loamy soils with moderate rainfall and well developed

drainage. An infiltration factor of 10 % is adopted for this area, which appears to be reasonable looking to the hydrogeological and geomorphological settings. Although, there is no need to use this theoretical approach in this case, which has been monitored on a comprehensive scale, an attempt can be made to find out if it matches with the ground water recharge as calculated by increment in the ground water storage and it is found that it matches very well.

*Area of core zone * rainfall * infiltration = Recharge*

$$12 \; x \; 1000 \; x \; 1000 \; x \; 0.431 \; x \; 0.1 = \quad 0.517 \; mcm$$

4.2.2.8 Ground Water Recharge of 10 km Area (Buffer Zone)

Buffer zone has mainly granitic gneisses as principal aquifer occupying an area of 478.62 Sq.Km (490.62 - 12 Sq.Km of core zone) in the tehsils of Hurda and Shahpura of Bhilwara district and Kekri tehsils of Ajmer district. An area of 3410 hectares of the buffer zone is irrigated by Arwar dam and Agucha pond and other smaller ponds while the balance area of 4450 hectares is irrigated by open wells.

The ground water fluctuation of water table during pre-monsoon and post-monsoon periods were recorded for the year 2006 from the 30 key wells as per the guidelines of the Ministry of Environment & Forests and taking specific yield values of 1.5 % for granitic gneisses. Hydrological data of key wells of buffer zone of Rampura-Agucha mine monitored during 2006 is presented in **Table-4.2.2.** The ground water recharge by rain fall has been calculated as under.

- ***Increment in Ground Water Storage***

The rise of water table in key wells tapping gneisses was recorded for year 2006 when the area received rainfall of 792 mm (long term average being 430.87 mm). The rise of water level was found 5.15 m in the granitic gneisses after averaging for buffer zone. The ground water recharge is calculated as under;

*Area of core zone * Rise of water level * Specific yield = Recharge*

$$478.62 \; x \; 1000 \; x \; 1000 \; x \; 5.15 \; x \; 0.015 = \quad 36.97 \; mcm$$

The ground water recharge for the year 2006 by rainfall 792 mm when measured as increment in ground water storage amounts to 36.97 mcm, which adjusted for a normalized rainfall year (430.87 mm) amounts to 20.11 mcm.

- ***Return Flow of Irrigation***

The norms prescribed by the Estimate Committee for return seepage from the irrigation fields having loamy soils has been suggested as 20 % of the total water applied for the irrigation. The total water applied for irrigation from dams and open wells in the buffer zone is 35.45 mcm of which 20 % joins ground water storage as return flow of irrigation, amounting to 7.09 mcm.

*Water applied for irrigation * Return seepage = Recharge*

$$35.45\ x\ 0.20 = \quad 7.09\ mcm$$

The total ground water recharge of buffer zone from all the sources therefore amounts to 27.20 million cubic metres.

The ground water recharge can also be roughly estimated by rainfall infiltration method taking 10 % of the annual rainfall as under;

*Area of Buffer zone * rainfall * infiltration = Recharge*

$$478.62\ x\ 1000\ x\ 1000\ x\ 0.431x\ 0.1 = \quad 20.63\ mcm$$

The ground water recharge calculated by increment in ground water storage (20.11 mcm) matches well with rainfall infiltration method (20.63 mcm).

4.2.2.9 Ground Water Discharge

- ***Ground Water Discharge of Core Zone***

The ground water discharge in the core zone comprising mines area of 12 sq.km takes place mainly by withdrawal from two open wells which are rarely pumped as the water requirement of water is met from radial collector wells located on Banas river, about 57 km away from mines. The mine discharge contributes to the extraction of ground water from the mining area. So there is hardly any ground water discharge from core-zone. However, taking 50 cubic meter per day from each well and average operation of 30 days a year, the annual ground water withdrawal amounts to;

*Number of wells * yield/day * Number of days operation = Annual withdrawal*

2 x 50 x 30 = 0.003 mcm

The mine gets an average inflow of 250 cubic meter per day, which is pumped and utilized in the process. Discharge through mining amounts to;

*Mine Discharge * Number of days = Annual withdrawal*

250 x 360 = 0.09 mcm

It is observed that against the ground water recharge of core zone for normalized rainfall year of 0.51 mcm, the annual ground water withdrawal is 0.093 mcm, thereby making the present status of ground water development about 18 % of the long term ground water recharge.

TABLE-4.2.2
HYDROLOGICAL DATA OF KEY WELLS OF BUFFER ZONE OF RAMPURA-AGUCHA MINE MONITORED DURING 2006

Sr. No	Village	Owner's Name	Latitude	Longitude	Depth Of Well (M)	Pre Monsoon Water Level (M)	Post Monsoon Water Level (M)	Aquifer	Yield (M^3/D)	Pump Capacity (Hp)	Purpose
1	Jorapura	Baluji	25°53'37.8''	74°38'00.5''	22.00	20.10	8.48	Gneisses	50.00	5 HP/DE	Irrigation
2	Babrio Ka Khera	Ramchandra	25°52'12.8''	74°37'23.8''	30.00	14.50	10.4	Gneisses	60.00	7.5 HP/EM	Irrigation
3	Gaj Singh Pura	Bhanwarji Jatt	25°49'19.9''	74°41'42.4''	8.05	7.35	2.68	Gneisses	50.00	5HP/EM	Irrigation
4	Jai Singh Pura	Iswarji	25°48'24.0''	74°41'21.9''	12.80	10.75	7.11	Gneisses	-	Manual	Drinking
5	Bhojraj	Hemrajji	25°47'42.1''	74°40'56.8''	19.50	18.10	9.13	Gneisses	90.00	10HP/EM	Irrigation
6	Bhojraj	Kailash	25°47'18.5''	74°41'10.1''	20.02	18.95	10.01	Gneisses	-	Manual	Drinking
7	Pushpakumari	Agucha	25°51'06.8''	74°42'23.1''	24.25	22.25	8.34	Gneisses	40.00	5HP/EM	Irrigation
8	Naya Lakhmipura	Hiraji	25°53'17.0''	74°43'29.3''	33.53	22.01	11.13	Gneisses	60.00	5HP/EM	Irrigation
9	Bhadvo Ki Kotri	Raran Dhobi	25°53'13.5''	74°44'25.0''	17.10	12.80	8.08	Gneisses	50.00	3HP/EM	Irrigation
10	Kothian	Kailash Sadhu	25°52'26.5''	74°45'53.0''	14.00	12.60	9.18	Gneisses	50.00	3HP/EM	Irrigation
11	Armia	Pradeep	25°51'29.3''	74°47'28.8''	22.50	20.10	9.53	Gneisses	-	Manual	Drinking
12	Hurda	Public well	25°54'02.7''	74°40'58.1''	13.10	6.25	3.98	Gneisses	-	Manual	Drinking
13	Agucha	HZL (W-10)	25°50'12.5''	74°43'56.1''	22.15	19.98	14.70	Gneisses	60.00	5HP/EM	Domestic
14	Agucha	HZL (W-9)	25°50'07.3''	74°44'17.8''	22.10	20.93	15.80	Gneisses	-	Manual	Domestic
15	Agucha	HZL (W-22)	25°49'41.1''	74°43'47.5''	15.12	7.28	1.30	Gneisses	-	Manual	Domestic
16	Agucha	Narender Singh	25°49'03.8''	74°43'39.1''	12.00	9.50	8.19	Gneisses	60.00	5HP/DE	Irrigation
17	Agucha	Ramprasad	25°48'26.4''	74°43'52.8''	23.00	20.45	16.9	Gneisses	60.00	5HP/DE	Irrigation
18	Bhopalpur	Brijkoshore Singh	25°48'01.5''	74°44'04.3''	12.50	11.20	7.68	Gneisses	-	Manual	Drinking
19	Bhopalpur	Shankar	25°47'45.9''	74°44'15.3''	15.25	12.10	8.18	Gneisses	50.00	5HP/EM	Irrigation
20	Barantiya	Prem Chand	25°45'57.5''	74°44'44.4''	20.00	18.10	14.28	Gneisses	50.00	5HP/EM	Irrigation
21	Jasoria	Public well	25°44'57.3''	74°42'54.9''	14.00	12.80	11.09	Gneisses	-	Manual	Drinking
22	Kalapipal	Kumawat	25°45'07.7''	74°42'38.8''	14.90	12.80	10.01	Gneisses	-	Manual	Drinking
23	Chainpuria	Shankar	25°46'27.3''	74°42'16.4''	18.00	17.80	14.59	Gneisses	30.00	3HP/DE	Irrigation
24	Chainpuria	Ramuji	25°46'53.3''	74°42'13.2''	20.51	15.76	6.38	Gneisses	60.00	5HP/EM	Irrigation
25	Indrati Ka Khera	Duda Ram	25°47'48.5''	74°42'27.3''	18.00	16.80	13.98	Gneisses	30.00	3HP/DE	Irrigation
26	Bhajras	Gangaram	25°46'50.9''	74°41'04.3''	15.81	12.80	8.09	Gneisses	60.00	5HP/EM	Irrigation
27	Rupalikalan	Public well	25°47'17.4''	74°38'27.5''	11.00	10.03	6.38	Gneisses	-	Manual	Drinking
28	Barla	Bagghu	25°50'21.0''	74°38'42.7''	11.25	11.00	4.9	Gneisses	-	Manual	Drinking
29	Gulabpura	Kailash Chandra	25°54'05.8''	74°38'47.1''	26.20	10.40	7.91	Gneisses	60.00	7.5HP/EM	Irrigation
30	Itidia	Mahadev	25°51'25.5''	74°48'56.7''	14.50	13.10	10.13	Gneisses	50.00	5HP/EM	Irrigation
31	Khamor	Panna jat	25°46'28.1''	74°46'15.1''	12.70	10.20	5.02	Gneisses	80.00	7.5HP/EM	Irrigation
32	Amartia	Public well	25°47'27.3''	74°46'12.7''	14.00	9.40	8.74	Gneisses	-	Manual	Drinking
33	Tasvaria	Pukhraj	25°50'11.2''	74°37'27.1''	24.00	21.14	16.98	Gneisses	40.00	5HP/EM	Irrigation

- ***Ground Water Discharge in Buffer Zone***

Ground water discharge in the buffer zone takes place mainly by dugwells operated for irrigation by cultivators. There are 2165 dugwells tapping gneisses yield on average 80 cum/day. The annual ground water withdrawal from these wells is calculated as under.

*Number of wells * yield/day * Number of days operation = Annual withdrawal*

$$2165 \; x \; 80 \; x \; 120 = \quad 20.78 \; mcm$$

In addition, the drinking and livestock water requirement of all the villages located in the buffer zones is met by open dugwells and hand pumps and is around 0.85 million cubic metres. The total ground water discharge therefore amounts to 21.63 million cubic metres. It is observed that against the total ground water recharge of buffer zone of 27.20 mcm, the ground water discharge is 21.63 mcm, indicating the status of ground water development as 79.5 %. The study therefore indicates that the area of buffer zones is safe zone for future ground water development and has surplus exploitable ground water potential.

4.2.2.10 Present Status of Ground Water Development of the Area

The state ground water organization, the Ground Water Department also works out the status of ground water development for each Tehsil every year and publishes the findings once in two years after monitoring the key wells. The findings of the Ground Water Department released for the year 2004, indicate that ground water potential zone comprising gneisses of Hurda and Shahpura Tehsils of Bhilwara District and adjoining areas of Ajmer district fall in Safe zone and the present status of ground water development is 105 % of the long-term ground water recharge. This includes the drinking and livestock water requirement of the Tehsils for the projected population of the year 2025. The findings of the present study also match with assessment made by the Ground Water Department.

4.2.2.11 Water Table and its Behavior

Rajasthan Ground Water Department (RGWD) monitors the ground water fluctuation at 6 locations in the study area. The data was made available to us on the water levels in the dug wells for pre-monsoon and post-monsoon periods from 1984 to 2005. The fluctuation levels indicate the recharging of the well due to surrounding water bodies and run-off water in monsoon season.

In pre-monsoon season the water levels drop considerably. The lowest water level recorded was 15.0 m in Agucha village. The ground water level in pre-monsoon season ranged between 9.1 to 15.0 m. The average water levels were found to be around 11.5 m in the study area. Some of the wells go dry during severe summer. The marginal increase in water levels was recorded in post monsoon season. The over all pattern of the ground water level show that average ground water level fluctuation is around 1.36 to 4.15 m.

The details of the observatory wells and water levels from year 1984 to 2005 are given in **Table-4.2.3** and **Table-4.2.4.**

TABLE-4.2.3
DETAILS OF THE OBSERVATORY WELLS IN THE STUDY AREA

Sr. No.	Village	Block	Hydrological formation	Type of well	Depth of well (m bgl)
1	Agucha	Hurda	Gneiss	Dug well	15.00
2	Barantiya	Hurda	Gneiss	Dug well	15.00
3	Barla	Hurda	Gneiss	Dug well	15.00
4	Barla	Shahapura	Schist	Dug well	09.35
5	Kothiyan	Shahapura	Gneiss	Dug well	12.90
6	Nai Arwar	Shahapura	Gneiss	Dug well	14.70

Source: State Ground Water Department, Bhilwara
Note: BGL – Below Ground Level

4.2.2.12 Observations on Surface Water

The major surface water bodies in the project area are the Khari and Mansi Rivers and Agucha Tank as explained above. A number of old earthen tanks are traditionally used to store water for domestic purposes and for dry season irrigation. Being in a region of low rainfall but high agricultural dependency, the availability and quality of water is of major importance.

TABLE-4.2.4
GROUND WATER LEVELS IN THE STUDY AREA

Village	Agucha			Barantiya			Barla (Hurda)			Barla (Shahapura)			Kothiyan			Nai-Arwar		
	Depth of well-15 m			Depth of well-15 m			Depth of well-15 m			Depth of well-9.3 m			Depth of well-12.9 m			Depth of well-14.7 m		
Year	Pre	Post	Fluc	Pre	Post	Fluc	Pre	Post	Fluc	Pre	Post	Fluc	Pre	Post	Fluc	Pre	Post	Fluc
1984	08.70	08.60	0.10	07.75	04.40	3.35	09.95	05.10	4.85	06.60	6.60	0.00	09.25	05.75	3.50	04.00	3.05	0.95
1985	10.15	13.00	2.85	11.20	06.30	4.90	09.00	09.55	0.55	07.60	5.95	1.65	NA	10.60	NA	03.85	2.58	1.27
1986	13.70	13.95	0.25	11.80	05.80	6.00	09.40	12.10	2.70	07.25	6.90	0.35	12.00	10.65	1.35	05.80	4.30	1.50
1987	13.90	13.70	0.20	11.85	10.40	1.45	12.15	11.30	0.85	06.60	7.95	1.35	12.10	09.75	2.35	12.50	4.65	7.85
1988	14.40	11.50	2.90	12.00	06.50	5.50	10.95	06.10	4.85	08.85	4.97	3.88	12.05	09.40	2.65	12.90	4.10	8.80
1989	13.55	13.55	0.02	08.20	03.10	5.10	06.66	04.20	2.46	05.30	2.90	2.40	12.75	09.85	2.90	06.09	5.70	0.39
1990	13.70	12.16	1.54	08.05	03.70	4.35	10.00	06.90	3.10	06.15	NA	NA	12.90	04.30	8.60	06.90	1.60	5.30
1991	10.45	10.85	0.40	05.50	04.15	1.35	06.85	06.10	0.75	05.20	1.50	3.70	10.40	04.25	6.15	04.40	5.40	1.00
1992	11.70	11.15	0.55	05.70	02.80	2.90	09.10	05.10	4.00	04.30	1.35	2.95	11.35	06.70	4.65	08.60	2.00	6.60
1993	12.18	12.60	0.42	12.30	04.30	8.00	10.05	11.10	1.05	04.00	1.50	2.50	11.35	07.15	4.20	08.80	4.70	4.10
1994	14.10	13.05	1.05	14.00	04.90	9.10	11.40	07.30	4.10	05.40	1.50	3.90	Dry	NA	NA	09.95	1.30	8.65
1995	12.00	12.78	0.78	07.80	04.55	3.25	09.30	09.65	0.35	05.75	3.68	2.07	09.91	09.10	0.81	08.70	3.10	5.60
1996	13.50	13.00	0.50	09.25	04.80	4.45	12.62	04.80	7.82	06.60	0.40	6.20	11.55	05.15	6.40	08.65	2.50	6.15
1997	10.85	09.60	1.25	07.20	04.20	3.00	08.80	05.30	3.50	03.00	0.95	2.05	10.55	06.75	3.80	03.40	2.60	0.80
1998	12.10	13.60	1.50	06.90	03.70	3.20	08.10	04.60	3.50	03.50	3.05	0.45	10.55	08.60	1.95	08.40	4.20	4.20
1999	13.40	13.40	0.00	06.90	06.20	0.70	10.50	10.40	0.10	06.30	3.80	2.50	Dry	Dry	NA	10.10	9.30	0.80
2000	13.70	14.45	0.75	13.00	13.40	0.40	12.20	09.40	2.80	06.55	2.40	4.15	Dry	Dry	NA	11.70	9.40	2.30
2001	15.00	13.95	1.05	14.40	07.75	6.65	13.70	12.50	1.20	08.40	6.60	1.80	Dry	Dry	NA	11.90	4.30	7.60
2002	13.90	Dry	13.90	09.70	09.25	0.45	11.65	12.55	0.90	09.00	9.10	0.10	Dry	Dry	NA	11.70	13.40	1.70
2003	Dry	Dry	NA	13.30	14.15	0.85	13.80	13.75	0.05	Dry	7.20	7.20	Dry	Dry	NA	13.55	13.65	0.10
2004	Dry	Dry	NA	11.90	8.60	3.30	10.86	11.95	1.09	8.45	1.45	7.0	Dry	Dry	NA	13.60	3.90	9.70
2005	Dry	Dry	NA	12.20	6.45	5.75	13.60	10.55	3.05	7.60	2.80	4.80	Dry	Dry	NA	6.30	12.20	5.90
2006	Dry	Dry	NA	9.90	6.00	3.90	13.25	4.65	8.60	Dry	5.60	5.60	Dry	Dry	NA	8.70	2.80	5.9
2007	Dry	Dry	NA	8.35	4.60	3.75	9.45	9.70	0.25	7.70	4.00	3.70	Dry	Dry	NA	7.40	2.05	4.9
2008	Dry	Dry	NA	8.40	13.90	5.5	9.20	13.60	4.40	7.45	3.90	3.55	Dry	Dry	NA	6.10	5.40	0.7

Source: State Ground Water Department, Bhilwara
Note: NA – Not Available Pre- Pre-monsoon Post: Post-monsoon Fluc: Fluctuation

4.3 Micro-Meteorology

The meteorological data recorded during the study period is very useful for proper interpretation of the baseline information as well as for input to prediction models for air quality dispersion. Historical data on meteorological parameters will also play an important role in identifying the general meteorological regime of the region.

4.3.1 Observations on Primary Data monitored by HZL and Vimta Labs Limited

HZL has installed a weather station on top of the laboratory building at height of 10 m from the ground. The weather parameters like wind speed, wind direction, temperature, relative humidity and rainfall are recorded at hourly interval. The monitored data generated during winter season (1st Dec 2008 to 28th February 2009) is presented in **Table-4.3.1.**

The recorded meteorological data during pre-monsoon, post-monsoon and winter season is presented in **Table-4.3.2.**

TABLE-4.3.1
SUMMARY OF THE METEOROLOGICAL DATA MONITORED BY HZL AT SITE

Month	Temperature (°C)		Relative Humidity (%)	Rainfall (mm)
	Max	Min		
January –2008	28.6	2.4	42.54	Nil
February-2008	35.7	1.9	33.89	Nil
March –2008	38.1	13.8	33.83	1
April 2008	44.3	15.5	36.10	21
May –2008	43.4	20.7	45.14	43
June-2008	39.8	20.0	74.04	109
July –2008	38.6	22.2	75.44	69
August –2008	39.0	22.6	76.40	63
September -2008	39.4	21.5	80.50	166
October-2008	40.3	17.5	46.68	Nil
November –2008	36.6	8.4	45.10	Nil
December - 2008	29.7	6.3	58.3	Nil
January –2009	30.7	4.6	10.26	Nil
February -2009	36.1	6.8	58.30	Nil

TABLE-4.3.2
SUMMARY OF THE METEOROLOGICAL DATA AT SITE BY VIMTA

Month	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	Cloud Cover (Oktas)	
	Max.	Min.	Max.	Min.		Min.	Max.
December, 2008	29.3	5.9	84	16	6.3	0/8	2/8
January, 2009	30.1	3.9	83	21	Nil	0/8	2/8
February, 2009	35.5	7.2	77	18	Nil	0/8	2/8

- ***Recorded By HZL***

The rainfall of 472 mm was recorded during the year 2008. The rainfall data recorded at Rampura Agucha mine from the year 1987 to 2008 is given in **Table-4.3.3.** The average rainfall at the mine area is 445.9 mm and is less than average rainfall recorded by IMD Ajmer, which is 528 mm.

TABLE-4.3.3
YEAR WISE RAINFALL RECORDED AT RA MINES (FROM 1987 – 2008)

Year	Rainfall (mm)
1987	440.0
1988	508.0
1989	455.0
1990	806.0
1991	315.4
1992	288.4
1993	294.5
1994	457.0
1995	308.5
1996	480.6
1997	453.0
1998	309.0
1999	180.0
2000	352.0
2001	428.0
2002	153.0
2003	575.0
2004	604.0
2005	418.0
2006	792.0
2007	721.0
2008	472.0
Average Annual Rainfall	**445.9**

- ***Wind Pattern (Monitored by VIMTA)***

The wind pattern for the study period representing winter season are discussed here under and shown in **Figure-4.3.1** and the data is presented in **Table-4.3.4**.

TABLE-4.3.4
SUMMARY OF WIND PATTERN AT THE STUDY AREA

Season	Winter Season 2008-09
First Predominant Wind Direction	WSW (16.7)
Second Predominant Wind Direction	NE (13.5)
Predominant Wind Speeds (kmph)	1.0 to 5.0 5.0 to 11.0
Calm Conditions (%)	30.4 %

Note: Figures in parenthesis indicates percentage of time wind blows

A review of the wind rose diagram shows that predominant winds are from western side. The predominant wind direction is from WSW direction followed by NE..

Predominant winds from West South West direction were observed for 16.7% of the total time, with wind speeds and frequencies in the range of 1-5 kmph (9.7.1%) and 5-11 kmph (7.0%). In North East direction the winds were observed for 13.5% of the total time with wind speeds and frequencies in the range of 1-5 kmph (7.5%) and 5-11 kmph (6.0%). In North West direction the winds were observed for 10.2% of the total time with wind speeds and frequencies in the range of 1-5 kmph (5.2%) and 5-11 kmph (5.0%) respectively. In other directions, the percentage frequencies observed were WNW (5.6%), N (5.1%), SSW (4.6%), ESE (3.9%), W (2.7%), SW (2.5%), S (1.7%), SE (1.4%), SSE (0.7%), NNW (0.3%), E (0.3%), ENE (0.3%) and NNE (0.1%). Calm conditions prevailed for 30.4 % of the time.

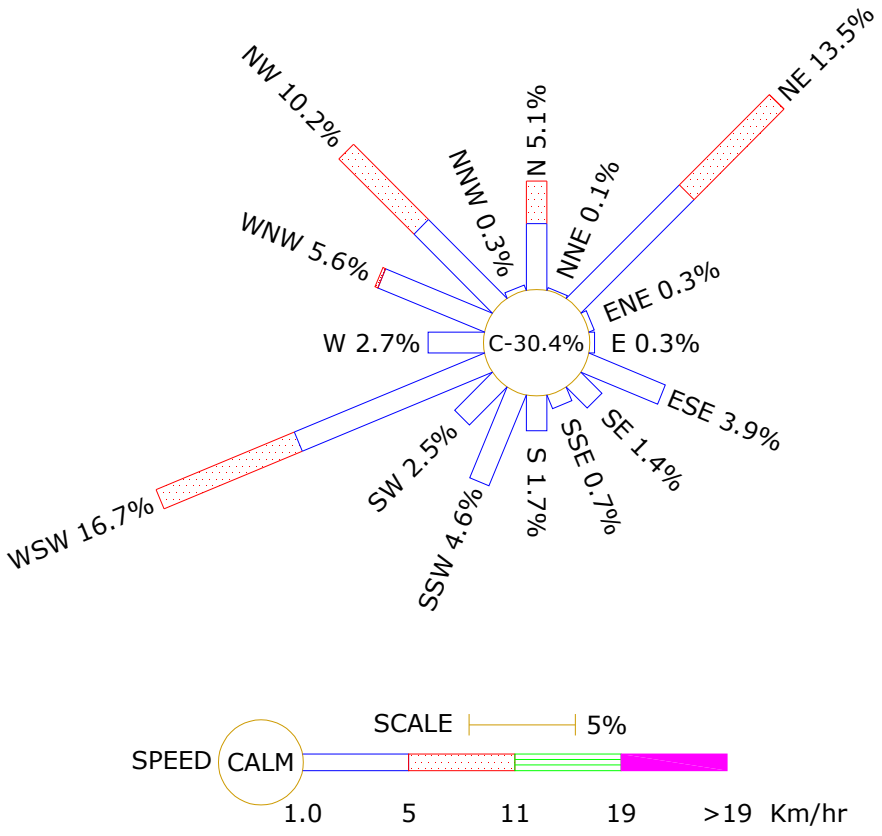


FIGURE-4.3.1
WIND ROSE – WINTER SEASON (2008-2009)

4.3.2 Data Collection from IMD Ajmer

The meteorological data has been collected from IMD, Ajmer for the parameters such as atmospheric pressure, temperature, relative humidity, rainfall, cloud cover, wind speed and direction. The data at IMD is usually measured twice a day viz., at 0830 and 1730 hr. The data recorded by IMD is given in **Table-4.3.5.**

TABLE-4.3.5
CLIMATOLOGICAL DATA GENERATED AT IMD STATION, AJMER (1997-2006)

Month	Temperature (0C)		Relative Humidity (%)		Rainfall
	Mean Max	Mean Min	0830	1730	(mm)
January	24.5	10.0	60.6	27.8	0.3
February	27.0	13.0	52.9	22.6	10.8
March	32.6	18.8	39.4	16.0	2.3
April	38.0	24.8	30.4	14.0	6.4
May	39.9	27.7	40.6	19.6	27.5
June	38 .5	27.4	56.5	33.7	89.3
July	34.1	25.9	73.1	56.6	167.4
August	32.6	24.8	77.8	62.1	135.6
September	34.5	24.8	66.4	47.2	60.9
October	34.5	21.3	52.9	29.3	24.7
November	30.7	16.4	50.8	27.0	1.2
December	26.5	11.7	47.4	25.0	1.6
	Total Rainfall (mm)				**528.0**

TABLE-4.3.6
SUMMARY OF WIND PATTERN – IMD AJMER

Season	First Predominant Winds		Second Predominant Winds		% Calm Condition	Predominant Wind Speed (kmph)
	0830	1730	0830	1730		
Winter	N (7.7%)	N (19.6%)	NE (6.7%)	SW (14.7%)	49.5 %	1-19
Pre-Monsoon	SW (29.6%)	W (11.6%)	SW (41.7%)	W (22.0%)	14.3 %	1-19
Monsoon	SW (42.0%)	W (28.8%)	SW (42.7%)	W (21.6%)	12.25 %	1-19
Post Monsoon	SW (8.5%)	N (6.0 %)	N (22.0%)	SW (11.5%)	55.5 %	1-19
Annual	SW (21.4%)	W (11.8%)	SW (27.7%)	W (13.8%)	34.1%	1-19

Note: Figures in parenthesis indicates % of time wind blows

- **Wind Speed/Direction**

Generally, light to moderate winds prevail throughout the year. Winds were light to moderate particularly during the morning hours. During the afternoon hours the winds were stronger. The season-wise description of the wind patterns are presented below:

i) Wind Pattern During Pre-Monsoon Season (0830 hours)

The wind pattern analysis shows that the predominant wind direction is from SW with wind frequency of 29.6%. This is followed by 11.6% frequency from W. The other observed directions are N (7.0%), NE (5.6%), S (5.0%), NW (3.0%), SE (2.3), E (1.0%), WSW (0.6%). The calm conditions prevailed for 34.3% of time. The wind speeds of 1.1-5.0 Km/hr, 5.1-11.0 Km/hr, 11.1-19.0 Km/hr and more than 19.0 km/hr were recorded.

1730 hours:

The analysis of wind pattern shows that the predominant wind direction is from SW with wind frequency of 41.7%. It is followed by the frequency of 22% from W. The other observed directions are N (11.3%), NW (7.7%), S (4.0%), NE (3.3%), SE (1.0%) and WSW (0.3%). The calm conditions prevailed for 8.7% of time. The wind speeds of 1.1-5.0 Km/hr, 5.1-11.0 Km/hr, 11.1-19.0 Km/hr and more than 19.0 km/hr were recorded.

The wind-rose diagram showing the wind speed and directions for the Pre-Monsoon season at IMD, Ajmer station is depicted as **Figure-4.3.2.**

ii) Wind Pattern During Monsoon Season

0830 hours:

The analysis of wind pattern shows that the predominant wind direction is from SW with wind frequency of 42.0%. It is followed by W with 28.8% frequency. The other observed directions are NW (3.8%), NE (3.8%), S (3.0%), N (3.0%), SE (1.7%), WNW (0.6%) and WSW (0.3%). The calm conditions prevailed for 13.0% of time. The wind speeds of 1.1-5.0 Km/hr, 5.1-11.0 Km/hr, 11.1-19.0 Km/hr and more than 19.0 km/hr were recorded.

1730 hours:

The analysis of wind pattern shows that the predominant wind direction is from SW with wind frequency of 42.7%. It is followed by W with 21.6% frequency. The other observed directions are N (7.2%), NW (5.6%), NE (5.0%), S (3.7%), SE (2.2%) and E (0.5%). The calm conditions prevailed for 11.5% of time. The wind speeds of 1.1-5.0 Km/hr, 5.1-11.0 km/hr, 11.1-19.0 km/hr and more than 19.0 km/hr were recorded.

The wind-rose diagram showing the wind speed and directions for the Monsoon season at IMD, Ajmer station is depicted as **Figure-4.3.3.**

iii) Wind Pattern during Post-Monsoon Season

0830 hours:

The analysis of wind pattern shows that the predominant wind direction is from SW with wind frequency of (8.5%). It is followed by N with 6.0% frequency. The other observed directions are W (4.5%), S (3.0%), NE (3.0%), SE (2.0%), NW (1.5%) and E (1.0%). The calm conditions prevailed for 70.5% of time. The wind speeds of 1.1-5.0 Km/hr, 5.1-11.0 Km/hr, 11.1-19.0 Km/hr and more than 19.0 km/hr were recorded.

1730 hours:

The analysis of wind pattern shows that the predominant wind direction is from N with wind frequency of 22.0%. It is followed by SW with 11.5% frequency. The other observed directions are NE (8.5%), W (7.0%), NW (6.0%), S (2.5%), SE (1.5%) and SSE (0.5%). The calm conditions prevailed for 40.5% of time. The wind speeds of 1.1-5.0 km/hr, 5.1-11.0 km/hr, 11.1-19.0 km/hr and more than 19.0 km/hr were recorded.

The wind-rose diagram showing the wind speed and directions for the Post-Monsoon season at IMD, Ajmer station is depicted as **Figure-4.3.4.**

iv) Wind Pattern during Winter Season

0830 hours:

The analysis of wind pattern shows that the predominant wind direction is from N with wind frequency of 7.7%. It is followed by NE with 6.7% frequency. The other observed directions are SW (5.3%), S (2.7%), W (2.3%), E (0.7%) and SSE (0.3%). The calm conditions prevailed for 70.0% of time. The wind speeds of 1.1-5.0 km/hr, 5.1-11.0 km/hr, 11.1-19.0 km/hr and more than 19.0 km/hr were recorded.

1730 hours:

The analysis of wind pattern shows that the predominant wind direction is from N with wind frequency of 19.6%. It is followed by SW with 14.7% frequency. The other observed directions are NE (8.7%), S (8.3%), W (7.7%), NW (6.3%), SE(5.0%) and E (0.7%). The calm conditions prevailed for 29.00% of time. The wind speeds of 1.1-5.0 km/hr, 5.1-11.0 km/hr, 11.1-19.0 km/hr and more than 19.0 km/hr were recorded.

The wind-rose diagram showing the wind speed and directions for the Winter season at IMD, Ajmer station is depicted as **Figure-4.3.5.**

Annual Wind Pattern

0830 Hours:

A review of the wind rose diagram shows that predominant winds are mostly from SW and followed by W directions**.**

The analysis of wind pattern shows that the predominant wind direction is from SW with wind frequency of 21.4%. It is followed by W with 11.8% frequency. The other observed directions are N (5.7%), NE (4.8%), S (3.4%), NW (2.3%) and SE (2.3%). The calm conditions prevailed for 47.0% of time. It can be observed that the wind speeds are predominantly in the range of 1.1-5.0 kmph.

1730 Hours:

A review of the wind rose diagram shows that predominant winds are mostly from SW and followed by W directions**.**

The analysis of wind pattern shows that the predominant wind direction is from SW with wind frequency of 27.7%. It is followed by W with 14.6% frequency. The other observed directions are N (15.0%), NE (6.4%), NW (6.4%), S (4.6%) and SE (2.4%). The calm conditions prevailed for 22.4% of time. It can be observed that the wind speeds are predominantly in the range of 1.0.-5.0 kmph.

The wind-rose diagram showing the wind speed and directions for the entire year at IMD, Ajmer station is depicted as **Figure-4.3.6.**

4.3.3 Upper Wind/Upper Air Climatological Data

The nearest upper air recording IMD station is at Jodhpur at a distance of about 200 km from the RA Mine. The data has been compiled and presented in subsequent sections.

4.3.3.1Inversions and Stable Layers near Ground

A stable layer could either form at the ground or at an elevation. In the latter case, it becomes necessary to completely define it by its base, top and thickness. The base has been taken as the level at which the lapse rate leading to stability commences, the top, where it terminates with the difference between the two providing the thickness. For the study of frequency distribution of stable layers, the atmosphere within the boundary layer (1.5 km) has been divided into thirteen layers, first ten are at an interval of 100 m followed by two layers of 250 m each by the India Meteorological Department.

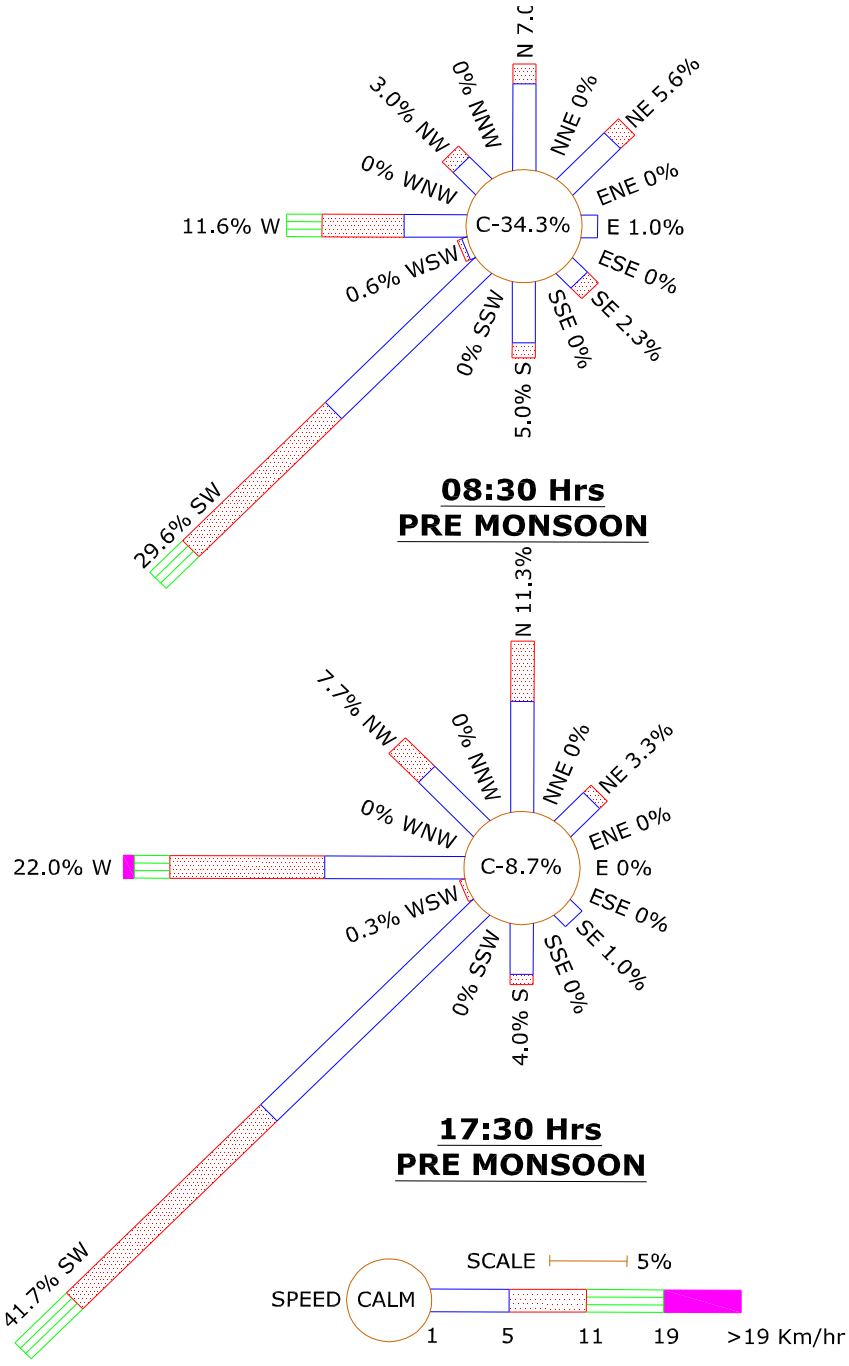


FIGURE-4.3.2
WIND ROSE – PRE-MONSOON (IMD - AJMER)

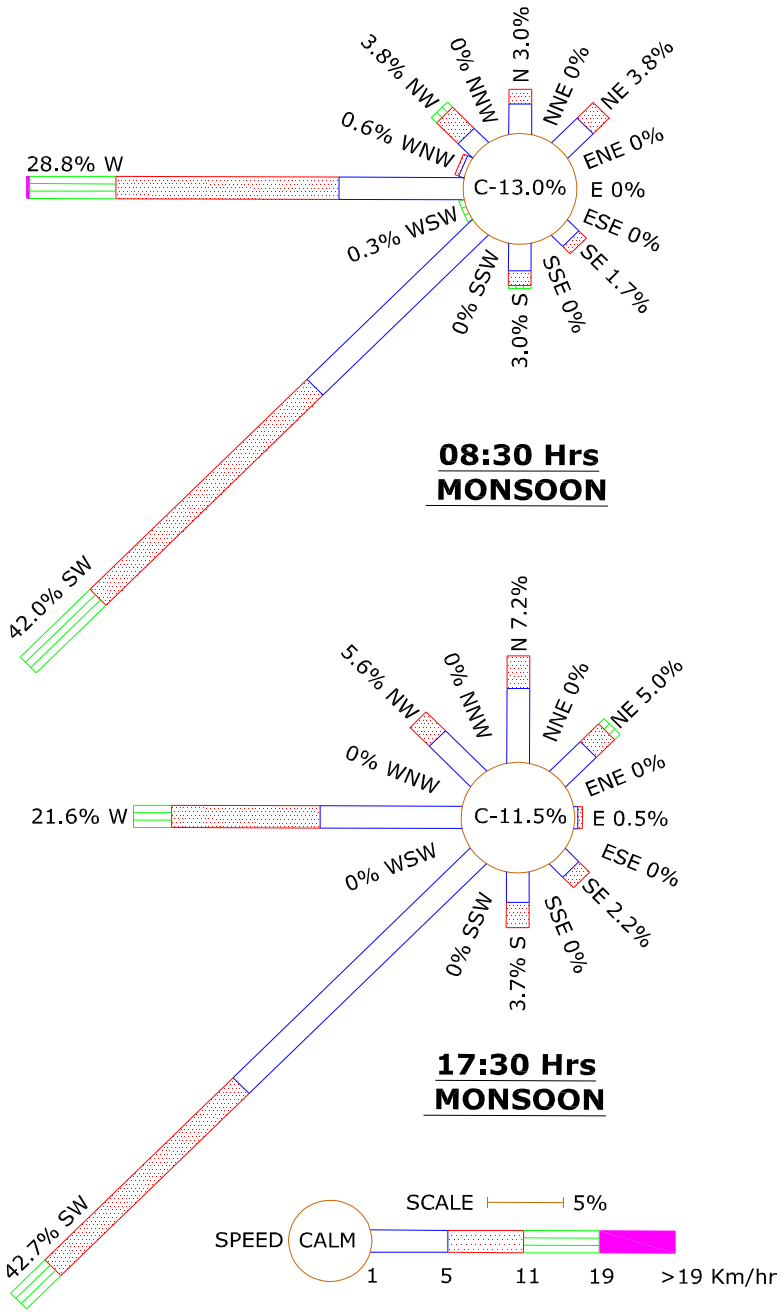


FIGURE-4.3.3
WIND ROSE - MONSOON (IMD - AJMER)

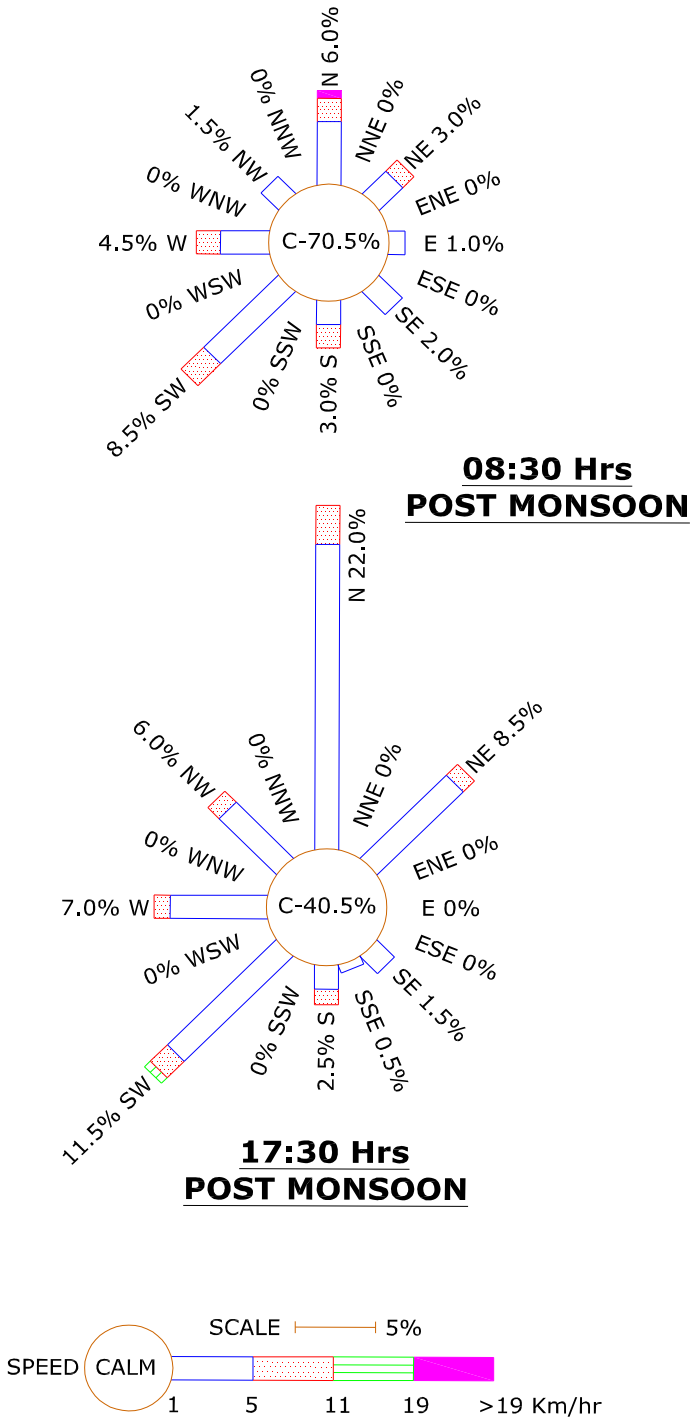


FIGURE-4.3.4
WIND ROSE - POST MONSOON (IMD - AJMER)

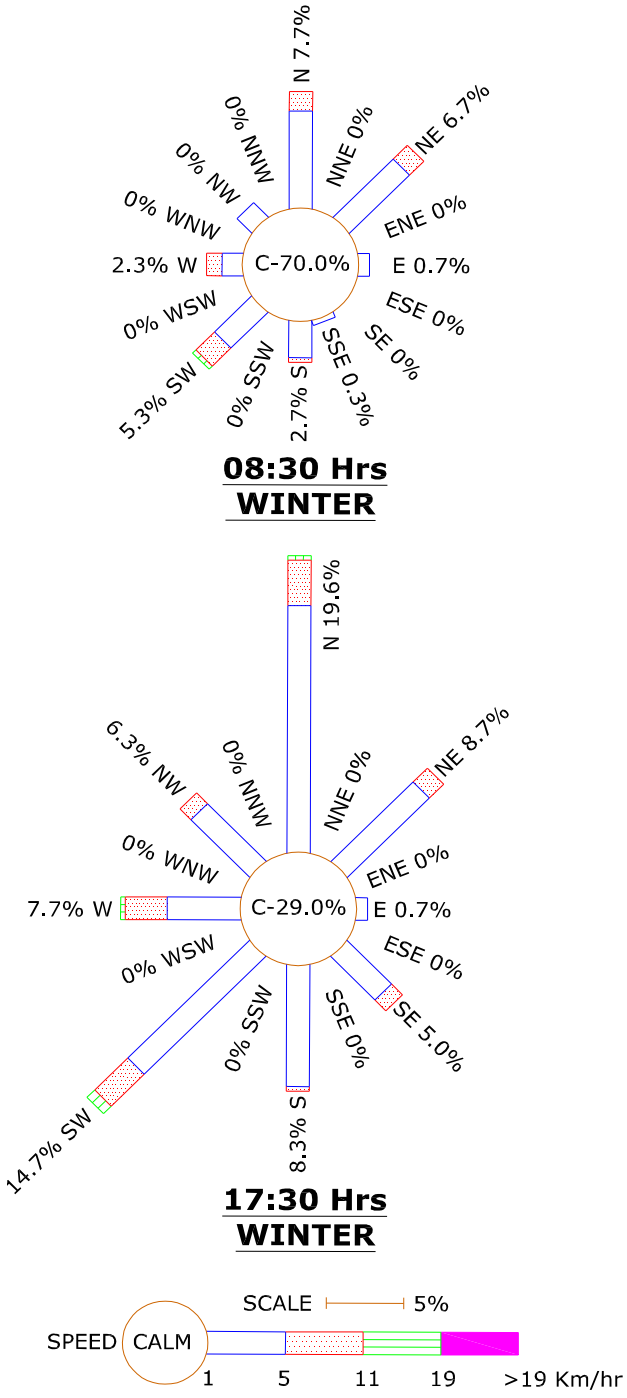


FIGURE-4.3.5
WIND ROSE - WINTER (IMD - AJMER)

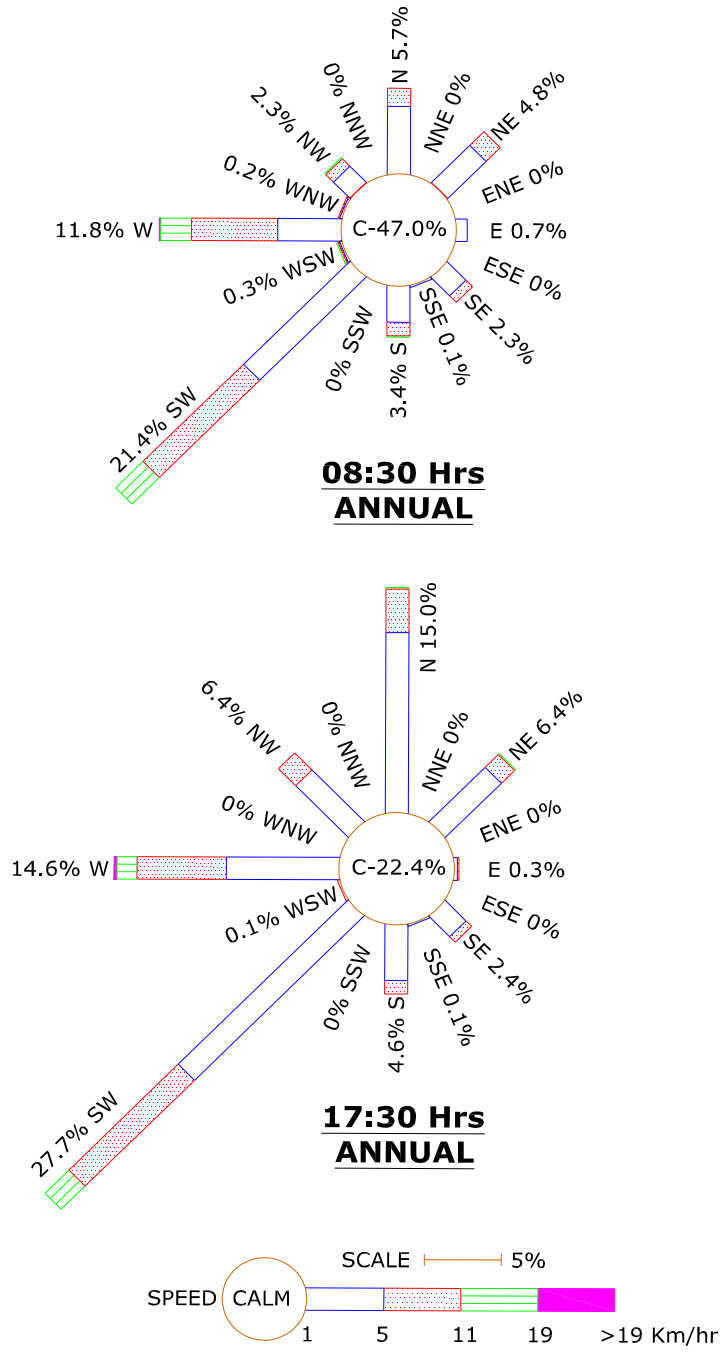


FIGURE-4.3.6
WIND ROSE - ANNUAL (IMD - AJMER)

Data available on stable layers (ground based and elevated inversions), both for morning (00 GMT) and afternoon (12 GMT) data have been compiled from the data published by India Meteorological Department. Percentage frequencies of stable layers (Inversion) both for ground based and elevated inversions, as computed for Jodhpur area are tabulated in **Tables-4.3.7** and **4.3.8** respectively.

1] Ground Based Inversions

The frequencies, in percent of ground based inversions at 00 and 12 GMT hours for Jodhpur is given in **Table-4.3.7**.

TABLE-4.3.7
PERCENTAGE FREQUENCIES OF GROUND BASED INVERSIONS

Range (m)	Pre-Monsoon		Monsoon		Post Monsoon		Winter	
	00 GMT	12 GMT	00 GMT	12 GMT	00 GMT	12 GMT	00 GMT	12 GMT
0 - 100	0	0	0	0	0	0	0	0
101 - 200	0	0	0	0	0	0	0	0
201 - 300	10	0	1	0	2	0	10	0
301 - 400	39	1	3	0	29	1	62	1
401 - 500	65	2	18	2	70	20	92	2
501 - 600	90	1	6	1	52	0	63	1
601 - 700	23	0	2	0	14	0	12	1
701 - 800	12	0	3	0	5	0	8	0
801 - 900	9	0	1	0	4	0	4	0
901 - 1000	4	0	1	0	1	0	2	0
1001 - 1250	0	0	0	0	1	0	1	0
1251 - 1500	0	0	0	0	0	0	0	0
> 1500	0	0	0	0	0	0	0	0

The season wise frequencies and percent of ground based inversions are presented below:

Pre-Monsoon Season

The total highest frequency is observed during this season between a height range of 201-1000 m. The highest frequency of 90% is observed during this season between the height ranges of 501 to 600 m from the ground level at 00 GMT hours. At 12 GMT hours, the highest percentage frequency is observed as 2% in the heights ranging between 401-500 m.

Monsoon Season

The total highest frequency is observed during this season between a height range of 201-1000 m. The highest frequency of 18% is observed during this season between a height range of 401 to 500 m from the ground level at 00 GMT hours. At 12 GMT hours, the highest percentage frequency is observed as 2% in a height range of 401-500 m.

Post Monsoon Season

The total highest frequency is observed during this season between a height range of 201-1250 m. The highest frequency of 70% is observed during this season between a height range of 401 to 500 m from the ground level at 00 GMT hours. At 12 GMT hours, the highest percentage frequency is observed as 20% in a height range of 401-500 m.

Winter Season

The total highest frequency is observed during this season between a height range of 201-1250 m. The highest frequency of 92% is observed during this season between a height range of 401 to 500 m from the ground level at 00 GMT hours. Whereas at 12 GMT hours, the highest percentage frequency is observed as 2% in a height range of 401-500 m.

2] Elevated Inversions

The frequencies, in percent of elevated inversions at 00 and 12 GMT hours for Jodhpur is given in **Table-4.3.8**. The season wise discussion is given below:

TABLE-4.3.8
PERCENTAGE FREQUENCIES OF ELEVATED INVERSIONS

Range (m)	Pre-Monsoon		Monsoon		Post Monsoon		Winter	
	00 GMT	12 GMT	00 GMT	12 GMT	00 GMT	12 GMT	00 GMT	12 GMT
0 – 100	0	0	0	0	0	0	0	0
101 – 200	0	0	0	0	0	2	0	0
201 – 300	0	0	0	0	0	0	0	0
301 – 400	0	0	0	0	0	0	0	0
401 – 500	2	0	1	1	0	0	0	0
501 – 600	2	0	0	0	1	0	4	0
601 – 700	5	1	3	1	0	0	1	1
701 – 800	3	0	2	1	2	0	1	0
801 – 900	5	0	4	2	0	1	0	0
901 – 1000	5	2	14	1	0	0	2	1
1001 - 1250	8	1	14	0	4	1	1	1
1251 - 1500	1	0	6	4	0	0	0	0
> 1500	0	0	0	0	0	0	0	0

Pre-Monsoon Season

The total highest frequency is observed during this season between a height range of 401-1500 m. The highest frequency of 8% is observed during this season between a height range of 1001 to 1250 m from the ground level at 00 GMT hours. Whereas at 12 GMT hours, the highest percentage frequency is observed as 2% in a height range of 901-1000 m.

Monsoon Season

The total highest frequency is observed during this season between a height range of 401-1500 m. The highest frequency of 14% is observed during this season between a height range of 901 to 1000 m and 1001 to 1250 m from the ground level at 00 GMT hours. Whereas at 12 GMT hours, the highest percentage frequency is observed as 4% in a height range of 1251-1500 m.

Post-Monsoon Season

The total highest frequency is observed during this season between a height range of 501-1250 m. The highest frequency of 4% is observed during this season between a height range of 1001 to 1250 m from the ground level at 00 GMT hours. Whereas at 12 GMT hours, the highest percentage frequency is observed as 2% in a height range of 101-200 m.

Winter Season

The total highest frequency is observed during this season between a height range of 501-1250 m. The highest frequency of 4% is observed during this season between a height range of 501 to 600 m from the ground level at 00 GMT hours. Whereas at 12 GMT hours, the highest percentage frequency is observed as 1% in a height range of 601-700 m.

3] Conclusions

Multiple ground based inversions are found in general, almost invariably in all the seasons and it is found to occur in a height range of 201 to 1000 m from the surface. The percentage occurrence of ground based inversion is found to be more pronounced within the first 800 m above the surface. Elevated inversions are found in all the seasons at a height range of 0 m to 700 m. The elevated inversions are found in all the seasons normally in the height range of 401 to 1500 m. This can be attributed to usually high average ground radiation and surface temperatures in the region.

4.4 Air Quality

The ambient air quality with respect to the study zone of 10 km radius around the mine lease boundary forms the baseline information. The various sources of air pollution in the region are mining, industrial, transportation and residential activities. The prime objective of the baseline air quality study was to assess the existing air quality of the area. This will also be useful for assessing the conformity to standards of the ambient air quality after proposed expansion is completed. The study area represents mostly rural environment with intermittent mixed land uses such as HZL mining and industrial activities.

HZL is also monitoring ambient air quality in and around the mine lease area at six locations as part of post project monitoring program. The results of this monitoring have also been included to understand impacts of existing activities, if any, and trends.

This section describes the selection of sampling locations, methodology adopted for sampling, analytical techniques and frequency of sampling. The monitoring was carried out during winter season (1st December 2008 to 28th February 2009).

4.4.1 Methodology Adopted for Air Quality Survey

4.4.1.1 Selection of Sampling Locations

The monitoring locations were selected based on the following considerations:

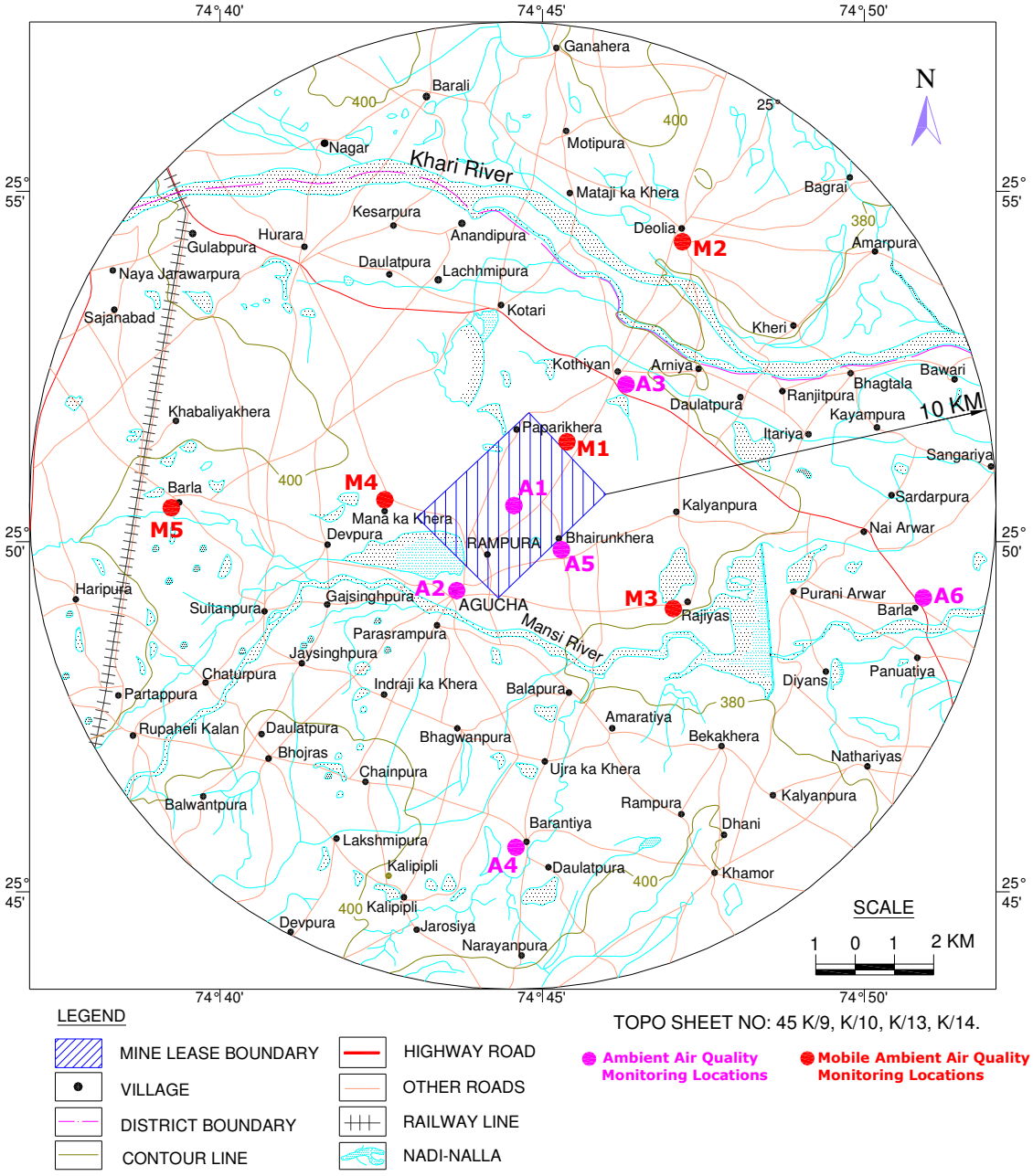
- Meteorological conditions on a synoptic basis;
- Topography of the study area; and
- Representatives of likely impacts.

Ambient Air Quality Monitoring stations were set up at **Six** permanent locations and **Five** mobile locations with due consideration to the above mentioned criteria. **Table-4.4.1** gives the details of environmental setting around each monitoring station. The locations of the selected stations with reference to the existing site is given in the same table and also depicted in **Figure-4.4.1**.

4.4.1.2 Frequency and Parameters for Sampling

Ambient air quality monitoring was carried out at a frequency of two days per week at each location representing winter season. The baseline data of air environment was generated for the below mentioned parameters:

- Total Suspended Particulate Matter (TSPM);
- Respirable Particulate Matter (RPM);
- Sulphur dioxide (SO_2);
- Oxides of Nitrogen (NOx);
- Carbon Monoxide (CO)
- Lead;
- Zinc;
- Cadmium; and
- Dustfall.



LEGEND

- MINE LEASE BOUNDARY
- VILLAGE
- DISTRICT BOUNDARY
- CONTOUR LINE
- HIGHWAY ROAD
- OTHER ROADS
- RAILWAY LINE
- NADI-NALLA

TOPO SHEET NO: 45 K/9, K/10, K/13, K/14.

- Ambient Air Quality Monitoring Locations
- Mobile Ambient Air Quality Monitoring Locations

FIGURE-4.4.1
AIR QUALITY SAMPLING LOCATIONS

TABLE-4.4.1
DETAILS OF AMBIENT AIR QUALITY MONITORING LOCATIONS

Station Code	Name of the Station	Distance w.r.t. Mine Center (km)	Direction w.r.t. Mine Center	Environmental Setting
Ambient Air Quality Locations				
A1	HZL Mine Area	0.0	Mine Site	Mining and Industrial environment associated with frequent movements of heavy-duty trucks and dumpers. HZL is also monitoring regularly at this location.
A2	Agucha Village	0.7	SW	Rural setting with mixed land uses. Traffic movement also observed during monitoring. HZL is also monitoring regularly at this location.
A3	Kothiyan Village	2.4	NE	Rural setting with residential land use associated with vehicular movements. Dusty environment due to loose soil. HZL is also monitoring regularly at this location.
A4	Barantiya	6.2	S	Rural setting with residential land uses. Dusty environment due to loose soil.
A5	Bherukhera village	0.8	ESE	Rural setting with residential land uses in the vicinity of RA Mine. Dusty environment due to loose soil.
A6	Barla (Shahpura)	8.8	ESE	Rural setting with residential land uses. Dusty environment due to loose soil.
Mobile Ambient Air Quality Locations				
MA1	Papari Khera	0.5	NE	Rural setting with residential land uses in the vicinity of RA Mine. Dusty environment due to loose soil.
MA2	Deoliya	6.0	NNE	Rural setting with residential land uses. Dusty environment due to loose soil.
MA3	Rajiyas	3.9	SE	Rural setting with residential land uses in the vicinity of RA Mine. Dusty environment due to loose soil.
MA4	Mana ka khera	0.9	W	Rural setting with residential land uses in the vicinity of RA Mine. Dusty environment due to loose soil.
MA5	Barla (Hurda)	6.0	W	Rural setting with residential land uses. Dusty environment due to loose soil.

4.4.1.3Duration of Sampling

The duration of sampling of Total Suspended Particulate Matter (TSPM), RPM, SO_2, NOx, Lead, Zinc and Cadmium was one 24-hourly continuous sample per day and CO was sampled for 8 hours continuous thrice in 24 hour duration monitoring. The monitoring was conducted for two days in a week for four weeks in a month for three months at fixed locations and once at five mobile locations. This is to allow a comparison with the present revised standards mentioned in the latest Gazette notification of the Central Pollution Control Board (CPCB) (May 20, 1994).

4.4.1.4 Method of Analysis

The air samples were analyzed as per standard methods specified by Central Pollution Control Board (CPCB), IS: 5184 and American Public Health Association (APHA).

4.4.2 Details of the Sampling Locations

The details of AAQM stations, their relative locations and distances with reference to the mining lease area and the environmental setting around the AAQM location is described below:

- ***HZL Mine Area (A1)***

The Respirable Dust Sampler (RDS) was installed adjacent to the mine pit at a height of about 2.0 m from the ground level. The distance between the haul-road connecting the mine with beneficiation plant is about 30 m from this AAQM station. This location represents totally the mine environment associated with mining, blasting and transportation of ore from the mine to the beneficiation plant by heavy-duty dumpers, which create dust pollution. Water sprinkling is regularly done on the haul road to reduce dust pollution.

- ***Agucha Village (A2)***

The AAQM station at Agucha village is located at a distance of about 0.7 km from the mine lease boundary in SW direction. The RDS was installed at a height of about 5 m above the ground level. This location is characterized by mixed landuse consisting of residential and commercial nature. The internal roads are of water bound macadam(WBM) type. Vehicular movements take place at a distance of about 300 m from the monitoring station. Burning of firewood for cooking is a common phenomenon, which causes smoke.

- ***Kothiyan Village (A3)***

The AAQM station at Kothiyan village is about 2.4 km from the mine boundary in ENE direction. The RDS was installed at 4 m height above the ground level at about 30 m from a pucca Major District Road (MDR) connecting Shahpura with Hurda and results in some sort of dust and automobile pollution. This location is characterized mostly by residential activities associated with intermittent movements of vehicles. Dusty environment prevailed in the surroundings due to presence of loose soils and dusty roads. Burning of firewood for cooking is a common phenomenon in the village hence causes smoke and air pollution.

- ***Barantiya Village (A4)***

The AAQM station at Barantiya village is about 6.2-km from the mine lease boundary in the South. The RDS was installed at about 4 m height above the ground level at a distance of 400 m from a pucca road connecting Agucha with Bhilwara. This location is characterized exclusively by residential activities with dusty internal roads. Dusty environment prevailed in the surroundings due to

presence of loose soils and dusty roads. Burning of firewood for cooking is a common phenomenon in the village hence causes smoke and some extent of air pollution.

- ***Bherukhera (A5)***

The AAQM station at Bherukhera village is located near the mine lease boundary in ESE direction. The RDS was installed on a building at about 4 m height above the ground level. This location is characterized exclusively by residential activities with dusty internal roads and agricultural activities. Dusty environment prevailed in the surroundings due to presence of loose soils and dusty roads. Burning of firewood for cooking is a common phenomenon in the village hence causes smoke and some extent of air pollution.

- ***Barla (Shahpura) (A6)***

The AAQM station at Barla village in Shapura tehsil is located at about 8.8-km fom the mine lease boundary in the ESE. The RDS was installed on a temple at about 4 m height above the ground level. This location is at a distance of about 400 m from the MDR connecting Shahpura with Hurda. This location is characterized exclusively by residential activities with dusty internal roads. Dusty environment prevailed in the surroundings due to presence of loose soils and dusty roads. Burning of firewood for cooking is a common phenomenon in the village hence causes smoke and some extent of air pollution.

4.4.3 Details of the Mobile Sampling Locations

The details of Mobile AAQM stations, their relative locations and distances with reference to the mine center and the environmental setting around them are described below:

- ***Papari Khera (Khera Palola) Village (MA1)***

The mobile AAQM station at Papari Khera village is near the mine lease boundary in the North East of the mine. The RDS was installed at about 3 m height above the ground level on a residential building. This location is characterized exclusively by residential activities with dusty internal roads. Dusty environment prevailed in the surroundings due to presence of loose soils and dusty roads. Burning of firewood for cooking is a common phenomenon in the village hence causes smoke and some extent of air pollution.

- ***Deoliya Village (MA2)***

The mobile AAQM station at Deoliya village is about 6.0-km from the mine lease boundary to the NNE of the mine. The RDS was installed at about 3 m height above the ground level on a residential building. This location is characterized exclusively by residential activities with dusty internal roads. Dusty environment prevailed in the surroundings due to presence of loose soils and dusty roads. Burning of firewood for cooking is a common phenomenon in the village hence causes smoke and some extent of air pollution.

- ***Rajiyas (MA3)***

The mobile AAQM station at Rajiyas village is about 3.9-km from the mine lease boundary in the SE of the mine. The RDS was installed at about 3 m height above the ground level on a residential building. This location is characterized exclusively by residential activities with dusty internal roads. Dusty environment prevailed in the surroundings due to presence of loose soils and dusty roads. Burning of firewood for cooking is a common phenomenon in the village hence causes smoke and some extent of air pollution.

- ***Mana ka Khera (MA4)***

The mobile AAQM station at Munjikakhera village is at about 0.9-km from the mine lease boundary in the West of the mine. The RDS has been installed at about 3.5 m height above the ground level on a residential building. This location is characterized exclusively by residential activities with dusty internal roads. Dusty environment prevailed in the surroundings due to presence of loose soils and dusty roads. Burning of firewood for cooking is a common phenomenon in the village hence causes smoke and some extent of air pollution.

- ***Barla (Hurda) (MA5)***

The mobile AAQM station at Barla village in Hurda tehsil is at about 6.0-km from the mine lease boundary in the West of the mine. The RDS has been installed at about 3.5 m height above the ground level on a residential building. This location is characterized exclusively by residential activities with dusty internal roads. Dusty environment prevailed in the surroundings due to presence of loose soils and dusty roads. Burning of firewood for cooking is a common phenomenon in the village hence causes smoke and some extent of air pollution.

4.4.4 Sampling and Analytical Techniques

Respirable Dust Samplers BL-461 of Envirotech instruments were used for monitoring Total Suspended Particulate Matter (TSPM), Respirable fraction (<10 microns) and gaseous pollutants like SO_2 and NOx.

Mylar bags and pulse pumps were deployed for collection of three 8 hourly samples of Carbon dioxide. Gas Chromatography techniques have been used for the estimation of CO.

Total Suspended Particulate Matter and RPM present in ambient air is sucked through the cyclone. Coarse and non-respirable dust is separated from the air stream by centrifugal forces acting on the solid particles. These separated particulates fall through the cyclone's conical hopper and collect in the sampling cup placed at the bottom. The fine dust (<10 microns) forming the respirable fraction of the TSPM passes the cyclone and is retained by the filter paper. A tapping is provided on the suction side of the blower to provide suction for sampling air through a set of impingers. Samples of gases were drawn at a flow rate of 0.2 liters per minute (lpm).

TSPM and RPM have been estimated by gravimetric method. Modified West and Gaeke method (IS-5182 part-II, 1969) has been adopted for estimation of SO_2. Jacobs-Hochheiser method (IS-5182 part-IV, 1975) has been adopted for the estimation of NOx.

CO Tubes have been used to collect the three 8 hourly samples for carbon monoxide. The CO levels were analyzed through Gas-Chromatography.

TABLE-4.4.2
TECHNIQUES USED FOR AMBIENT AIR QUALITY MONITORING

Sr. No.	Parameter	Technique	Minimum Detectable Limit (μg/m^3)
1	TSPM	Respirable Dust Sampling (Gravimetric method)	5.0
2	RPM	Respirable Dust Sampling (Gravimetric method)	5.0
3	Sulphur Dioxide	West and Gaeke	4.0
4	Nitrogen Oxide	Jacob & Hochheiser	4.0
5	Carbon Monoxide	Gas Chromatography	12.5

- ***Dust fall Measurement***

Dustfall was measured using dustfall jars. The dustfall jar was installed at every AAQ location for one month during AAQ monitoring. The jar was filled with 2.5 litre of water. The water in the jar was mixed with copper sulphate solution (0.02 N solution) to prevent any growth of algae. A funnel was attached to the top of the jar on which dust falls and slides into the jar. The water level in the jar is constantly maintained in such way that the 2.5-liter of water is retained. After one month the water was analyzed for total un-dissolved matter, ash, total dissolved matter and total solids to arrive at dust fall concentration. Dustfall in 1 m^2 area was calculated by using following formula:

$$Factor = \frac{127.3 \times 10^4}{d^2}$$

where d = top diameter of funnel in meter.

The factor is multiplied to the mg of dust collected and divided by number of days to get the dust deposition in mg/m^2/day.

Analysis of Collected Matter

Analysis was carried out at central laboratory of VIMTA Labs. The weight of the total un-dissolved matter was obtained after filtration. The weight of ash was obtained by combustion of the un-dissolved matter. The weight of the total dried soluble matter obtained from the residue from a measured portion of filtrate after evaporation to dryness.

4.4.5 Presentation of Primary Data

The survey results monitoring recorded during winter season are presented in detail in **Annexure-X**.

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. The summary of these results for each location representing winter season are presented in **Table-4.4.3.** These are compared with the standards prescribed by Central Pollution Control Board (CPCB) for rural zone.

4.4.5.1 Observations of Primary Data

- ***Mine Area***

The maximum SPM concentrations was observed to be 232.1 µg/m^3 which is within stipulated standards of 500 µg/m^3. Similarly, maximum RPM concentration was observed to be 93.6 µg/m^3 which is also within stipulated standards of 150 µg/m^3.

The concentrations of SO_2, NOx, CO, Pb, Zn and Cd were observed to be within the permissible standards applicable for industrial area.

- ***Residential Area***

The maximum SPM concentration was observed to be 187.3 µg/m^3 which is within stipulated standards of 200 µg/m^3.

Concentrations of other parameters were observed to be within the specified standards.

4.4.6 Dust Fall Rate Measurements

The dust fall rates have been monitored at five locations once each during study period. The selected locations and the dust fall concentrations are given in **Table-4.4.4**. The maximum rate of total solids in the collected dust fall sample was found at the Mine dump site. About 374 mg/m^2/day maximum was recorded d at the Mine dump site. The minimum dustfall rates are observed at Barla village measured to be 212mg/m^2/day during winter season.

TABLE- 4.4.3 (A)
SUMMARY OF THE AMBIENT AIR QUALITY LEVELS- FIXED LOCATIONS (WINTER SEASON 2008-2009)

Location	TSPM (µg/m³)				RPM (µg/m³)				SO_2 (µg/m³)				NO_X (µg/m³)				CO (µg/m³)			
	Max	Min	Avg	98%	Max	Min	Avg	98%	Max	Min	Avg	98%	Max	Min	Avg	98%	Max	Min	Avg	98%
HZL Mine Area (A1)	232.1	181.2	201.9	229.8	93.6	71.2	80.9	92.6	18.3	11.7	14.8	18.3	23.6	14.1	18.9	23.5	251	106	154	231
Agucha Village (A2)	175.1	122.4	152.2	172.8	67.4	44.1	55.7	65.9	14.3	9.4	12.1	14.3	15.2	10.8	12.8	15.2	217	93	148	213
Kothiyan Village (A3)	181.5	129.8	156.1	181.1	66.8	43.5	54.8	66.1	13.4	10.3	11.9	13.3	16.9	10.7	14.6	16.8	175	86	120	164
Barantiya (A4)	145.7	109.8	128.5	144.2	58.8	40.8	51.5	58.2	11.4	7.5	9.7	11.4	14.8	10.1	12.6	14.7	164	80	116	160
Bherukhera Village (A5)	187.3	112.1	150.9	184.9	67.3	42.6	54.8	65.6	12.1	7.1	10.0	12.0	15.5	10.5	13.1	15.5	164	87	120	161
Barla (Shahpura) (A6)	142.5	100.8	120.3	140.8	55.7	39.3	47.4	55.5	11.1	6.5	9.2	11.0	13.4	9.1	11.3	13.3	173	82	123	168
Range	**100.8-232.1**				**39.3-93.6**				**6.5-18.3**				**9.1-23.6**				**80-251**			

Location	Lead (µg/m³)		Zinc (µg/m³)		Cadmium (µg/m³)	
	Max	Min	Max	Min	Max	Min
HZL Mine Area (A1)	0.34	0.18	0.46	0.26	BDL	BDL
Agucha Village (A2)	BDL	BDL	BDL	BDL	BDL	BDL
Kothiyan Village (A3)	0.22	0.13	0.28	0.14	BDL	BDL
Barantiya (A4)	BDL	BDL	BDL	BDL	BDL	BDL
Bherukhera Village (A5)	0.18	BDL	0.23	BDL	BDL	BDL
Barla (Shahpura) (A6)	BDL	BDL	BDL	BDL	BDL	BDL
Range	**BDL-0.34**		**BDL-0.46**		**BDL**	

BDL-Below Detectable Limit (>0.1 µg/m³)

TABLE-4.4.3 (B)
SUMMARY OF THE AMBIENT AIR QUALITY LEVELS - MOBILE LOCATIONS

Sr. No	Location	TSPM (µg/m³)		RPM (µg/m³)		SO_2 (µg/m³)		NOx (µg/m³)		CO (µg/m³)		Pb (µg/m³)		Zn (µg/m³)		Cd (µg/m³)	
		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	Paparikhera (M1)	205.3	187.2	75.5	62.4	12.9	10.3	15.6	11.6	237	111	0.21	0.12	0.37	0.24	BDL	BDL
2	Deoliya (M2)	168.3	129.3	54.7	45.3	14.8	11.8	15.9	13.4	169	99	BDL	BDL	BDL	BDL	BDL	BDL
3	Rajiyas (M3)	113.5	102.8	47.4	44.5	10.6	8.6	13.6	11.2	182	98	BDL	BDL	BDL	BDL	BDL	BDL
4	Manaka khera (M4)	153.5	123.1	67.7	53.5	11.1	8.4	14.4	11.1	190	108	BDL	BDL	BDL	BDL	BDL	BDL
5	Barla Village (Hurda) (M5)	135.4	112.9	55.5	44.3	12.5	11.9	15.3	11.8	177	101	BDL	BDL	BDL	BDL	BDL	BDL
	Range	**102.8-205.3**		**44.3-75.5**		**8.4-14.8**		**11.1-15.9**		**98-237**		**0.12-0.21**		**0.24-0.37**		**BDL**	

BDL-Below Detectable Limit (>0.1 µg/m³)

TABLE-4.4.4
SUMMARY OF DUSTFALL RATES

Location	Dust fall Rate ($mg/m^2/day$)	Lead (mg/kg)	Zinc (mg/kg)	Cadmium (ppm)
Winter Season				
Mine Dump site	374	23	23	<0.001
Kothiyan	276	19	21	<0.001
Barantiya	261	11	15	<0.001
Bherukhera	318	20	25	<0.001
Barla (Shahpura)	212	12	16	<0.001
Range	**212-374**	**11-23**	**15-23**	**<0.001**

4.4.7 Stack Monitoring

Stack monitoring has been carried out at four locations in the industrial complex and the results are presented in **Table-4.4.5.**

TABLE-4.4.5
STACK MONITORING RESULTS

Stacks	SPM (mg/Nm^3)	NOx (mg/Nm^3)	SO_2 (mg/Nm^3)	CO (mg/Nm^3)
Pre-monsoon Season				
Primary Crusher	101.2	-	-	-
Secondary Crusher	97.2	-	-	-
Fine Ore Bin	75.2	-	-	-
DG Stack	-	998.7	705.1	194.2

4.4.8 Results of Ambient Air Quality Monitoring by HZL

HZL is also monitoring ambient air quality in and around the mine lease area at five locations comprising of three locations in core zone and two locations in buffer zone as part of post project monitoring program. HZL is monitoring at these locations with frequency of weekly once for 24 hourly duration. The parameters monitored are SPM, RPM, SO_2 and NOx. The dustfall rates are monitored monthly. The results of past two years for three common locations monitored by both HZL and VIMTA are presented graphically to understand trends.

It is observed that the results monitored by HZL are within the stipulated standards. The data indicates that the concentrations are comparable with the concentrations monitored by VIMTA.

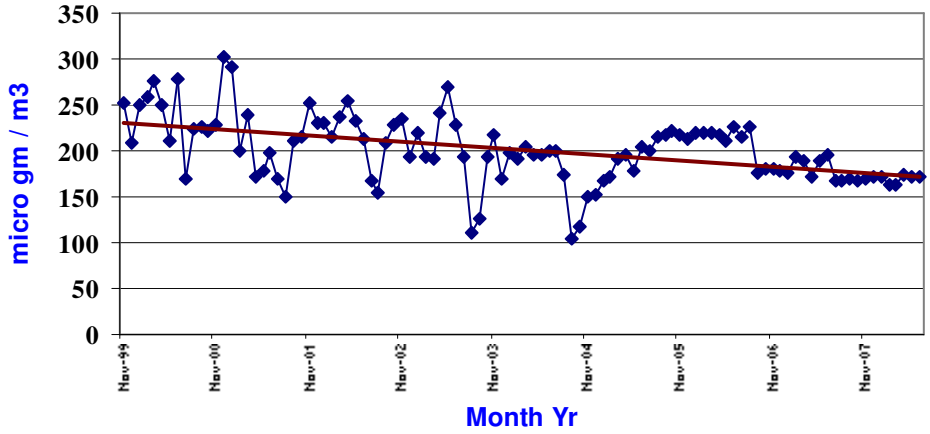
The trends of the SPM concentrations at Mine site and surrounding villages (Agucha, Kothiya & Bherukhera) are shown in **Figure-4.4.2.**

4.4.9 Stack Monitoring by HZL

The stacks attached to primary crusher, secondary crusher and fine ore bin are monitored every month for particulate matter emissions by HZL. The results of the stack monitoring from year 2008 to 2009 are graphically presented in **Figure-4.4.3**. The graphs indicate that the trend of particulate matter concentrations are decreasing and below the standard of 150 mg/Nm^3.

FIGURE-4.4.2
AMBIENT AIR QUALITY MONITORING LOCATIONS

Ambient air monitoring at Mine site



Ambient air monitoring at Kothiyan village

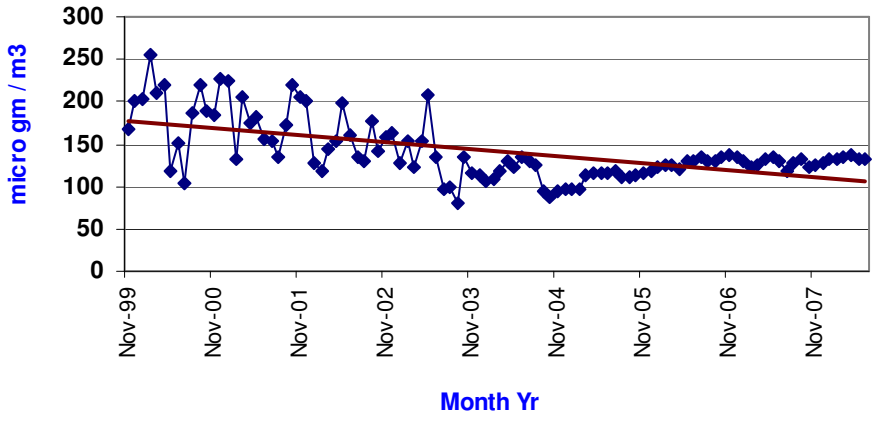
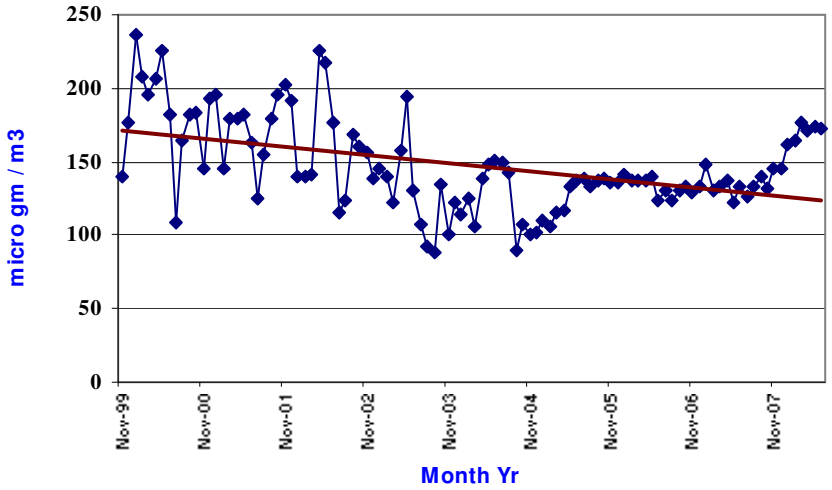


FIGURE-4.4.2
AMBIENT AIR QUALITY MONITORING LOCATIONS

Ambient air monitoring at Agucha village



Ambient air monitoring at Bherukhera village

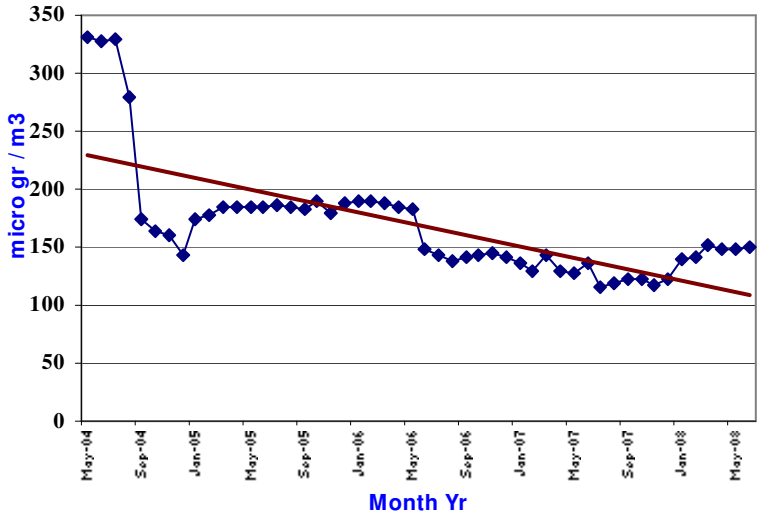
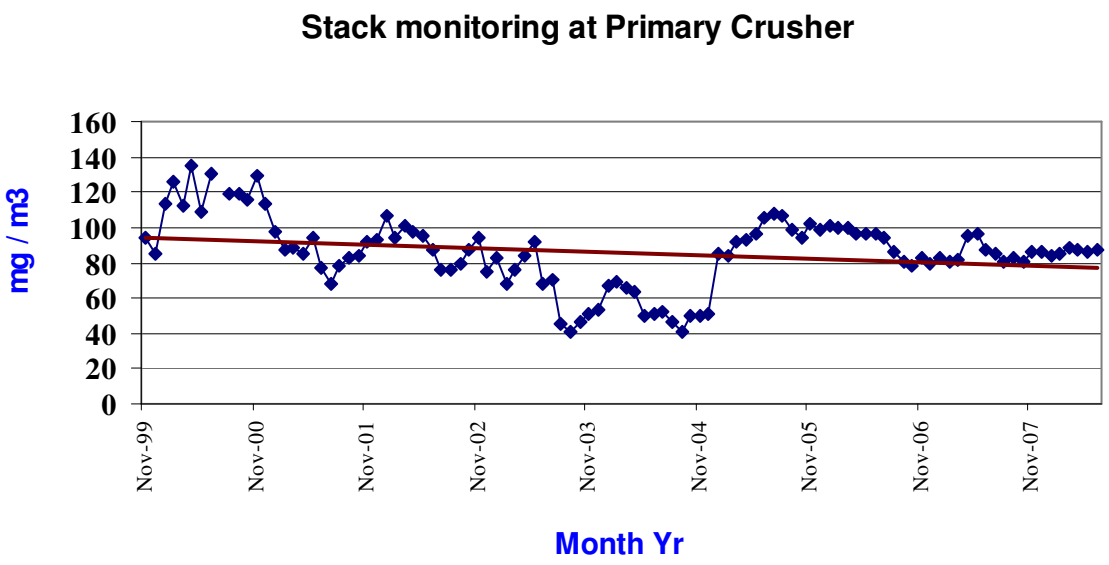
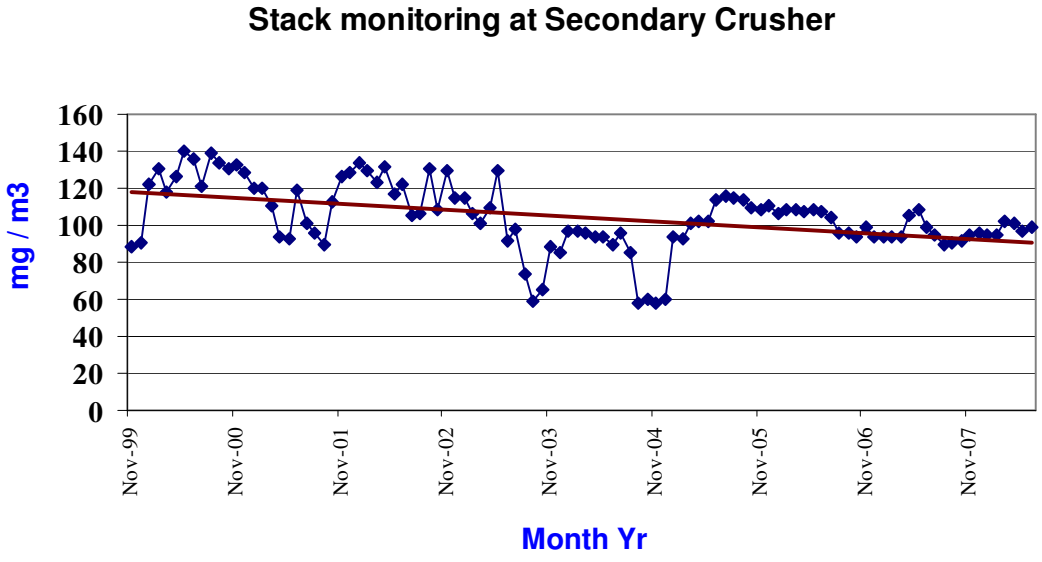


FIGURE-4.4.3
STACK MONITORING LOCATIONS





4.5 Water Quality

Selected water quality parameters of surface and ground water resources within 10 km radius of the study area have been studied for assessing the water environment and evaluate anticipated impact of the proposed project. Understanding the water quality is essential in preparation of Environmental Impact Assessment and to identify critical issues with a view to suggest appropriate mitigation measures for implementation.

The purpose of this study is to:

- Assess the water quality in the study area for critical parameters;
- Evaluate the impacts on agricultural productivity, habitat conditions, recreational resources and aesthetics in the vicinity; and
- Predict impacts of the proposed project on water quality of the area

The required information has been collected through primary surveys and also from secondary sources. HZL also regularly collects water samples within core and buffer zone and analysis for critical parameters including heavy metals like lead, zinc and cadmium.

4.5.1 Methodology

Reconnaissance survey was undertaken and monitoring locations were finalized based on:

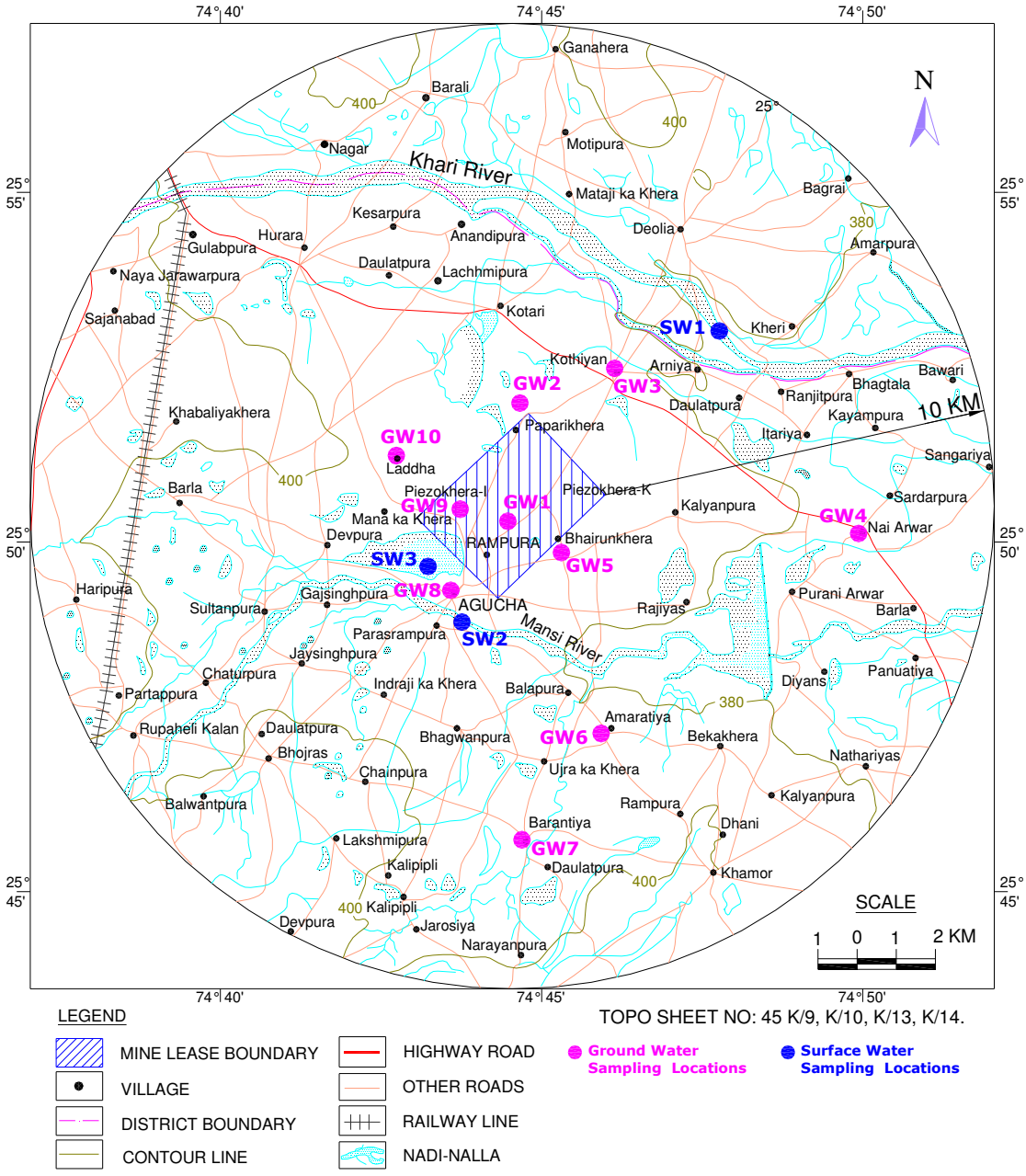
- Drainage pattern;
- Location of residential areas representing different activities/likely impact areas;
- Likely areas, which can represent baseline conditions, and
- HZL's monitoring locations.

Ten ground water and **three** surface water sources consisting of bore wells and dug wells and RA Mine pit covering 10 km radial distance from the mine were collected in winter season and examined for physico-chemical, heavy metals and bacteriological parameters in order to assess the effect of mining, industrial and other activities on surface and ground water quality. The ground water sources include two monitoring wells of HZL in the vicinity of tailing dam of RA Mine. Three surface water sampling locations were selected to assess the surface water quality. The samples were analyzed as per the procedures specified in 'Standard Methods for the Examination of Water and Wastewater' published by American Public Health Association (APHA).

Samples for chemical analysis were collected in polyethylene carboys. Samples collected for metal content were acidified with 1ml HNO_3. Samples for bacteriological analysis were collected in sterilized glass bottles. Selected physico-chemical and bacteriological parameters have been analyzed for projecting the existing water quality status in the study area. Parameters like temperature, Dissolved Oxygen (DO) and pH were analyzed at the time of sample collection.

4.5.2 Water Sampling Locations

The water sampling locations are listed below in **Table-4.5.1** and depicted in **Figure-4.5.1**.



LEGEND

- MINE LEASE BOUNDARY
- VILLAGE
- DISTRICT BOUNDARY
- CONTOUR LINE
- HIGHWAY ROAD
- OTHER ROADS
- RAILWAY LINE
- NADI-NALLA
- Ground Water Sampling Locations
- Surface Water Sampling Locations

TOPO SHEET NO: 45 K/9, K/10, K/13, K/14.

FIGURE-4.5.1
WATER SAMPLING LOCATIONS

TABLE-4.5.1
DETAILS OF WATER SAMPLING LOCATIONS

Station Code	Location/Village	Direction w.r.t. Mine Lease area	Distance w.r.t. Mine Lease Boundary (km)	Environmental Setting
Ground Water				
GW-1	RA Mine pit	-	-	Mine pit water – Industrial area
GW-2	Dug well at PapriKhera	N	0.5	Agricultural fields in outskirts of village
GW-3	Kothian public water supply well	NEE	2.4	Rural environment. Barren land in outskirts of village
GW-4	Dug well at Nayi Arwar	ESE	6.5	In Agricultural fields
GW-5	Hand pump at Bherun Khera	ESE	0.2	Rural residential environment
GW-6	Hand pump at Amaratiya	SSE	4.5	Rural residential setting
GW-7	Hand pump at Barantiya	S	6.2	Rural residential setting
GW-8	Agucha public water supply well	SW	0.7	Agricultural fields/ Residential setting
GW-9	Monitoring bore well – I of HZL	-	-	Within mine area, near downstream of waste dump. HZL also monitors on monthly basis.
GW-10	Dug well at Laddha	NW	1.5	Rural residential setting
Surface Water				
SW1	Khari River (near Kheri)	NE	5.0	Water used for irrigation.
SW2	Mansi river (Agucha)	S	1.0	Water used for irrigation.
SW3	Agucha pond (Agucha)	SSW	0.7	Water used for irrigation.

4.5.3 Presentation of Results

The results of the water quality monitored during winter season are given in **Table-4.5.2** and **Table-4.5.3** respectively**.** The results were compared with standards for drinking water as per IS:10500-1983 "Specifications for Drinking Water" for ground water and with Class 'C' water quality (fit for drinking after conventional treatment) as per IS:2296-1982 "Tolerance Limits for Inland Surface Waters subject to Pollution" for surface water. The results of treated effluents are compared with GSR-422.

TABLE-4.5.2
ANALYSIS RESULTS FOR WATER – WINTER SEASON -GROUND WATER

Parameters	Units	IS:10500 Limits	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10
pH	-	6.5 -8.5	6.5	7.9	7.9	7.8	7.6	7.1	7.6	7.5	7.6	7.5
Colour	Hazen	5 (25)	4	3	2	4	1	2	3	2	1	2
Taste	-	Agreeable	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag
Odor	-	U.O	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO
Conductivity	µ S/cm	$	1051	4100	1080	680	825	729	640	2900	1591	3800
Turbidity	NTU	5(10)	6	4	3	5	4	1	2	3	1	2
TDS	mg/l	500 (2000)	608	2096	565	378	508	471	410	1576	1095	1920
Total Hardness as $CaCO_3$	mg/l	300 (600)	306	700	225	152	317	412	212	600	365	620
Total Alkalinity	mg/l	200 (600)	255	765	264	221	264	355	276	391	569	502
Calcium as Ca	mg/l	75 (200)	70.2	80	58	44.8	80	114	60.8	180	118	160
Magnesium as Mg	mg/l	30 (100)	30.9	121.5	19.4	9.7	31.2	30	14.6	36.5	24.1	53.5
Residual Chlorine	mg/l	0.2 Min.	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Boron	mg/l	1	0.01	0.03	0.03	<0.01	0.03	0.02	0.01	0.03	0.01	0.13
Chlorides as Cl	mg/l	250 (1000)	113.3	433.9	89.3	38.9	104.7	38.5	24.2	574.3	153.1	701.9
Sulphates as SO_4	mg/l	200 (400)	91.9	168.1	56.2	31.2	26.4	7.5	10.5	103.7	44.2	85.5
Fluorides as F	mg/l	1.0 (1.5)	1.0	1.6	1.2	1.5	0.8	1.1	0.2	1.4	0.9	0.6
Nitrates as NO_3	mg/l	45 (NR)	5.4	60.4	10.8	4.1	32.4	17.4	2.7	0.7	53.6	22.4
Sodium as Na	mg/l	$	119	612.5	118.2	79.4	57	18.2	46.9	220	225	528
Potassium as K	mg/l	$	4.7	12	5.3	2.7	9.2	2.6	7.7	22.5	4	15
Phenolic Compounds	mg/l	0.001 (0.002)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cyanides as CN	mg/l	0.05 (NR)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Anionic Detergents	mg/l	0.2 (1.0)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mineral oil	mg/l	0.01 (0.03)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium as Cd	mg/l	0.01 (NR)	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic as As	mg/l	0.01 (NR)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper as Cu	mg/l	0.05 (1.5)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lead as Pb	mg/l	0.05 (NR)	0.17	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Manganese as Mn	mg/l	0.1 (0.3)	0.8	0.02	0.02	<0.01	0.03	0.01	0.02	0.02	0.01	0.01
Iron as Fe	mg/l	0.3 (1.0)	2.7	0.01	0.02	0.1	0.04	0.03	0.02	0.03	0.06	0.01
Chromium as Cr^{+6}	mg/l	0.05 (NR)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Selenium as Se	mg/l	0.01 (NR)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc as Zn	mg/l	5(15)	41.2	0.17	0.02	0.03	0.06	0.13	0.07	0.02	0.01	0.04
Aluminium as Al	mg/l	0.03(0.2)	<0.01	0.03	<0.01	<0.01	0.04	0.04	<0.01	<0.01	<0.01	<0.01
Mercury as Hg	mg/l	0.001(NR)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Pesticides	mg/l	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
E.Coli	-	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Total Coliforms	MPN/100 ml	10	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3

 # Values in parenthesis are maximum permissible limits in absence of alternate source.$: Limits not specified, NR: No Relaxation, UO: Un-Objectionable, Ag: Taste agreeable, Abs: Absent, BDL: Below Detectible levels

TABLE-4.5.3
ANALYSIS RESULTS FOR SURFACE WATER – WINTER SEASON

Sr. No.	Parameters	Units	Class C of IS: 2296 Limits	Khari River SW1	Mansi River SW2	Agucha Pond SW3
1	pH	-	6.5 to 8.5	7.4	7.5	7.3
2	Colour	Hazen	300	3.6	4.2	3.5
3	Conductivity	µS/cm	$	365	273	285
4	Dissolved oxygen	mg/l	4 Min.	6.1	5.9	4.6
5	BOD, 3day @ 27°C	mg/l	3	<3	<3	<3
6	Total dissolved solids	mg/l	1500	239	176	186
7	Total hardness as $CaCO_3$	mg/l	$	96	86	89
8	Chlorides as Cl	mg/l	600	53.9	14.3	19.6
9	Fluorides as F	mg/l	1.5	0.3	0.4	0.4
10	Sulphates as SO_4	mg/l	400	28.6	11.7	9.8
11	Alkalinity	mg/l	$	106	102	110
12	Nitrates as NO_3	mg/l	50	0.9	0.5	0.7
13	Cyanides as CN	mg/l	0.05	<0.05	<0.05	<0.05
14	Calcium as Ca	mg/l	$	18.2	14.5	26.7
15	Magnesium as Mg	mg/l	$	5.8	12.4	2.4
16	Sodium as Na	mg/l	$	38.6	13.5	18.2
17	Potassium as K	mg/l	$	8.2	7.2	5.9
18	Iron as Fe	mg/l	50	0.09	0.08	0.1
19	Chromium as Cr	mg/l	0.05	<0.05	<0.05	<0.05
20	Cadmium as Cd	Mg/l	0.01	<0.01	<0.01	<0.01
21	Lead as Pb	mg/l	0.1	0.04	0.02	<0.01
22	Copper as Cu	mg/l	1.5	<0.01	<0.01	<0.01
23	Arsenic as As	mg/l	0.2	<0.01	<0.01	<0.01
24	Selenium as Se	mg/l	0.05	<0.01	<0.01	<0.01
25	Phenolics as C_6H_5OH	mg/l	0.005	<0.005	<0.005	<0.005
26	Zinc as Zn	mg/l	15	0.03	0.02	0.01
27	Mercury as Hg	mg/l	$	<0.001	<0.001	<0.001
28	Anionic detergents as MBAS	mg/l	1	<0.2	<0.2	<0.2
29	Oil and grease	mg/l	0.1	<0.1	<0.1	<0.1
30	Insecticides	mg/l	Absent	Absent	Absent	Absent
31	Total Coliforms	MPN/ 100ml	5000	12	10	9

 # Values in parenthesis are maximum permissible limits in absence of alternate source.$: Limits not specified, NR: No Relaxation, UO: Un-Objectionable, Ag: Taste agreeable, Abs: Absent

Observations

Water quality sources covering 10 km radial distance were examined for physico-chemical, heavy metals and bacteriological parameters in order to assess the effect of industrial and other activities on water quality. Samples were collected and analyzed as per the procedure laid down in the standard methods for the examination of water and wastewater (APHA).

Surface water sample were collected during the EIA studies in winter season.

Concentrations of parameters for ground and surface water quality are presented in **Table-4.5.2** and **Table-4.5.3(A)**. Most of the values are found to be either within limit or within extended limit. Presence of heavy metals is observed but the concentrations are well within the permissible limits. The overall quality considerations as far as water quality in the study area indicate absence of any

external polluting sources like industries and represent uncontaminated conditions. The comparison of pre-project and present water quality is given in **Chapter-5**.

4.5.3.1Ground Water Quality

The results of the ground water quality monitored during study period are given in **Table-3.4.2**. The results were compared with standards for drinking water as per IS:10500-1991 "Specifications for Drinking Water" for ground water and with Class 'C' water quality (fit for drinking after conventional treatment).

Most of the villages in the project area have bore well and tube well facilities, as most of the residents of these villages make use of this water for drinking, agricultural, and other domestic uses. Therefore, bore well samples have been considered for sampling.

The analysis results indicate a pH range of 6.5 to 7.9, which is well within the desirable limit of 6.5 to 8.5. The TDS was observed to range between 378 to 2096 all samples are within the permissible limit of 2000 mg/l except for samples collected at one location. Total hardness was observed to range between 212 to 620 mg/l, within the permissible limit of 600 mg/l except for sample collected at three samples.

Chlorides are found to range between 38.5 to 574.3 mg/l. The chloride concentrations were observed to be within the permissible limit of 1000 mg/l. Fluorides are found to range between 0.2 to 1.9 mg/l and within the permissible limit of 1.5 mg/l except for samples collected at three locations. Nitrates are found to range between 0.7 to 60.4 mg/l and exceeding the prescribed limit of 45.0 mg/l at two locations. Presence of heavy metals is observed but the concentrations are within the permissible limits.

4.5.3.2Surface Water Quality

The results for the parameters analyzed for surface water samples are presented in **Table-4.5.3(B)** and are compared with Class 'C' water quality (fit for drinking after conventional treatment) as per IS:2296-1982 "Tolerance Limits for Inland Surface Waters subject to Pollution" for surface water.

The pH of the surface water samples collected ranges in between 7.3 to 7.5. The conductivity recorded in the range of 273 to 365 μs/cm.

The sodium and potassium concentrations varied between 13.5 to 38.6 mg/l and 5.9 to 8.2 mg/l respectively. The Higher concentration of sodium and potassium was observed in – Khari River (SW1).

Total hardness expressed as $CaCO_3$ ranges between 86 to 96 mg/l. The concentration of nitrate fluctuates between 0.5 to 0.9 mg/l with higher concentration of nitrate observed in Khari River (SW1).

4.5.4 Water Quality Monitored by HZL

HZL is monitoring water quality in and around the mine lease area. HZL is collecting water samples from near by wells once in a month and analysing for physico-chemical parameters and heavy metals like Lead, Zinc, Iron and Cadmium.

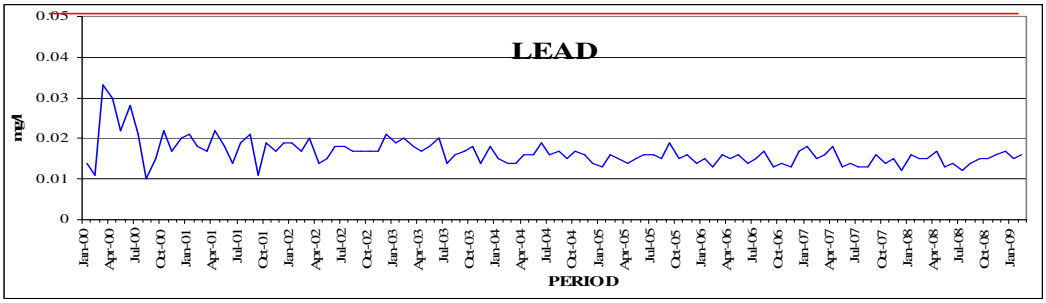
The results indicate that the concentrations of lead, zinc, iron and cadmium are well within the permissible limits applicable for ground water. The trends of heavy metals in the monitoring wells are presented in **Figure-4.5.2** to **Figure-4.5.5.**

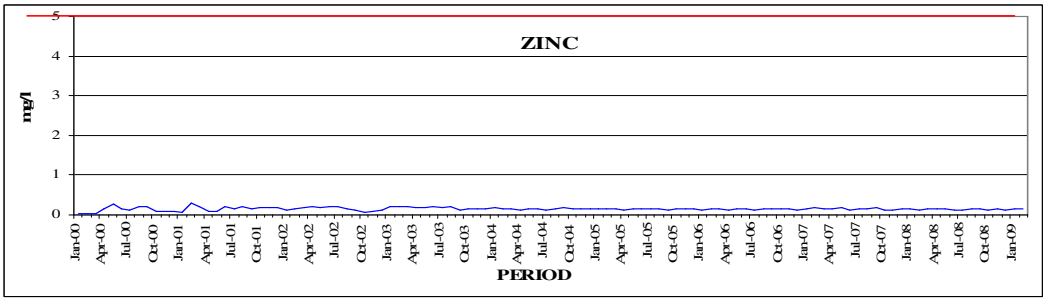
- ***Mine Water Analysis***

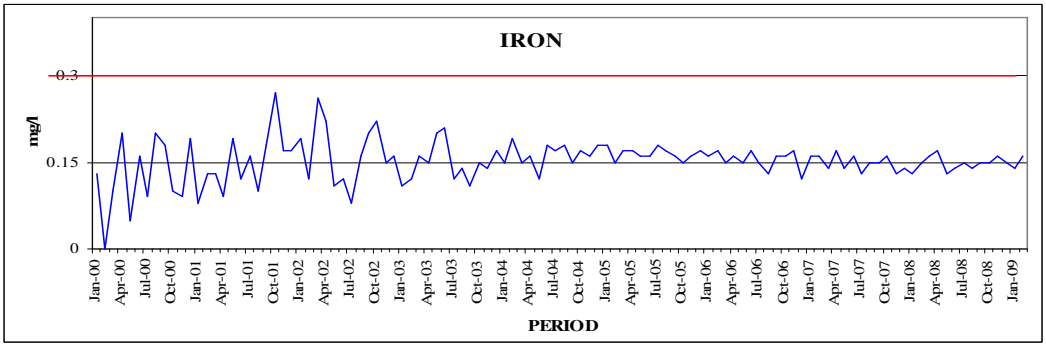
The mine water collected in the mine pit is monitored for physico-chemical parameters and heavy metals every month. The results indicate that the mine water is slightly acidic to neutral in nature. The concentration of total dissolved solids is high. The concentration of heavy metals like lead, zinc, cadmium and iron is high. The analysis results from January-07 to May-08 are presented in **Table-4.5.4.** It should be noted that mine water is pumped to tailing dam from where water is recycled in the beneficiation plant. These results are more or less same with the results analyzed by Vimta.

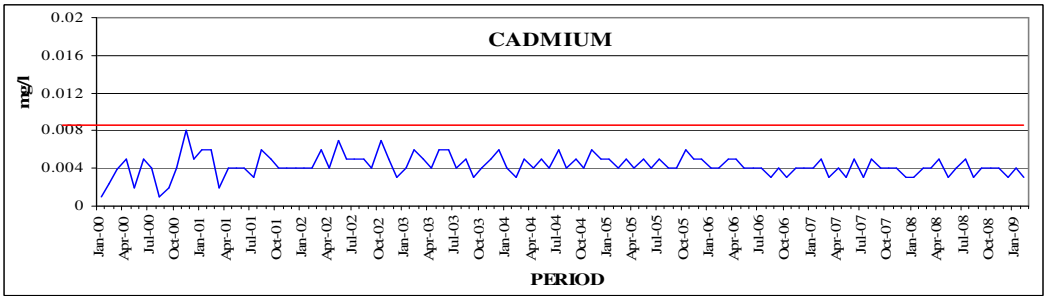
TABLE-4.5.4
MINE WATER ANALYSIS RESULTS (HZL)
(mg/l except pH)

Month	Parameters								
	pH	Alkalinity	Chlorides	Hardness	TDS	Pb	Zn	Cd	Fe
Jan-07	6.81	90	395	1043	3744	0.16	33.38	0.13	0.75
Feb-07	6.87	100	400	1059	3775	0.18	31.54	0.15	0.86
Mar-07	6.77	85	415	1086	3690	0.19	30.44	0.12	0.94
Apr-07	6.72	80	380	1032	3684	0.15	32.87	0.13	0.80
May-07	6.89	100	398	1090	3710	0.17	34.43	0.14	0.79
Jun-07	6.82	90	390	1122	3742	0.21	30.29	0.14	0.88
Jul-07	6.74	82	384	1075	3712	0.21	32.47	0.12	0.96
Aug-07	6.89	100	396	1060	3680	0.15	30.09	0.15	0.79
Sep-07	6.85	95	370	1094	3699	0.19	31.44	0.15	0.85
Oct-07	6.70	75	384	1105	3728	0.14	32.79	0.12	0.69
Nov-07	6.85	95	375	1080	3744	0.18	30.54	0.14	0.82
Dec-07	6.82	90	378	1095	3709	0.13	34.32	0.14	0.80
Jan-08	6.75	80	387	1108	3728	0.16	32.95	0.15	0.86
Feb-08	6.84	92	402	1089	3745	0.14	33.69	0.12	0.73
Mar-08	6.79	88	387	1075	3753	0.13	34.76	0.13	0.72
Apr-08	6.92	102	372	1094	3740	0.17	30.94	0.16	0.85
May-08	6.76	82	396	1108	3750	0.14	32.06	0.12	0.79









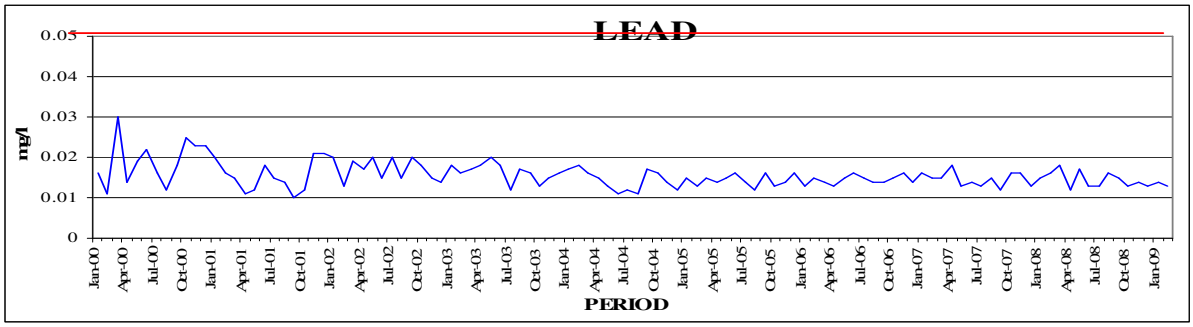
Actual Value Graph

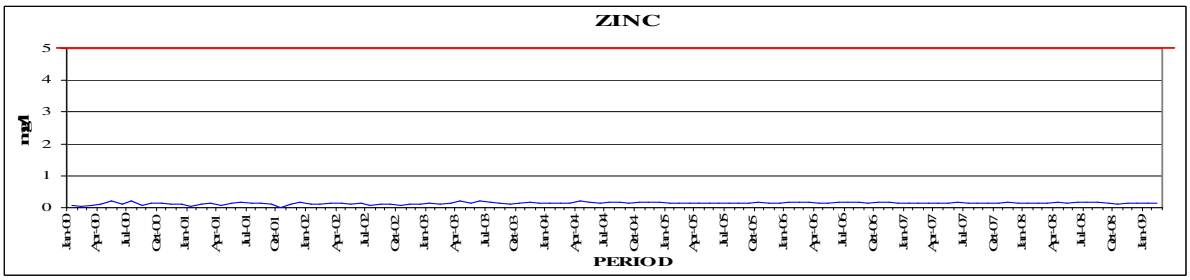
Trend Line

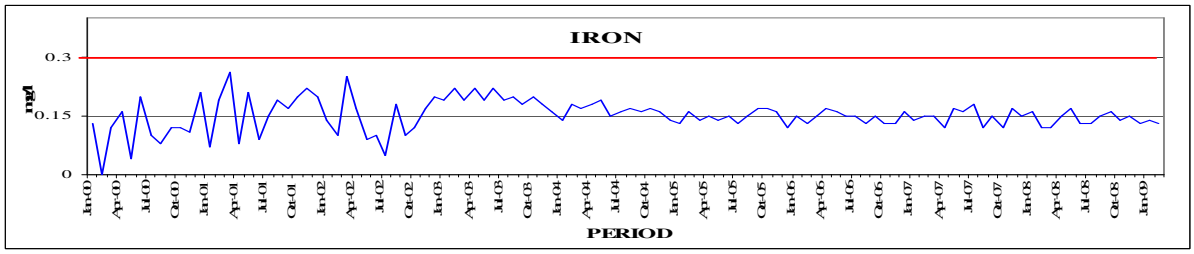
Standard Limit for Drinking Water

FIGURE-4.5.2

HEAVY METAL TRENDS IN MONITORING – PIEZOMETER NO.I







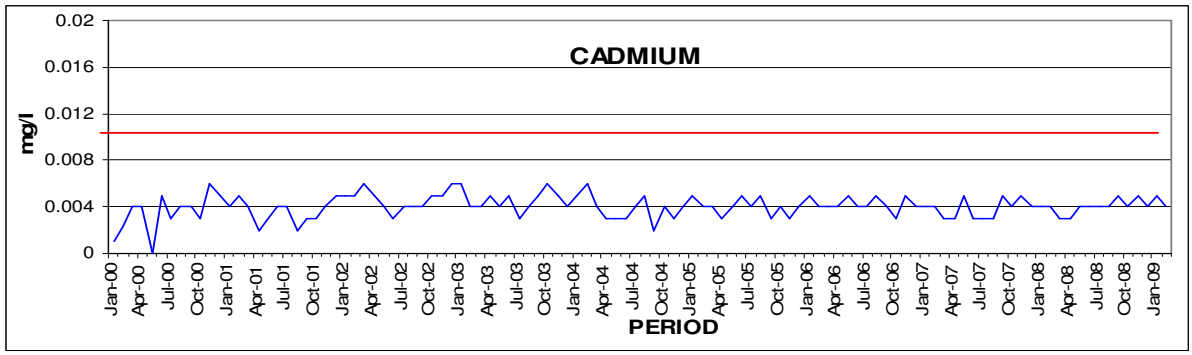


FIGURE-4.5.3
HEAVY METAL TRENDS IN MONITORING - PIEZOMETER - K

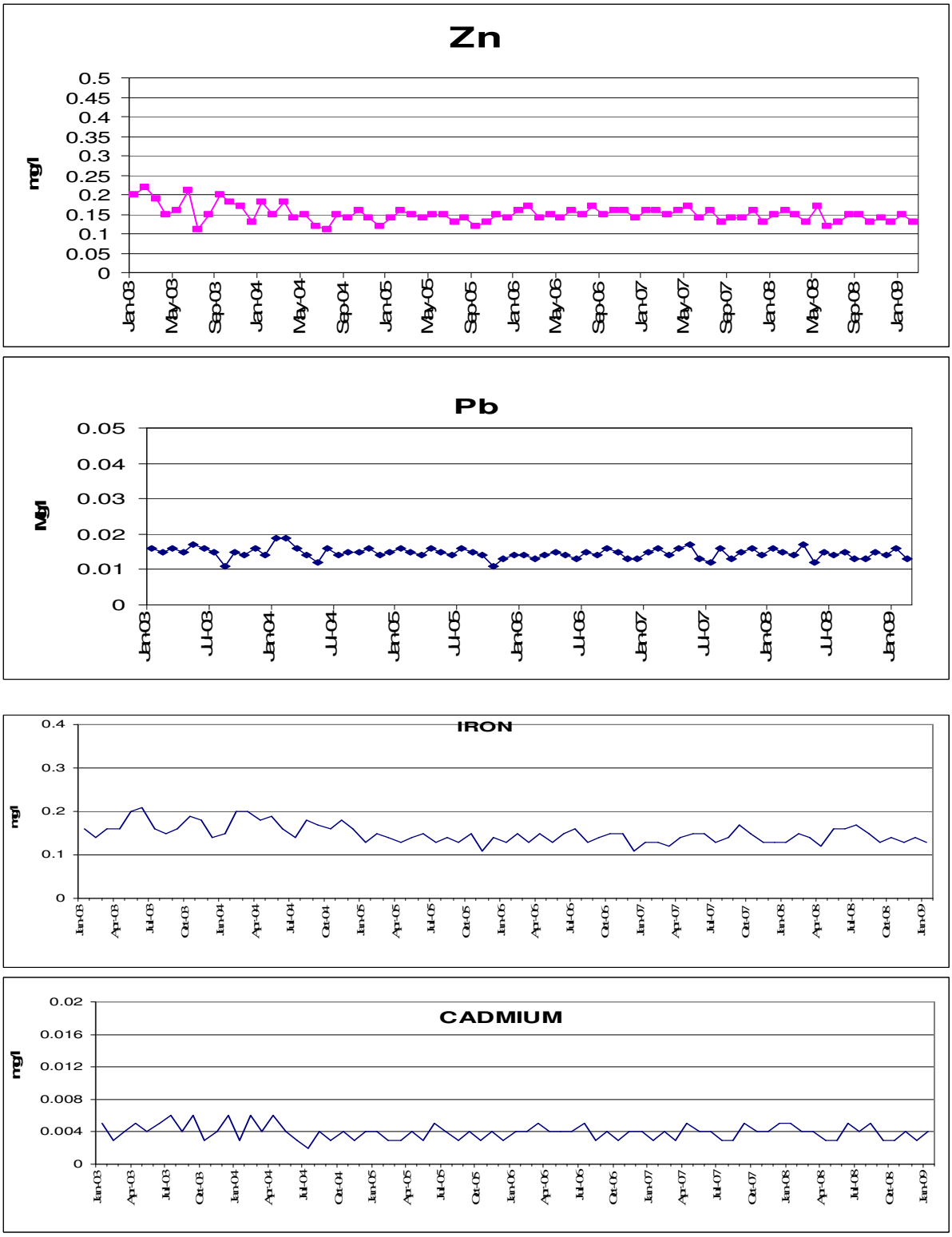
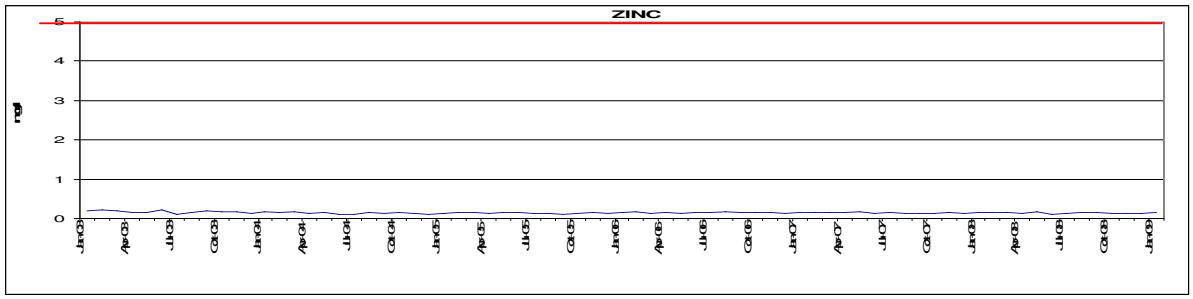
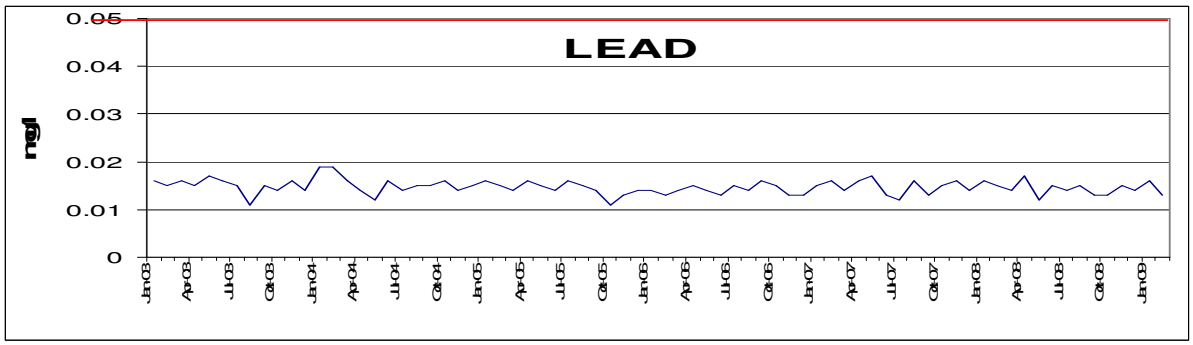
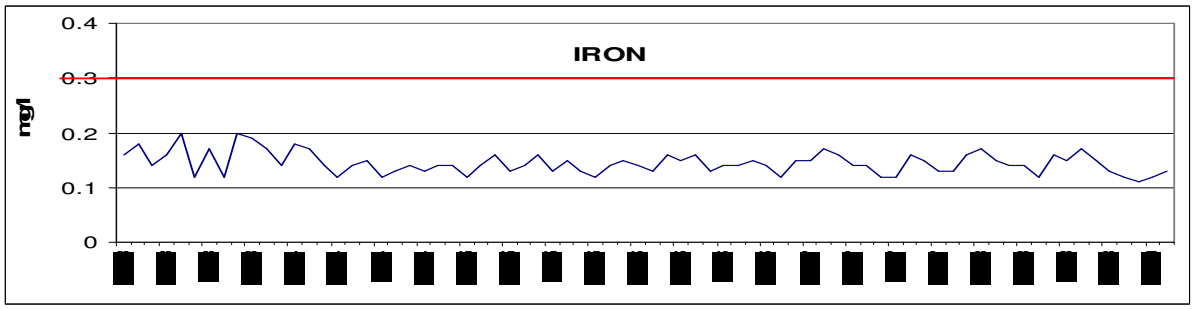


FIGURE-4.5.4
HEAVY METAL TRENDS IN AGUCHA VILLAGE







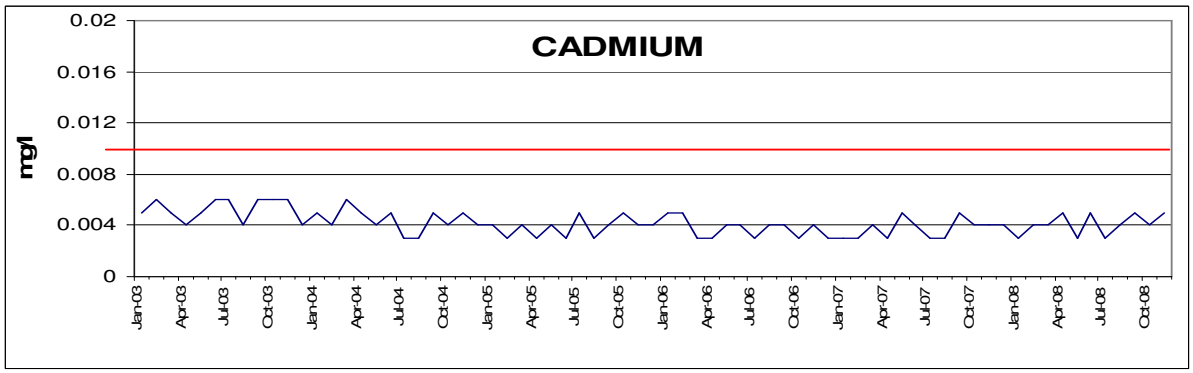


FIGURE-4.5.5
HEAVY METAL TRENDS IN KOTHIYA VILLAGE

4.6 Soil Characteristics

The baseline information on soils in the area is essential for assessing the impacts of current activities on the soil quality and the anticipated impacts in future after enhancement of the mining capacity. Accordingly, the assessment of the soil quality has been carried out.

4.6.1 Data Generation

For studying soil quality in the region, sampling locations were selected to assess the existing soil conditions in and around the project area representing various land use conditions. The physical, chemical and heavy metal concentrations were determined. The samples were collected by ramming a core-cutter into the soil upto a depth of 90 cm.

The sampling locations have been identified with the following objectives:

- To determine the baseline soil characteristics of the study area;
- To determine the impact of current activities on soil characteristics; and
- To determine the impact on soils more importantly from agricultural productivity point of view.

Six locations within 10-km radius of the mine lease boundary were selected for soil sampling in winter season. At each location, soil samples were collected from three different depths viz. 30 cm, 60 cm and 90 cm below the surface and homogenized. The homogenized samples were analyzed for physical and chemical characteristics. Samples were taken twice during the study period. The samples have been analyzed as per the established scientific methods for physico-chemical parameters. The heavy metals have been analyzed by using Inductive Coupled Plasma Analyzer.

The details of the sampling locations are given in **Table-4.6.1** and are shown in **Figure-4.6.1**. The soil quality for all the locations during winter season is tabulated in **Table-4.6.2.** The results are compared with standard classification given in **Table-4.6.3.** HZL also regularly monitors soil characteristics in around the mine area at six locations.

TABLE-4.6.1
DETAILS OF SAMPLING LOCATIONS

Code	Location	Distance wrt site (km)	Direction	Present Land Use
S1	Agricultural land near Kothian	2.4	NEE	Agricultural land
S2	Agricultural land near Bherun Khera	ML boundary	ESE	Agricultural land
S3	Agricultural land near Amartiya	4.5	SSE	Agricultural land
S4	Agricultural land near Agucha	0.7	SW	Agricultural land
S5	Agricultural land near Gajsinghpura	3.2	SW	Agricultural land
S6	Agricultural land near Mana ka Khera	0.9	W	Agricultural land

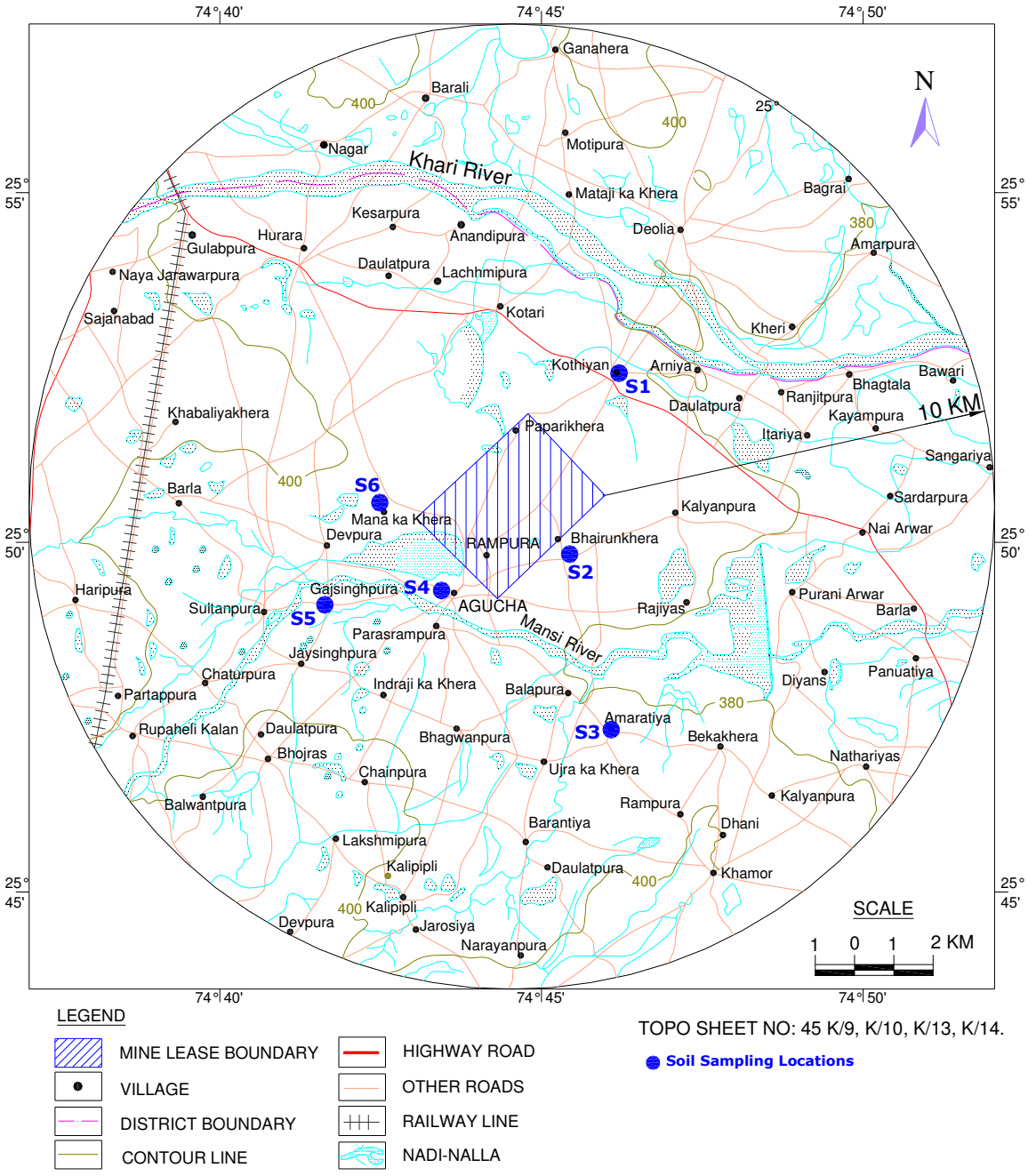


FIGURE-4.6.1
SOIL SAMPLING LOCATIONS

4.6.2 Baseline Soil Status

Soil characteristics of the selected locations for winter season are presented in **Table-4.6.2.** The generated soil quality data has been compared with the standard soil classification presented in the **Table 4.6.3.**

Kothian Village (S1)

Soil near Kothian village (S2) has been taken from agricultural field. The soil is reddish brown in colour with sandy loam texture. The potassium and nitrogen are available are with less quantity while Phosphorous is available in more than sufficient quantity. The soil is found to be alkaline in nature (pH-8.3). Presence of heavy metals like lead and zinc is observed.

Bherun Khera (S2)

Soil at this location is taken from an agricultural field. The soil is observed to be reddish brownish in colour predominantly with sandy loam texture. The soil is alkaline (7.8 pH). The NPK values are observed to be medium to sufficient. The organic matter in the soil is adequate. The porosity of the soil is medium to less. The presence of heavy metals like Zinc and Lead are observed in the soil sample.

Amartiya Village (S3)

Soil at Amartiya village (S3) is also from agricultural field with sandy loam texture and Reddish brown in colour. The EC is found to be 0.80 mmho/cm, which is average. Presence of Zinc and Lead content is observed. The Phosphorous and potassium is less in quantities while Nitrogen is observed to be in sufficient quantity.

Agucha Village (S4)

The soil pH is observed to be alkaline. The EC is observed to be 0.54 mmho/cm, which is average. The NPK values indicate that phosphorous quantity is less while nitrogen and potassium quantities are observed to be sufficient. The presence of heavy metals is observed.

Gajsinghpura Village (S5)

Soil near to Gajsinghpura village (S5) is taken from an agricultural field. It is basically sandy-loam with brownish colour. The NPK values are observed to be less to sufficient. The soil is observed to be neutral in nature while EC is observed to be 0.20 mmho/cm. The presence of Zinc and Lead content is observed at this location.

Mana Ka Khera Village (S6)

Soil near to Mona Ka Khera village (S6) is taken from agricultural field. The soil is having Sandy loam texture and brownish colour. The soil is observed to be slightly alkaline. The Potassium and Phosphorous values are less while Nitrogen is observed to be sufficient. Presence of heavy metals is also observed at this location.

TABLE-4.6.2
SOIL ANALYSIS RESULTS – WINTER SEASON

Parameters	Unit	Kothiyan (S1)	Bhairun khera (S2)	Amaratiya (S3)	Agucha (S4)	Gajsinghpura (S5)	Mana ka khera (S6)
Colour		Reddish brown	Brownish	Reddish brown	Brownish black	Brownish	Brownish
Soil Texture	-	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Sand	%	19	31	24	23	26	25
Clay	%	43	42	42	40	42	41
Silt	%	38	27	34	37	31	34
Bulk Density	gm/cc	1.3	1.2	1.3	1.2	1.1	1.2
pH (1:5 aq. extract)	-	8.3	7.8	9.1	8.0	8.2	8.7
Electrical Conductivity (1:5 extract)	mmho/cm	150	1206	802	545	203	300
Water Soluble Chloride as Cl	mg/kg	35.2	211.9	669.5	371.5	35.1	159.2
Water Soluble Sulphate as SO_4	mg/kg	410.4	1204.7	102.6	94.7	24.9	28.3
Exchangeable Calcium as Ca	mg/ Kg	4488	4974	2499	3294	2490	2790
Exchangeable Magnesium as Mg	mg/ Kg	303	544	158	121	315	303
Exchangeable Sodium as Na	mg/ Kg	41.4	52.2	36.0	33.4	44.8	38.4
Available Potassium as K	Kg/ha	139	169.3	145.6	191.7	174.8	136.3
Available Nitrogen as N	Kg/ha	42.2	38.4	31.7	69.8	61.2	17.7
Available Phosphorous as PO_4	Kg/ha	127.6	222.9	128.9	116	130.7	139.9
Organic Carbon	%	0.06	0.16	0.27	0.2	0.05	0.15
Organic Matter	%	0.12	0.3	0.49	0.36	0.10	0.27
Sodium Absorption Ratio	--	0.07	0.1	0.08	0.07	0.08	0.08
Aluminium as Al	%	1.98	1.67	1.87	2.12	2.23	2.02
Iron as Fe	%	1.38	1.3	1.76	1.63	1.72	1.84
Manganese as Mn	mg/kg	76.2	96.3	83.4	93.0	76.7	82.6
Boron as B	mg/kg	46.3	58.3	51.3	43.6	72.8	52.6
Zinc as Zn	mg/kg	64.8	103.6	75.3	71.2	76.8	83.4
Lead as Pb	mg/kg	31.1	41.6	39.4	42.5	32.4	40.3
Mercury as Hg	ppm	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium as Cd	mg/kg	1.22	1.02	1.35	1.13	1.01	0.95

TABLE-4.6.3
STANDARD SOIL CLASSIFICATION

Sr. No.	Soil Test	Classification
1	pH	<4.5 Extremely acidic 4.51- 5.00 Very strongly acidic 5.51-6.0 moderately acidic 6.01-6.50 slightly acidic 6.51-7.30 Neutral 7.31-7.80 slightly alkaline 7.81-8.50 moderately alkaline 8.51-9.0 strongly alkaline 9.01 very strongly alkaline
2	Salinity Electrical Conductivity (mmhos/cm) (1ppm = 640 mmho)	Upto 1.00 Average 1.01-2.00 harmful to germination 2.01-3.00 harmful to crops (sensitive to salts)
3	Organic Carbon (%)	Upto 0.2: very less 0.21-0.4: less 0.41-0.5 medium, 0.51-0.8: on an average sufficient 0.81-1.00: sufficient >1.0 more than sufficient
4	Nitrogen (Kg/ha)	Upto 50 very less 51-100 less 101-150 good 151-300 Better >300 sufficient
5	Phosphorus (Kg/ha)	Upto 15 very less 16-30 less 31-50 medium, 51-65 on an average sufficient 66-80 sufficient >80 more than sufficient
6	Potash (Kg/ha)	0 -120 very less 120-180 less 181-240 medium 241-300 average 301-360 better >360 more than sufficient

Source: Hand Book of Agriculture, ICAR, New Delhi

4.6.3 Baseline Soil Status

It has been observed that the texture of soil is mostly clayey in the study area. It has been observed that the pH of the soil ranged from 7.8 to 9.1 indicating that the soils are usually moderately to very strongly alkaline in nature.

The electrical conductivity was observed to be in the range of 150 to 1206 µS/cm, with the maximum (1206 µS/cm) observed in Bhairunkhera (S2) and with the minimum (150 µS/cm) observed in Kothiyan (S1).

The nitrogen values ranged between 17.7 to 69.8 Kg/ha. The maximum value (69.8 Kg/ha) was observed in village Agucha (S4), the minimum value (17.7 Kg/ha) was observed in Mana ka Khera village (S6) indicating that the soils have very less to less quantity of nitrogen.

The phosphorus values ranged between 116 to 222.9 Kg/ha. The maximum value (222.9 Kg/ha) was observed in Bhairunkhera village (S2), the minimum value (116 Kg/ha) was observed in Agucha (S4) indicating that the soils have more than sufficient quantity of phosphorus.

The potassium values range between 136.3 to 191.7 Kg/ha. The maximum value (191.7 Kg/ha) was observed in Agucha (S4) and the minimum value (136.3 Kg/ha) was observed in the village Mana ka Khera village (S6) indicating that the soils have less to medium quantity of potassium.

NPK values are less to more than sufficient in most of the locations. Occurrence of heavy metals is observed from all the locations.

4.6.4 Soil Characteristics Monitored by HZL

The soil quality is monitored by HZL to assess the heavy metal content of lead, zinc, iron and cadmium in the soil outside the mine lease area. The soil samples are collected twice a year in the post-monsoon season and pre-monsoon season. The results for the year 2008 are presented in **Table-4.6.4,** and **Table-4.6.5.**

TABLE-4.6.4
SOIL QUALITY MONITORED BY HZL FOR THE YEAR 2008

(May, 2008) (Pre Monsoon)

Sr. No.	Location	Pb (ppm)	Zn (ppm)	Fe (ppm)	Cd (ppm)
1	Jai Singh Pura	24.87	59.33	52.63	0.84
2	Daulat Pura	26.00	52.00	44.50	0.92
3	Bhillon Ka Khera	28.58	85.25	118.34	0.96
4	Kalyan Pura	19.80	82.90	61.70	1.15
5	Muna Ka Khera	18.99	42.44	48.25	1.05
6	Gaj Singh pura	19.10	55.40	73.20	0.97
7	Agucha Plantation	18.45	53.67	52.80	1.14
8	Bherukhera	17.72	54.60	62.49	1.13
9	Magzine	20.47	48.37	47.63	0.89

Values are expressed in ppm

TABLE-4.6.5
(October, 2008) (Post Monsoon)

Sr. No.	Location	Pb (ppm)	Zn (ppm)	Fe (ppm)	Cd (ppm)
1	Jai Singh Pura	24.00	51.55	45.90	0.80
2	Daulat Pura	24.20	52.10	45.50	0.86
3	Bhillon Ka Khera	28.95	72.75	106.75	0.92
4	Kalyan Pura	17.75	82.25	64.56	1.10
5	Muna Ka Khera	18.95	35.40	48.82	0.92
6	Gaj Singh pura	17.20	48.65	72.75	0.80
7	Agucha Plantation	17.35	56.25	48.95	1.10
8	Bherukhera	16.65	48.50	62.58	1.20
9	Magzine	19.85	47.00	47.65	1.12

Values are expressed in ppm

4.7 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 loudness distributed over the audible frequency range. Various noise scales have been introduced to describe, in a single number, the response of an average human to a complex sound made up of various frequencies at different loudness levels. 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 a human ear.
The impact of noise sources on surrounding community depends on:

- Characteristics of noise sources (instantaneous, intermittent or continuous in nature). It can be observed that steady noise is not as annoying as one which is continuously varying in loudness;

- The time of day at which noise occurs, for example high noise levels at night in residential areas are not acceptable because of sleep disturbance; and

- The location of the noise source, with respect to noise sensitive landuse, which determines the loudness and period of exposure.

The environmental impact of noise can have several effects varying from Noise Induced Hearing Loss (NIHL) to annoyance depending on loudness of noise. The environmental impact assessment of noise from the mine operations and vehicular traffic can be undertaken by taking into consideration various factors like potential damage to hearing, physiological responses, annoyance and general community responses.

The main objective of noise monitoring in the study area is to establish the baseline noise levels and assess the impact of the total noise expected to be generated after the proposed expansion of the mining activities.

4.7.1 Identification of Sampling Locations

A preliminary reconnaissance survey has been undertaken to identify the major noise generating sources in the area. Noise at different noise generating sources have been identified based on the activities in the village area and ambient noise due to traffic.

The noise monitoring has been conducted for determination of noise levels at **ten locations** including 4 locations within the mining complex and 9 locations outside the complex in the study area. The noise levels at each of the locations were recorded for 24 hours during winter season. The environmental setting of noise monitoring locations within the mining complex as well as outside the mining complex are given in **Table-4.7.1** and depicted in **Figure-4.7.1**.

4.7.2 Method of Monitoring

Sound Pressure Level (SPL) measurements were recorded at all locations. The readings were taken every hour for 24 hours. The daytime noise levels have been monitored during 6 am to 9 pm and nighttime levels during 9 pm to 6 am at all the locations covered in 10 km radius of the study area.

4.7.3 Parameters Measured During Monitoring

For noise levels measured over a given period of time, it is possible to describe important features of noise using statistical quantities. This is calculated using the percent of the time certain noise levels are exceeding the time interval. The notation for the statistical quantities of noise levels are described below:

- L_{10} is the noise level exceeded 10 per cent of the time
- L_{50} is the noise level exceeded 50 per cent of the time and
- L_{90} is the noise level exceeded 90 per cent of the time

Equivalent Sound Pressure Level (L_{eq}):

The Leq is the equivalent continuous sound level, which is equivalent to the same sound energy as the actual fluctuating sound measured in the same period. This is necessary because sound from noise source often fluctuates widely during a given period of time. This is calculated from the following equation:

$$L_{eq} = L_{50} + \frac{(L_{10} - L_{90})^2}{60}$$

L_{day} is defined as the equivalent noise level measured over a period of time during day (6 am to 9 pm).

L_{night} is defined as the equivalent noise level measured over a period of time during night (9 pm to 6 am).

A noise rating developed by **E P A** for specification of community noise from all the sources is the Day-Night Sound Level, (L_{dn}).

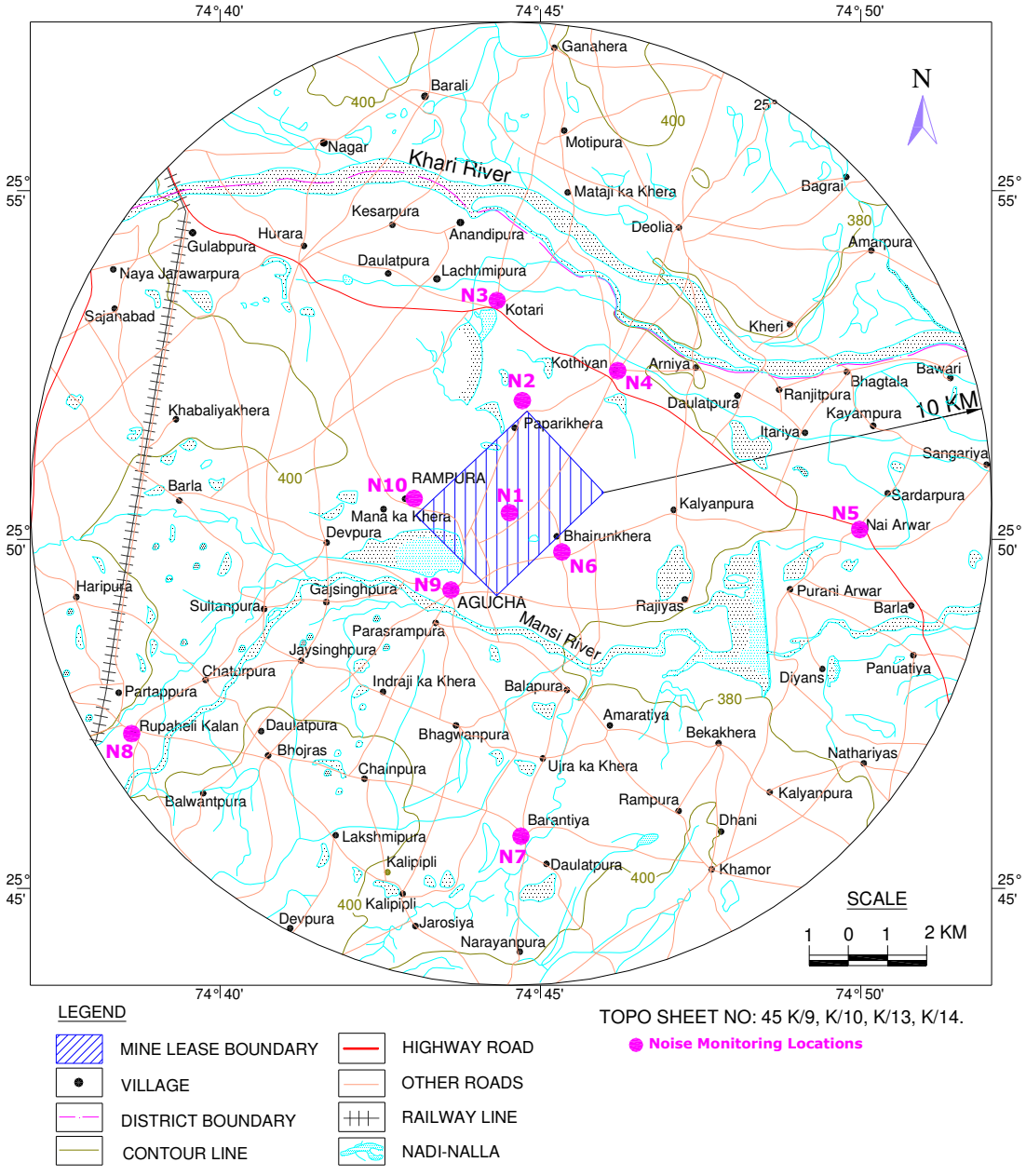


FIGURE-4.7.1
NOISE MONITORING LOCATIONS

TABLE- 4.7.1
DETAILS OF NOISE MONITORING LOCATIONS (OUTSIDE MINING COMPLEX)

Station Code	Location/Village	Distance w.r.t. Mine Lease Boundary (km)	Direction w.r.t. Mine Lease area	Details of the Surroundings
N1	Pit side View Point	Within mine	Mine Area	Predominantly mining activities associated with mining, blasting and transportation of ore to the beneficiation plant through heavy-duty dumpers and movement of light vehicular movements of HZL.
N2	Papari Khera	0.5	N	Predominantly rural residential zone surrounded by agricultural fields. Rare movements of automobiles consisting of light and heavy vehicles on the road.
N3	Kotari	3.2	N	Predominantly rural residential zone surrounded by agricultural fields. Normal movements of automobiles consisting of light and heavy vehicles on the MDR.
N4	Kothiyan	2.4	NE	Predominantly rural residential zone surrounded by agricultural fields. Normal movements of automobiles consisting of light and heavy vehicles on the MDR.
N5	Nai Arwar	6.5	E	Predominantly rural residential zone surrounded by agricultural fields. Traffic movements observed to be less.
N6	Bhairun Khera	0.2	ESE	Predominantly rural residential zone surrounded by agricultural fields. Vehicular movements are observed to be marginal.
N7	Barantiya	6.2	S	Predominantly rural residential zone surrounded by agricultural fields. Vehicular movements of light automobiles and intermittent movements of heavy vehicles occur.
N8	Rupaheli Highway (Joining point of NH-79 with Agucha-Rupaheli)	9.2	SW	Predominantly rural residential zone surrounded by agricultural fields. Movements of moderate to heavy traffic consisting of all types of light and heavy vehicles coming from National Highway.
N9	Agucha	0.7	SW	Predominantly residential and commercial zone surrounded by agricultural fields. Intermittent movements of light motor vehicles.
N10	New Rampura	0.5	W	Predominantly rural residential zone surrounded by agricultural fields. Normal movements of automobiles consisting of light and heavy vehicles on the MDR.

Day-Night Sound Level (L_{dn}):

The noise rating developed for community noise from all sources is the Day-Night Sound Level(L_{dn}). It is similar to a 24 hr equivalent sound level except that during night time period (10 pm to 6 am) a 10 dB (A) weighting penalty is added to the instantaneous sound level before computing the 24 hr average.

This night time penalty is added to account for the fact that the noise during night, when people are usually in sleep, is judged as more annoying than the same noise during the day time.

The L_{dn} for a given location in a community may be calculated from the hourly L_{eq}'s, by the following equation.

$$L_{dn} = 10 \log \{1/24[15(10^{Ld/10}) + 9\ (10^{(Ln+10)/10})]\}$$

where L_d is the equivalent sound level during the day time (6 am to 9 pm) and L_n is the equivalent sound level during the night time (10 pm to 6 am).

4.7.4 Presentation of Results

The statistical analysis is done for measured noise levels at all of the locations for each season. The parameters are analyzed for L_{10}, L_{50}, L_{90}, L_{eq}, L_{day}, L_{night}, and L_{dn}. The statistical analysis of results for premonsoon and post monsoon season are given in **Table- 4.7.2** and **Table- 4.7.3** respectively.

TABLE-4.7.2
AMBIENT NOISE LEVELS
(LOCATIONS WITHIN THE MINE COMPLEX)

Locations	Average Noise Levels in dB(A)						
	L_{10}	L_{50}	L_{90}	L_{eq}	L_d	L_n	L_{dn}
Administration building	65.1	58.6	50.5	62.2	68.6	56.1	67.8
Pit side (View point)	73.1	59.8	51.9	67.3	69.6	57.3	68.9
Secondary crusher	88.4	82.8	78.4	84.5	81.5	76.4	84.0
Central Workshop	73.7	66.2	61.3	68.8	72.4	62.3	72.4

4.7.5 Parameters Measured During Monitoring

The statistical analysis is done for measured noise levels at ***ten*** locations during the study period. The parameters are analyzed for L_{day}, L_{night}, and L_{dn}. These results for the monitored period during December 2008 are tabulated in **Table-4.7.3.**

TABLE-4.7.3
AMBIENT NOISE LEVELS

Location	Average Noise Levels in dB(A)						
	L_{10}	L_{50}	L_{90}	L_{eq}	L_d	L_n	L_{dn}
Pit side (View point)	76.8	61.3	52.9	70.8	71.5	58.4	70.6
Papari Khera	49.9	45.4	40.2	47.0	49.2	39.7	49.4
Kotari	55.4	49.7	46.2	51.1	52.4	44.5	53.3
Kothiyan	56.1	45.8	37.9	51.3	49.9	44.1	52.0
Nai Arwar	55.3	44.8	41.3	48.1	48.8	43.2	51.0
Bhairun Khera	56.8	46.8	42.4	50.3	51.8	42.1	51.9
Barantiya	55.2	46.6	38.8	51.1	49.7	40.9	50.2
Rupaheli Highway	64.1	56.4	47.9	60.8	62.2	49.8	61.4
Agucha	32.1	51.4	43.2	53.5	61.3	47.6	60.2
New Rampura	56.4	46.1	40.5	50.3	52.1	42.1	52.1

Observations

a) Day time Noise Levels (L_{day})]

Residential zone: The daytime noise levels at the residential locations ranged between 48.8-52.4 dB(A). The maximum value of 52.4 dB(A) was recorded at Kotari and the minimum value of 48.8 dB(A) was recorded at the Nai Arwar village. The noise levels are observed to be below the prescribed limit of 55 dB(A).

Commercial zone: The daytime noise levels of 61.3 and 62.2 dB(A) were observed. The noise levels are observed to be below the prescribed limit of 65 dB(A).

Industrial zone: The maximum noise level of 71.5 dB(A) was observed at the Pit side of RA Mines, which is within the permissible limit of 75 dB(A) as per DGMS norms.

b) Night time Noise Levels (L_{night})

Residential zone: The nighttime noise levels ranged between 39.7 to 44.5 dB(A). The maximum value of 44.5 dB(A) was recorded at Kotari and the minimum value of 39.7 dB(A) was recorded at the Village Papari Khera. The nighttime noise levels were observed to be below the prescribed limit of 45 dB(A).

Commercial zone: The nighttime noise levels of 47.6 and 49.8 dB(A) were observed. The nighttime noise levels were observed to be below the prescribed limits of 55 dB(A).

Industrial zone: The noise level of 58.4 dB(A) was observed at the Pit side of RA Mines, which is within the permissible limit of 70 dB(A) as per CPCB norms.

4.8 Traffic Density Survey

The traffic studies were carried out in February 2009 during the study period. The main objective of the survey is to characterize the type, category and number of

vehicles plying on the roads. The locations where traffic monitoring was conducted are given in **Table 4.8.1**.

4.8.1 Presentation of Results

The traffic volume at each location is given in **Table-4.8.1** and discussed below.

TABLE-4.8.1
TRAFFIC COUNT (FEBRUARY 2009)

Location	2/3 Wheelers	Car/Jeep	Tractor	Buses	Truck's/Multi Axels/ Trailors/Tankers	Total PCU'S
Rampura Agucha Mine Gate	378	290	167	32	626	2954
New Rampura	344	268	227	37	256	2000
Agucha	286	182	118	54	323	1810
Bhairun khera	132	42	41	2	50	387
Barantiya	166	97	23	14	60	471
Kothiyan	228	122	73	49	74	824
Kotari	294	226	44	94	92	1063
Nai Arwar	298	175	56	98	74	1008
Papari Khera	224	99	19	-	41	391
Rupaheli Junction	124	100	48	61	157	960

Note: Number of Vehicles/day

The traffic survey conducted in the study area revealed that the highest traffic is observed at Rampura Agucha Main Gate. The major volume of traffic comprises of trucks and light motor vehicles.

4.9 Flora and fauna studies

4.9.1 Introduction

A detailed ecological survey of the study area was conducted, particularly with reference to listing of species and assessment of the existing baseline ecological (Terrestrial) conditions in the study area.

4.9.2 Objectives of Ecological Studies

The present study was undertaken with the following objectives:

- To assess the nature and distribution of vegetation in and around the project site;
- To assess the distribution of animal life spectra;
- To asses the biodiversity and to understand the resource potential; and
- To ascertain migratory routes of fauna if any
- Possibility of presence of breeding grounds, if any
- To understand impacts of current mining activities on ecology, if any;
- To estimate the Heavy metal content in leaves in and around mine lease area and
- To predict impacts of proposed expansion on ecology.

4.9.3 Methodology Adopted for the Survey

To achieve the above objectives a detailed study of the area was undertaken with the mine lease area as its centre. The different methods adopted were as follows:

- Generation of primary data by undertaking systematic ecological studies in the area;
- Discussion with local people so as to elicit information about local plants, animals and their uses; and
- Gathering data for ethnobiology.

The present report gives the review of published secondary data and the results of field sampling conducted during winter season, 2008-09.

4.9.4 Review of Secondary Published Data

4.9.4.1 From Census and Forest Working Plan of Bhilwara District

- ***Physiography***

The district Bhilwara is situated between 25°.00' to 27°.50' North Latitude and 74°.03' to 75°.25' East longitude. It is bounded in the north by Ajmer District, in the north -west, west and south west by Udaipur and Rajasamand districts. In the south and south south-east by Chittorgarh district. In the east and north east by Bundi and Tonk disticts. The total length of the district from west to east is 144 km. while the breadth from North to south is approximately 104-km.

- ***Agriculture***

Agriculture is the main occupation of a majority of the population of the Bhilwara District. The major crops in district of Bhilwara are Maize, Wheat, jo, til, Urad, Moong, Jeera, Gram, Ground Nut, Raee, Mustard & Cotton are the major crops of the Bhilwara District. Kharif crops constitute the bulk of the food production in the district since the agricultural activities are mostly dependent on Monsoons. Kharif crops include urad, maize, moong, groundnut etc.. Rabi crops are usually sown in November whereas Kharif crops are sown with the beginning of the first rains in July.

- ***Forests***

The forest crop is mainly xerophytic species common to the more arid tracts of India. The district is completely outside the timberline i.e. Teak, Sal and Sissoo zone of the tropical and sub-tropical India. The main species found in the district are Dhokra (*Anogeissus pendula*), Kumpta (*Acacia rupestris*), Salar (*Boswellia serrata*), Khejri (*Prosopis spicigera*), Khair(*Acacia catechu*), Ber (*Zizyphus jujube*), JinjaI(*Bauhinia racemosa*), Koulassi (*Dichrostachys Cineria*), Aranja (Acacia leucophloe), Go (*Lannea grandis*), Tambolia (*Ehretia laevis*), Sainjora (Moringa concanensis),Thor (*Euphorbia nivula*), Grangan (*Grewia populifolia*), Jharbor (*Zizyphus numalarica*), Dassen (*Phus mysorensis*), Firangan (*Grewia pillosa),* Salepan (*Securenega oblota*), Arni (*Clerodendron phlomoides*), Neem (*Azadirachta indica*), Semal (*Salmalia malabarica*), Pipal (*Ficus relisiosa*), Golia dhau (*Anogeissus latifolia*), Lambaba (*Bridelia retusa*), Timbru (*Disospyros melanoxylon*), Umbia (*Saccopetalum tomentosum*), Ghatolon (*Randia dumetorum*), Kalia (*Albizia odaratissima*), Kar(*Sterculia urens*), Khirni (*Wrightia tomentosa*), Bahera (*Terminalia bellerica*), Amaltas (*Cassia fistula*) and Bijasar (*Soymida fabrifuga*) etc. The most common grasses found in the district are *Cenchurus ciliaris, Schima marvosus, Dichanthium annulatus, Chloris barbata, Chrysopogon maintanus* and *Eremonopogon foevealatus* etc.

- ***Reserve Forest***

In study area, as per Forest department of Bhilwrara, there are no reserved or protected forests in study area. Six designated village forest areas belong to panchayats along the banks of Khari and Mansi Rivers. The details of panchayat forest areas are presented in **Table-4.9.1.**

- ***Plantations***

There are a number of small plantations within the area, some augment forested area and some form part of the social forestry programmes, particularly evident at roadsides. Trees commonly used for planting include *Acacia nilotica, Eucalyptus, Dalbergia sissoo, Cassia siamea* and *Prosopis julifera.* Plantations and fields are often hedged with cactus-Euphorbia nerifolia. Hindusthan Zinc Limited area is having a good number of plants. *Dalbergia sisso, Leucena leucophloe, Cassia fistula, Cassia siamea, Parkinsonia sp, Pithocolobium dulce, Pongamia glabra, Casuarina sp, Albizzia procera, Albizzia amara.* As corporate policy of Hindusthan Zinc Limited, extensive green belt programme is under implementation to make greenery in and round mine lease.

TABLE-4.9.1
DETAILS OF VILLAGE FOREST LANDS IN STUDY AREA

Name of the forest block	Direction	Distance from Mine Site (in Km)	Area(ha)
Bhilwara District			
Asind Tehsil			
Pratapura	Southwest	9.0	4.05
Raghunathpura ki dhani	Southeast	8.8	9.13
Hurda Tehsil			
Hurda Magra	North west	8.5	266.74
Shahapura Tehsil			
Mataji ka Kheda	North	6.0	48.17
Rampura	Southeast	7.7	33.17
Deopura	South west	9.5	31.00
Ajmer District			
Barli	North	8.5	210.85
Lamgara	North	9.5	35.85
		Total	**638.96**

4.9.5 Terrestrial Ecological Status: Primary Survey

Five locations were selected to conduct a detailed study within the study area. The selected locations are given in **Table-4.9.2** and **Figure-4.9.1.**

TABLE-4.9.2
DETAILS OF TERRESTRIAL ECOLOGICAL SAMPLING LOCATIONS

Station Code	Location/Village	Direction w.r.t. Mine Lease center	Distance w.r.t. Mine Lease Boundary (km)
TE-1	Near Village Kothiyan	NE	2.4
TE-2	Near Village Barla	ESE	8.8
TE-3	Near Village Barantiya	S	6.2
TE-4	Near Village Agucha	SW	0.7
TE-5	Near Village New Rampura	W	0.5

The primary data was generated through:

1. Preparing a general checklist of all plants encountered in the study area. This would indicate the bio-diversity for wild and cultivated plants. The plants so encountered were classified into life form spectrum according to the Raunkiaer's classification of life form spectrum;
2. Determining the bird population of migratory and local birds by taking 10 random readings at every location;
3. Observing mammals, amphibians and reptiles, noting their calls, droppings, burrows, pugmarks and other signs;
4. Carrying out physical observations from the village area and in and around mine lease areas, once during day time and once during night time for terrestrial fauna; and

5. Interviewing local inhabitants for knowing the uses of plants and animals and to get ethnobiological data.

4.9.5.1 Floristic Composition- Primary Survey

- ***Cryptogamic Vegetation***

The area shows many algae, fungi, bryophytes and ferns. Algae are present in aquatic bodies and in marshy places. Fungi, particularly from ascomycetes and basidiomycetes are located either on ground or epiphytically. Lichens of crustose, foliose and fruticose types are present on different substratas Lichens, Ascomycetes and Basidiomycetes could be observed near residential houses near habitations.

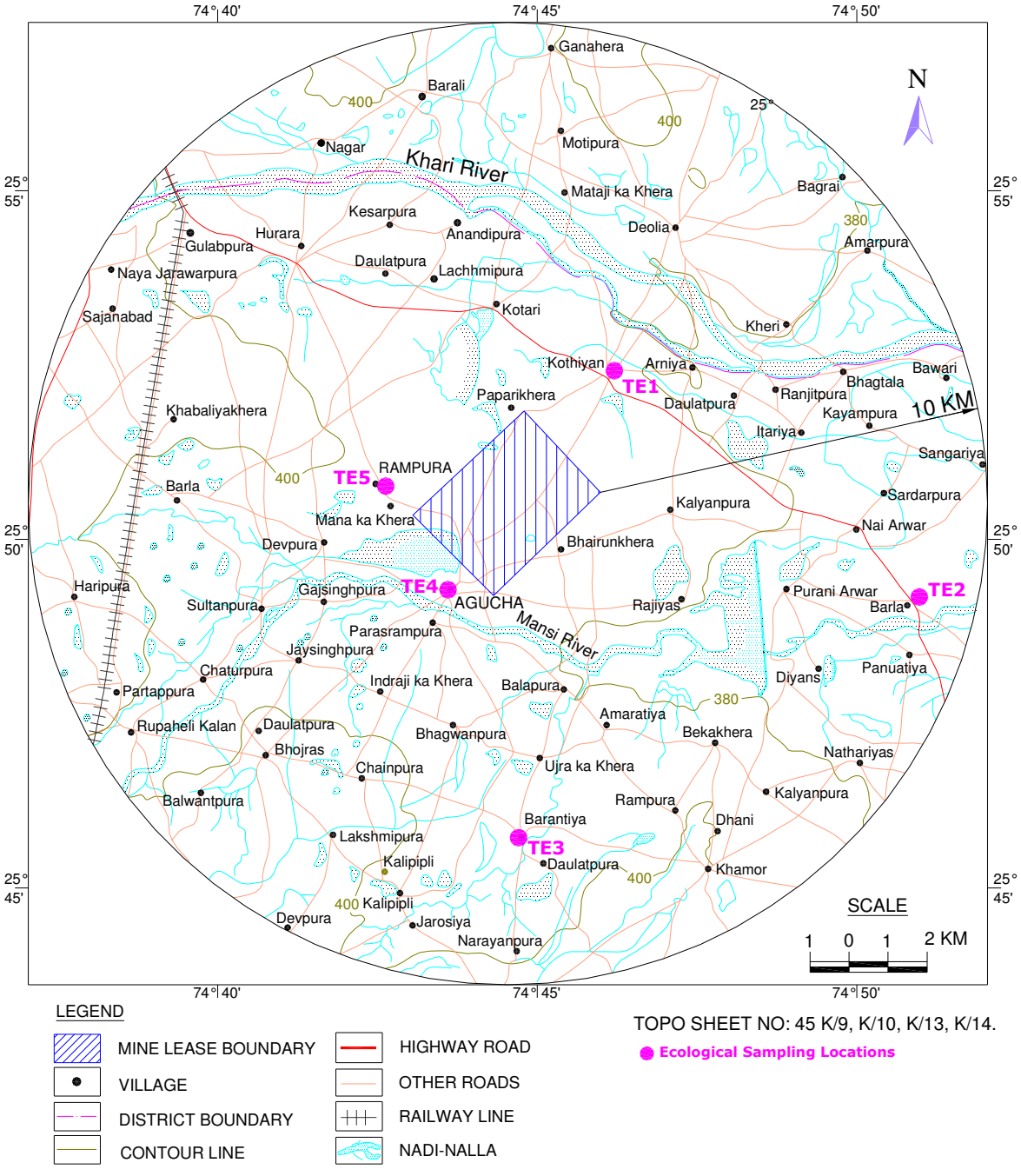
- ***Life Form Spectrum***

Raunkiaer defined life forms as the sum of adaptations of plants to the climate. Braun-Blanquet (1951), whose system is adapted in this study, modified the Raunkiaer's system. The following five best of the ten classes created by Braun-Blanquet is present in the study area.

Phanerophytes	:	Shrubs and trees
Therophytes	:	Annuals including ferns
Hydrophytes	:	Water plants except plankton
Hemicryptophytes	:	Plants with perennial shoots and buds close to surface.
Geophytes	:	Plants, with perennating parts buried in substratum.

During the field survey, a maximum number of 320 plant species (except algae, fungi and bryophytes) were recorded from the study area. **Table-1 of Annexure-XI** lists all the species recorded in the study area. The analysis of the data is presented in **Table-4.9.3.** In the study area, maximum number of species observed are therophytes (45.31%) followed by phanerophytes (33.44%).These classes are followed by hemicryptophytes (17.19%); geophytes, eiphytes and succulents were found in very few numbers. Hemicryptophytes (predominantly grasses and sedges) were found to be significant in the area.

Presence of large number of therophytes (annuals or herbaceous vegetation) and phanerophytes (shrubs and trees) indicates semiarid to mixed deciduous type of vegetation structure.



LEGEND

- MINE LEASE BOUNDARY
- VILLAGE
- DISTRICT BOUNDARY
- CONTOUR LINE
- HIGHWAY ROAD
- OTHER ROADS
- RAILWAY LINE
- NADI-NALLA

TOPO SHEET NO: 45 K/9, K/10, K/13, K/14.

● Ecological Sampling Locations

FIGURE-4.9.1
ECOLOGICAL SAMPLING LOCATIONS

TABLE-4.9.3
CLASS WISE DISTRIBUTION OF PLANT SPECIES IN THE STUDY AREA

Groups	**No.**	**%**
Phanerophytes (P)	107	33.44
Therophytes (T)	145	45.31
Hemicryptophytes (He)	55	17.19
Succulents	5	1.56
Epiphytes	2	0.63
Geophytes (G)	6	1.87
Total	**320**	**100**

- ***Comments on the Life Form Spectrum***

Life form spectrum is a reflection of plant community. A plant community is governed by several factors like climatic, edaphic, topographic and biotic. Even local variations in environment affect components of plant community.

The collection and the study of plants of Rajasthan can be traced back to the year 1852 when G.L Allen published a book "The views and flowers from Rajputana". Detailed district wise ecological studies by several researchers from various institutions and universities. Notable among these are those of Ramachandran (1950), Mulay and Ratnam (1951), Ratnam and Joshi (1952), Bakshi (1954), Nair and Nathawat (1956, 1957), Nair and Kanodia (1959), Nair, Kanodia and Thomas(1956), Nair and Malhotra(1961), Nair and Thomas (1962) and Nair and Koshy(1963). Detailed ecological studies conducted by Vyas (1962) and Vyas and Randeo (1964) in Alwar and Kumblagarh areas. Garg (1973), Randeo (1969), Agrawal (1971) and Yunuf (1984) conducted detail ecological studies in and aroung Udaipur hill ranges. The present study has been compared with the regional ecological studies conducted by various researchers and presented data in **Table-4.9.4.** The ratio of the total number of genera to species is 1: 1.49, which is more or less in conformity with whole of India (1:7) and low in compare with gangetic plain region (1:2.2).and high in comparision with western region (1.1.19).

TABLE-4.9.4
COMPARISON OF BIOLOGICAL SPECTRUM WITH REGIONAL SCENARIO

Groups	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	%	%	%	%	%	%	%
Lianes	7.8	8.5	8.2	8.5	1.85	4.74	-
Succulents	-	-	1.2	-	0.96	0.55	0.63
Parasites	-			1.2	1.38	0.27	0.56
Phanerophytes	14.3	40.6	23.6	30.8	25.46	25.97	33.44
Hemicryptophytes	15.5	2.4	7.6	3.5	2.70	-	17.19
Geophytes	-	-	-	-	18.51	-	1.87
Therophytes	40.1	46.71	51.7	42.5	38.50	65.08	45.31
Cryptophytes& Hydrophytes	22.3	1.79	7.7	13.5	10.64	3.39	-
Total number of plants recorded	**538**	**245**	**439**	**600**	**216**	**358**	**320**

1. Western Rajasthan

2. Mount Abu
3. Alwar
4. Gogunda and Prasad
5. Mota Maghra
6. Nahar Maghta
7. Present study

Plot Quadrate Method

This technique is used when only a part of a much larger area is sampled, on the basis of which, the total population of species in the larger area can be estimated

- **Shape and size of Quadrates**

The shape and sizes of the quadrates are selected, derived from previous experiences in undertaking similar studies. The plot quadrate method was adopted to evaluate phyto-sociological parameters like density, diversity and the frequency of the plants. The sizes of the quadrat e were selected on the basis of *species area curve*' and also based on the past experience of undertaking such studies. For the present ecological survey, quadrates of size 10m x 10m were selected for studying the vegetation pattern. About 10-20 quadrates were studied at each location depending upon the species diversity. The findings are presented in the following sections.

4.9.5.2 Phyto-sociological Studies

Herbaceous Vegetation

- **Near Village Kothiya (TE-1)**

This location is at about 4.3 km from centre of mine lease on north east direction. Among the 29 species of 27 genus identified, *Cassia occidentalis, Euphorbia nivula, Datura metal, Euphorbia hirta, Borreria strictus, Jatropha sp, Justicia simplex* and *Tridax procumbens arthenium hysterophorus, Justicia simplex, Cassia occidentalis, Indigofera cordifolia* and *Tridax procumbens* are observed to be dominant at this location. *Cassia occidentalis* (9.48%), *Euphorbia nivula* (8.34%), *Datura metal* (7.22%), *Euphorbia hirta* (7.33%), *Borreria strictus* (6.82%), *Jatropha sp* (6.82%), *Justicia simplex* (6.82%) and *Tridax procumbens* (6.63%) recorded highest relative basal area among all the studied population. The relative density among all the species observed was between 0.35%and 12.23%. The highest relative density observed among the studied species was 12.23% for *Aristida sp* and the lowest of 0.35% for *Phyla nudifloa.* The relative frequency among all the species observed was between 1.74%and 5.22% The highest relative frequency observed among the studied species was 5.22% for *Datura metal* and the lowest of 1.74%for *Justicia simplex* and *Phyla nudiflora.* The Importance Value Index (IVI) estimated for all species varied between 3.15 and 16.64 in the studied populations. The highest IVI was observed for *Aristida sp* (16.64) and the lowest IVI was observed for *Phyla nudiflora* (3.15) **(Table-2.1 of Annexure- XI)**.

- **Near Village Barla (Shahpura) (TE-2)**

This location is at about 10.2 km from centre of mine lease on east south east direction. Among the 27 species of 25 genus identified, *Justicia simplex, Cassia occidentalis, Parthenium hysterophorus, Jatropha sp, Blumea sp* and *Tephrosia purpuria* are observed to be dominant at this location. *Justicia simplex* (10.35%), *Cassia occidentalis* (9.10%), *Parthenium hysterophorus* (8.80%), *Jatropha sp* (8.28%), *Blumea sp* (7.76%) and *Tephrosia purpuria* (7.30%) recorded highest relative basal area among all the studied population. The relative density among all the species observed was between 0.17% and 11.63%. The highest relative density observed among the studied species was 11.63% for *Aristida sp* and the lowest of 0.17% for *Solanum surattensis..* The relative frequency among all the species observed was between 0.92% and 5.50%. The highest relative frequency observed among the studied species was 5.50% for *Cassia occidentalis, Datura metal* and *Parthenium hysterophorus.*The Importance Value Index (IVI) estimated for all species varied between 1.17 and 23.15 in the studied populations. The highest IVI was observed for *Parthenium hysterophorus* (23.15) and the lowest IVI was observed for *Solanum surattensis* (1.17) **(Table-2.3 of Annexure- XI)**.

- **Near Village Barantia (TE-3)**

This location is at about 8.5 km from mine site on south direction. Among the 26 species of 24 genus identified, *Justicia simplex, Phyla nudiflora, Euphorbia nivula, Datura metal, Thymus vulgus* and *Jatropha sp* are observed to be dominant at this location. *Justicia simplex* (10.98%), *Phyla nudiflora* (8.64%), *Euphorbia nivula* (8.05%), *Datura metal* (7.67%), *Thymus vulgus* (7.12%) and *Jatropha sp* (6.59%) recorded highest relative basal area among all the studied population. The relative density among all the species observed was between 0.36% and 11.91%. The highest relative density observed among the studied species was 11.91% for *Brachiorio racemosa* and the lowest of 0.36% for *Sporolobus diander.* The relative frequency among all the species observed was between 0.95% and 5.71%. The highest relative frequency observed among the studied species was 5.71% for *Datura metal and* the lowest of 0.95% for *Cassia tora* and *Tridax procumbens.* The Importance Value Index (IVI) estimated for all species varied between 2.33 and 21.44 in the studied populations. The highest IVI was observed for *Aristida sp (*21.44) and the lowest IVI was observed for *Cassia tora* (2.33) **(Table-2.4 of Annexure- XI)**.

- **Near Village Agucha (TE-4)**

This location is at about 2.7 km fromcentre of mine lease on south southwest direction. Among the 32 species of 30 genus identified, *Crotalaria medicagenia, Cassia occidentalis, Justicia simplex, Euphorbia nivula, Datura metal* and *Jatropha sp* are observed to be dominant at this location. *Crotalaria medicagenia* (13.78%), *Cassia occidentalis* (9.57%), *Justicia simplex* (9.40%), *Euphorbia nivula* (6.89%), *Datura metal* (6.09%) and *Jatropha sp* (5.64%) recorded highest relative basal area among all the studied population. The relative density among all the species observed was from 0.49% to 11.24%. The highest relative density observed among the studied species was 11.24% for *Dactylecterium aegypticum* and the lowest of 0.49% for *Chenopodium album* and *Physalis minima.*The relative frequency among all the species observed was between 0.73% and 6.57%. The highest relative frequency observed among the studied species was 6.57% for *Crotalaria*

medicagenia and the lowest of 0.73% for *Physalis minima.* The Importance Value Index (IVI) estimated for all species varied between 2.47 and 23.93 in the studied populations. The highest IVI was observed for *Crotalaria medicagenia* (23.93) and the lowest IVI was observed for *Xanthium strumarium* (2.47) **(Table-2.5 of Annexure- XI)**.

- **Near Village Rampura (TE-5)**

This location is at about 3.1 km from centre of mine lease on west direction. Among the 28 speciesof 27 genus identified, *Parthenium hysterophorus, Justicia simplex, Cassia occidentalis, Euphorbia nivula, Cassia tora, Alyscarpus moniliformis, Jatropha sp* and *Tridax procumbens* are observed to be dominant at this location. *Parthenium hysterophorus* (11.68%)*, Justicia simplex* (11.48%)*, Cassia occidentalis* (9.04%)*, Euphorbia nivula* (8.42%)*, Cassia tora* (6.91%)*, Alyscicarpus moniliformis* (6.89%)*, Jatropha sp* (6.89%) and *Tridax procumbens* (6.70%) recorded highest relative basal area among all the studied population. The relative density among all the species observed was between 0.37% and 14.74%. The highest relative density observed among the studied species was 14.74% for *Dactylectirium aegypticum and* the lowest of 0.37%for *Blumea sp, Physalis minima* and *Solanum surattensis* .The relative frequency among all the species observed was between 0.93% and 5.61%. The highest relative frequency observed among the studied species was 5.94% for *Cassia tora* and the lowest of 0.93% Physalis *minima.* The Importance Value Index (IVI) estimated for all species varied between 2.49 and 22.91 in the studied populations. The highest IVI was observed for *Parthenium hysterophorus* (22.91) and the lowest IVI was observed for *Solanum surattensis* (2.49) **(Table-2.2 of Annexure- XI)**.

Perennial Vegetation

- **Near Village Kothiya (TE-1)**

Among the 25 species of 23 genus identified, *Dalbergia sissoo, Grewia robustra, Azadirachta indica, Peltoforrum ferrusinum,* Carissa *spinarum* and *Anogeissus pendula* are observed to be dominant at this location. *Dalbergia sissoo* (11.27%)*, Grewia robustra* (8.53%)*, Azadirachta indica* (7.58%)*, Peltoforrum ferrusinum* (7.16%)*,* Carissa *spinarum* (9.84%) and *Anogeissus pendula* (6.16%) recorded highest relative basal area among all the studied population. The relative density among all the species observed was between 1.64% and 9.84%. The highest relative density observed among the studied species was 9.84% for *Carissa spinarum* and the lowest of 1.64% for *Acacia nilotica, Phoenix aculis, Annona muricata, Delonix regia* and *Dendrocalamus strictus.*The relative frequency among all the species observed was between 1.72% and 8.62%. The highest relative frequency observed among the studied species was 8.62% for *Anogeissus pendula* and *Carissa spinarum and* the lowest of 1.72% for *Acacia nilotica,Phoenix aculis, Annona muricata, Delonix regia, Dendrocalamus strictus* and *Prosopis spicegera.* The Importance Value Index (IVI) estimated for all species varied between 4.43 and 24.85 in the studied populations. The highest IVI was observed for *Butea monosperma* and *Carissa spinarum* (24.85) and the lowest IVI was observed for *Delonix regia, Dendrocalamus starictus* (4.43) **(Table-2.6 of Annexure- XI)**.

- **Near Village Barla (TE-2)**

Among the 18 species from 16 genus identified, *Prosopis spicegera, Aergle marmelos, Peltoforrum ferrusinum, Dalberiga sissoo, Grewia robustra, Peltoforrum ferrusinum,* and *Azadirachta indica* are observed to be dominant at this location. *Prosopis spicegera* (3.54%)*, Aergle marmelos* (8.80%)*, Peltoforrum ferrusinum* (7.98%)*, Dalberiga sissoo* (7.92%)*, Grewia robustra* (7.92%)*, Peltoforrum ferrusinum* (7.98%)*,* and *Azadirachta indica* (7.04%) recorded highest relative basal area among all the studied population. The relative density among all the species observed was between 1.49 %and 10.45%. The highest relative density observed among the studied species was 10.45% for *Peltoforrum ferrusinum and* the lowest of 1.49% for *Phoenix aculis* and *Azadirachta indica.*The relative frequency among all the species observed was between 1.69% and 8.47%. The highest relative frequency observed among the studied species was 8.47% for *Peltoforrum ferrusinum* and the lowest of 1.69 for *Phoenix aculis* and *Azadirachta indica.* The Importance Value Index (IVI) estimated for all species varied between 5.58 and 26.90 in the studied populations. The highest IVI was observed for *Peltoforrum ferrusinum* (26.90) and the lowest IVI was observed for *Phoenix aculis* (5.58) **(Table-2.8 of Annexure- XI)**.

- **Near Village Barantia (TE-3)**

Among the 20 species of 18 genus identified, *Azadirachta indica, Grewia robustra, Peltoforrum ferrusinum, Carissa spinarum, Anogeissus pendula, Butea monosperma and Ficus hispida* are observed to be dominant at this location. *Azadirachta indica* (23.36%)*, Grewia robustra* (10.12%)*, Peltoforrum ferrusinum* (6.95%)*, Carissa spinarum* (6.21%)*, Anogeissus pendula* (5.98%), *Butea monosperma* and *Ficus hispida* (5.11%) *recorded* highest relative basal area among all the studied population. The relative density among all the species observed was between 1.72% and 10.34%. The highest relative density observed among the studied species was 10.34% for *Carissa spinarum* and the lowest of 1.72% for *Phoenix aculis, Delonix regia.*The relative frequency among all the species observed was between 1.82% and 9.09%. The highest relative frequency observed among the studied species was 9.09% for *Carissa spinarum* and the lowest of 1.82% for *Phoenix aculis, Delonix regia* and *Prosopis spicegera.* The Importance Value Index (IVI) estimated for all species varied between 4.58 and 33.98 the studied populations. The highest IVI was observed for *Azadirachta indica* (33.98) and the lowest IVI was observed for *Delonix regia* (4.65) **(Table-2.9 of Annexure- XI)**.

- ***Near Village Agucha (TE-4)***

Among the 22 species of 20 genus identified, *Acacia nilotica, Phoenix aculis, Peltoforrum ferrusinum, Dlabergia sissoo, Grewia robustra* and *Azadirachta indica are* observed to be dominant at this location. *Acacia* nilotica (8.99%)*, Phoenix aculis* (8.47%)*, Peltoforrum ferrusinum* (7.81%)*, Dlabergia sissoo* (7.75%)*, Grewia robustra* (7.75%) and *Azadirachta indica* (6.89%) recorded highest relative basal area among all the studied population. The relative density among all the species observed was between 1.35%and 9.46%. The highest relative density observed among the studied species was 9.46% for *Acacia leucophloe* and *Peltoforrum ferrusinum* and the lowest of 1.35% for *Azadirachta indica* and *Dendrocalamus.* The relative frequency among all the species observed was between 1.61% and 8.06%.

The highest relative frequency observed among the studied species was 8.06% for *Peltoforrum ferrusinum and* the lowest of 1.61 for *Azadirachta indica, Dendrocalamus strictus* and *Prosopis spicegera.* The Importance Value Index (IVI) estimated for all species varied between 6.03 and 25.33 in the studied populations. The highest IVI was observed for *Peltoforrum ferrusinum* (25.33) and the lowest IVI was observed for *Dendrocalamus strictus* (6.03) **(Table-2.10 of Annexure- XI)**.

- **Near Village Rampura (TE-5)**

About 21 genus were recorded at the sampling location. Among the 22 species identified, *Peltoforrum ferrusinum, Dalberiga sissoo, Azadiraachta indica, Acacia nilotica* and *Pongamia glabra* are observed to be dominant at this location. *Peltoforrum ferrusinum* (8.76%)*, Dalberiga sissoo* (8.69%)*, Azadiraachta indica* (7.73%)*, Acacia nilotica* (7.30%) and *Pongamia glabra* (7.0%) recorded highest relative basal area among all the studied population. The relative density among all the species observed was between 1.52% and 10.61%. The highest relative density observed among the studied species was 10.61% for *Peltoforrum ferrusinum* and *Pongamia glabra* and the lowest of 1.52%for *Phoenix aculis, Azadirachta indica, Dendrocalamus strictus.* The relative frequency among all the species observed was between 1.72% and 10.34%. The highest relative frequency observed among the studied species was 10.34% for *Pongamia glabra* and the lowest of 1.72% for *Phoenix aculis, Azadirachta, Dendrocalamus strictus* and *Prosopis spicegera.*The Importance Value Index (IVI) estimated for all species varied between 5.87 and 27.99 in the studied populations. The highest IVI was observed for *Peltoforrum ferrusinum* (27.99) and the lowest IVI was observed for *Phoenix aculis* (5.87) **(Table-2.7 of Annexure- XI)**.

4.9.6 Plant Diversity

For better assessing the plant diversity, following different indices were formulated based on the vegetation studies carried out at five locations.

- ***Shannon-Weaver Index***

Shannon-Weaver Index considers two important characters of vegetation *i.e.* floristic richness and the proportional abundance of the species observed. The index is computed as;

Shannon-Weaver Index (H') = - sum (Pi ln Pi)

Where Pi = Proportional abundance of the i^{th} (individual) species.

Table-4.9.5 shows the floristic richness and species diversity indices for all five sampling locations considered in this study.

TABLE-4.9.5
FLORISTIC RICHNESS AND SPECIES DIVERSITY INDICES

Code	Name of the Area	Floristic Richness	Diversity Index
	Shannon-Weaver Index		
	Herbaceous Vegetation		
TE-1	Near Village Kothiya	93.52	2.62
TE-2	Near village Barla	92.50	2.78
TE-3	Near village Barantia	93.20	2.67
TE-4	Near village Agucha	93.60	2.83
TE-5	Near village Rampura	94.50	2.65
	Perennial Vegetation		
TE-1	Near Village Kothiya	69.50	2.65
TE-2	Near village Barla	69.50	2.43
TE-3	Near village Barantia	71.50	2.76
TE-4	Near village Agucha	70.50	2.25
TE-5	Near village Rampura	67.50	2.63

- ***Observations***

The Shannon-Weaver Index for all the five sampling locations was observed to be in the range of 2.62-2.83 and 2.25-2.65 for herbaceous and perennial vegetation. The highest index was observed at TE-4 location for herbaceous and in case of perennial vegetation the lowest is recorded in TE-3, which indicates more species diversity. The lowest index was observed at TE-1 for herbaceous and TE-4 for perennial vegetation, which indicates less species diversity.

4.9.7 Heavy Metal Content in Leaves and Fruits

4.9.7.1 Review of Literature

Heavy metals are natural constituents of earth's crust. They are found in soil, water, air and human food. A number of heavy metals exist in the environment of which only a few are essential for plants and animals. All life on earth depends upon the cycling of matter i.e. (nutrient elements and water) and flow of energy. There are 105 natural elements of which one fourth are known to be essential for living organisms. Of these elements trace metal like Copper, zinc, manganese iron, nickel and molybdenum etc play a significant role in the health and productivity of the living organisms. The details of metal content in the earth crust are presented in **Table-4.9.6**

The classical definition of a metal refers to the physical properties of the elemental state like malleability, ductility and conductivity. In a biological system metals exist as cations. Metals are commonly categorized into metals, heavy metals, essential metals, abundant metals, available metals, trace metals and nutrient metals.

Essential and toxic metals are determined on the basis of physiological effects. Heavy metals are distinguished based on specific gravity and atomic number. Metals having specific gravity > than 5 and atomic number more that 20 are considered as heavy metals.

The term heavy metal is being used in the recent years for the metal, which becomes toxic and hazardous for plants and animals due to their output into the environment as byproducts of anthropogenic activities.

Heavy metals as environmental contaminants of terrestrial ecosystem are not a recent phenomenon. They are ubiquitous in trace concentration in soils and vegetation and in fact many of them are required by plants and animals as micronutrients.

Naturally occurring surface mineralisation produces metal concentrations in soils and vegetation that are higher than those found around man made sources. The urbanization and industrialization associated with mining in the area has produced some amounts of heavy metals, which have become a source of pollution in the terrestrial system. The man-made sources of metal contamination of terrestrial environment are mainly associated with ore benefiation, agricultural practices, automobiles waste, and from atmospheric emissions.

TABLE-4.9.6
TRACE METAL CONCENTRATIONS IN EARTH CRUST

Sr. No	Metal	Concentrations (mg/kg)
1	Antimony	0.20
2	Arsenic	1.80
3	Barium	425.0
4	Beryllium	2.80
5	Cadmium	0.20
6	Chromium	100
7	Cobalt	25.0
8	Copper	55.0
9	Lead	12.50
10	Mercury	0.08
11	Molybdenum	1.50
12	Nickel	75.0
13	Selenium	0.05
14	Silver	0.07
15	Thallium	0.45
16	Vanadium	135.0
17	Zinc	70.00

The major categories of the source of metal contamination of terrestrial environment are recognized as:

- Natural sources such as surface mineralisation, volcanic outgassings, spontaneous combustion or forest fires;
- The use of metal containing agricultural sprays or soil amendments;
- The disposal of wastes from mines or mills;
- Emissions from large industrial sources, such as metal smelters and refineries;
- Emissions from municipal utilities such as coal or oil fired electricity generating stations or municipal incinerators;
- Emissions from moving sources like automobiles; and
- Other relative minor sources of terrestrial contamination like small scale industries

Industrialization has its inevitable effects on pollution of air, water and soil based on type of industry, nature of raw materials used and manufacturing process involved. These pollutants not only hinder the growth of plants but also bring about alteration in physico-chemical properties of the soil as the major site for accumulation of these pollutants in general and heavy metal in particular in terrestrial environments is the soil. Successful growth of plants on polluted soil mainly depends on their capacity to persist in the presence of increasing degree of pollution.

4.9.7.2 Zinc and related Heavy Metals in Study Area

Millions of tons of zinc bearing rocks are excavated from RA Mines. The ore is beneficiated at the beneficiation plant and transported to HZL's smelters where it is refined and converted into zinc and lead metals.

4.9.7.3 Plants and Air Pollution Damage

Shoots and Roots

The generalized plant structure consists of the shoots and root. The shoot is made up of the stem and leaves. This provides a structural framework for plant growth and gives photosynthetic tissues in leaves a favourable exposure to light. Through, water and nutrients from the soil are transported throughout the plant, and organic molecules manufactured in the leaves are moved to the roots and other plant parts. The stem further stores food and gives to the reproductive structure.

Stem tissues are largely protected by the outer cell layers and provide little access for atmospheric gases to the interior. Hence, pollutants rarely affect these tissues. Roots, on the other hand, particularly in the pines, firs and spruces, are normally associated with mychorrhizal fungi that enhance the uptake of water and nutrients. Air pollutants upset the normal carbohydrate balance in the roots, this association may be disrupted and plant growth adversely affected.

Nutrient and water uptake through the roots is generally not influenced directly by air pollutants since they are unlikely to enter the soil atmosphere in significant amounts. However, heavy metals or other toxic components in the soil can be harmful directly, when transported through the plant. These can be deposited on the soil by pollution or they may be made more mobile when present in soil minerals.

Leaf

The leaf is the principal photosynthetic organ of the plant and most subject to the influence of air pollutants. When fully developed the tissues of the stem merge with those of the leaf. The leaf therefore has basically the same tissues as the stem epidermis forms the outer layer, vascular tissue is arranged in veins, and photosynthetic tissue occupies the same region as dead cortex tissue in the stem.

In the leaf, whether net-veined (dicotyledons) or parallel veined (monocotyledons), and conifers), the vascular tissues are so arranged that no part

of the leaf is more than a few cells away from a vein. The veins consist of two cell tissue types: xylem and phloem. The xylem tissues are largely composed of tubular cells that begin to function passively to carry water from the roots to the leaves only after the xylem vessel cell is fully developed and dies. Phloem tissue is composed of living cells that has the capacity to move sugars and other products of photosynthesis to other parts of the plant by active transport.

The ground tissue in a leaf is called mesophyll. In addition to containing the vascular bundles, it is composed of two types of chlorophyll-bearing cells: elongated palisade cells that lie just beneath the upper epidermis, and loosely packed spongy mesophyll below the palisade layer. The center of the each palisade cell is occupied by large vacuole. The living cell contents, or cytoplasm which is filled with chloroplasts, is located in a thin layer near the cell surface. The spongy mesophyll cells are also packed with chloroplasts but lack such a large central vacuole. Air spaces abound within the leaf, both within the palisade layer and especially within the spongy mesophyll. Each cell surface is bathed with water from the nearby vessels-water containing a dilute mixture of nutrients and minerals taken up by the roots from the soil solution.

The cell surface area exposed to air within a leaf is large. This humid internal atmosphere communitcates with the atmosphere outside the leaf through tiny openings called stomata. Each stoma is defined by two lips like guard cells that can swell as their internal water pressure changes, causing the space between them to open. Out side air containing carbon dioxide enters the leaf. Simultaneously oxygen can exit through these openings. Stomata are part of the epidermal tissues of the leaf- a layer of flat largely transparent cells that are often provided with a waxy cuticle. Stomata usually occur on lower leaf surfaces but also may occur on the surface and on most green in herbaceous plants. In woody plant stems the lenticels of the bark perform a similar function of gas exchange

Stomata normally opens in daylight and close at night, during drought or when excessively distrurbed in wild storm. But their behavior is complex, water relations (turgor pressure) extremes of the light intensity and other factors such as carbondioxide concentrations and the pressure of air pollutants can affect them. Stomata are important factors in the sensitivity of and air pollutants plant must pass through them. The epidermis, except at the stomata, is covered by a waxy layer that makes it fairly resistant to the passage of the liquids and gases.

4.9.7.4 Methodology

An analysis was carried out for concentrations of heavy metals in plant leaves and fruits. The metals find their way in plants from the soil and leaves prove a good material to detect their concentration.

Preparation of Material

Mature leaves from different heights of plants were removed. The plants selected for metal analysis are dominant herbs, shrubs and trees in different direction and distances. The leaves were dried among the folds of blotting papers. The papers were changed daily until the leaves were thoroughly dried. Then they were placed in folders made from blotting papers, labelled so as to give information for site,

species name and date of collection and placed in plastic bags. The bags were handed over for analysis.

In every case enough quantity of leaves were collected. The samples were analysed for Lead as Pb, cadmium as Cd, Zinc as Zn, Manganese as Mn and Iron as Fe by using Induced coupled plasma spectrophotometer at central laboratory. The test methods were as per Methods of Analysis of Soils, plants and Water by Hormer d. Chapman and Parker F.prat Division of Agricultural sciences, University of California The details of collection of the samples and list of plant species are presented in **Table-4.9.7.**

TABLE-4.9.7
LIST OF PLANT SPECIES FOR HEAVY METAL ANALYSIS

Direction	Name of Village	Name of the Plant Species
TE-1	Near Village Kothiya	*Prosopis spicegera* *Azadirachta indica* *Dalbergia sissoo*
TE-2	Near village Barla	*Prosopis spicegera* *Azadirachta indica* *Dalbergia sissoo*
TE-3	Near village Barantia	*Prosopis spicegera* *Azadirachta indica* *Dalbergia sissoo*
TE-4	Near village Agucha	*Prosopis spicegera* *Azadirachta indica* *Dalbergia sissoo*
TE-5	Near village Rampura	*Prosopis spicegera* *Azadirachta indica* *Dalbergia sissoo*

4.9.7.5 Results

The plant samples were collected, analysed and results are presented in **Table-4.9.8 to 4.9.13.** The details are as follows

Leaf

- ***Lead***

Lead occurs naturally in all soils. Typically lead concentrations of 200-300 ug/g are not unusual in forested areas usually regarded as pristine. Lead in the USA and Europe continues to accumulate in forest soils far more rapidly than it flows out of the systems. Such accumulation occurs even in relatively unpolluted - forested environments.

The risk from lead is not so much to the plants, which take up very little, but to human health when affected plant parts are consumed. Lead contamination of plants is mostly from atmospheric deposition rather than absorption through the roots. Forage grasses may contain enough lead to threaten the health of grazing animals, but edible crops, being largely washed, pose little threat to humans.

The content of lead is in the ranges between 0.18μg/gm/dw to 0.45 μg/gm/dw in the studied samples. The highest concentration of lead was found to be 0.45 μg/gm/dw recorded in *Azadirachta indica* in village Rampura and lowest (0.18 μg/gm/dw) in *Prosopis spicegera* in village Barla.

- ***Cadmium***

Cadmium has received considerable recent attention as a medical problem causing cardiovascular and hypertension disorders. Cadmium occurs most frequently in association with zinc ores but is otherwise among the rarest metals in the earth's crust. Atmospherics sources are principally metal processing, fertilizers and industrial processes containing zinc, pesticides. Sewage also is high in cadmium and its use in soils has led to considerable study. Deposited on plants or soil, cadmium enters the food chain by uptake through the roots or leaves. Root uptake is greatest in acid soils.

Plant toxicity by cadmium first consists of reduced photosynthesis and transpiration rates, followed by general chlorosis. Such injury occurs only at concentrations well above those generally occurring even in contaminated area, which are rarely above 5-10 ug/g of topsoil. Normal background concentrations of cadmium in foliage are mostly well under 1 ppm on a dry weight basis. Concentrations vary among the plant parts, being greatest in leaves. Vertical differences in uptake and sensitivity also have been demonstrated.

The content of cadmium is in the range 0.001μg/gm/dw to 0.004 μg/gm/dw in the studied samples. The highest concentration of cadmium was found to be 0.004μg/gm/dw recorded in *Dalbergia sissoo* in village Rampura and lowest (0.001μg/gm/dw) in *Azadirachta indica, Prosopis spicegera* and *Dalbergia sissoo* in villages Kothiya, Barla and Barantia.

- ***Zinc***

Zinc is a micronutrient required in trace amounts essential to normal growth. In excess they can be harmful. As particulates their dispersal is limited to the proximity of the source. With current controls in modern smelters, direct pollution from these elements is largely historical. Greater concern with Zinc and copper comes from prolonged application in fungicidal treatments. Toxicity involves interference with normal metabolic reactions, blocking specific enzymatic reactions, and ultimately suppressing growth.

The content of Zinc is in the range 0.54 μg/gm/dw to 2.69 μg/gm/dw in the studied samples. The highest content of zinc was found to be 2.69μg/ gm/dw recorded in *Azadirachta indica* in village Rampura and lowest (0.54μg/gm/dw) in the species of *Azadirachta indica* in village Kothiya.

- ***Copper***

The content of copper is in the range 0.15μg/gm/dw to 0.89 μg/gm/dw in the studied samples. The highest content of copper was found to be 0.89μg/ gm/dw recorded in the *Azadirachta indica* in village Rampura and lowest (0.15μg/gm/dw) in the species of *Dalbergia sissoo* in village Barantia.

- ***Iron***

The content of iron is in the range 3.50 μg/gm/dw to 8.52 μg/gm/dw in the studied populations. The highest of iron was found to be 8.52 μg/gm/dw recorded in *Azadirachta indica* in village Rampua and lowest (3.50μg/gm/dw) in *Azadirachta Indica* in village Barla.

- ***Manganese***

The content of Manganese is in the range 3.50 μg/gm/dw to 7.50 μg/gm/dw in the studied plant materials. The highest concentration of Manganese was found to be 7.5 μg/gm/dw recorded in the species *Dalbergia sissoo* in village Agucha and lowest (3.50 μg/gm/dw) in the species of *Prosopis spicegera* in village Barla.

TABLE-4.9.8
CONCENTRATION OF LEAD IN LEAVES STUDY AREA (μg/gm/dw)

Sr. No	Name of the plant	Kothiya	Barla	Barantia	Agucha	Rampura
1	*Prosopis spicegera*	0.21	0.18	0.21	0.25	0.31
2	*Azadirachta indica*	0.32	0.19	0.25	0.39	0.45
3	*Dalbergia sissoo*	0.19	0.14	0.21	0.29	0.26

TABLE-4.9.9
CONCENTRATION OF CADMIUM IN LEAVES STUDY AREA (μg/gm/dw)

Sr. No	Name of the plant	Kothiya	Barla	Barantia	Agucha	Rampura
1	*Prosopis spicegera*	0.001	0.001	0.001	0.003	0.003
2	*Azadirachta indica*	0.002	0.001	0.002	0.002	0.002
3	*Dalbergia sissoo*	0.001	0.002	0.001	0.003	0.004

TABLE-4.9.10
CONCENTRATION OF ZINC IN LEAVES STUDY AREA(μg/gm/dw)

Sr. No	Name of the plant	Kothiya	Barla	Barantia	Agucha	Rampura
1	*Prosopis spicegera*	0.75	0.54	0.81	1.49	1.52
2	*Azadirachta indica*	0.54	0.98	0.75	2.21	2.69
3	*Dalbergia sissoo*	0.56	0.78	0.69	1.26	1.69

TABLE-4.9.11
CONCENTRATION OF COPPER IN LEAVES STUDY AREA (μg/gm/dw)

Sr. No	Name of the plant	Kothiya	Barla	Barantia	Agucha	Rampura
1	*Prosopis spicegera*	0.65	0.51	0.29	0.59	0.85
2	*Azadirachta indica*	0.59	0.87	0.78	0.64	0.89
3	*Dalbergia sissoo*	0.25	0.21	0.15	0.51	0.36

TABLE-4.9.12
CONCENTRATION OF IRON IN LEAVES STUDY AREA (µg/gm/dw)

Sr. No	Name of the plant	Kothiya	Barla	Barantia	Agucha	Rampura
1	*Prosopis spicegera*	5.21	5.21	4.25	5.98	6.51
2	*Azadirachta indica*	7.55	3.50	3.90	3.98	8.52
3	*Dalbergia sissoo*	6.2	5.50	4.50	5.20	6.80

TABLE-4.9.13
CONCENTRATION OF MANGANESE LEAVES IN STUDY AREA (µg/gm/dw)

Sr. No	Name of the plant	Kothiya	Barla	Barantia	Agucha	Rampura
1	*Prosopis spicegera*	5.60	3.50	3.95	4.50	6.20
2	*Azadirachta indica*	6.98	5.21	4.55	5.25	7.21
3	*Dalbergia sissoo*	4.65	4.50	5.50	7.5	6.50

4.9.8 Plants of Economic Importance

Cultivated plants provide valuable food resources to mankind like cereals, millets, vegetables, pulses, fruits, fodder, timber and wood for agricultural implements. In addition to these the following **cultigens** are present in the study area. The list of major economic importance plants is presented in **Table-1 of Annexure- XI.**

Cereals

- *Sorghum vulgare (wheat)*
- *Zea mays* (maize)
- *Pennisetum typhoideum*

Millets

- *Sorghum* spp. (jowar)

Pulses

- *Cajanus cajan* (pigeon pea)
- *Cicer aerietinum* (gram)
- *Pisum sativum* (peas)
- *Phaseolus* sp. (beans)
- *Dolichos liflorites(Horsegram)*
- *Vigna cating* (Cowgram cowpea)

Vegetables (leafy)

- *Hibiscus cannabis*
- *Spinacia oleracea* (spinach)

- *Trigonella foenum-graceum* (fenugreek)
- *Amaranthus viridis* (math)
- *Allium cepa* (onion)
- *Allium sativum* (garlic)

Vegetables (fruit)

- *Solanum melongena* (egg plant)
- *Momordica charantia* (Bitter gaurd)
- *Lycopersium esculentum* (tomato)
- *Trichosanthes anguina* (Ridge gaurd)
- *Trapa bispinosa* (Singhara)
- Hybiscus esculentus(Ladies finger)
- Carica papaya (Pappali)
- *Cucumis melo* (pumpkin)

Vegetables (roots)

- *Raphanus sativus* (radish)
- *Daucas carota* (carrot)

Fruits

- *Carica papaya* (papaya)
- *Cucurbita* spp.
- *Tamarindus indica* (tamarind)
- *Anona muricata(Ramaphal*)
- *Annona squamos(* Sithaphal)
- *Carrisa congesta* (karonda)
- *Arachis hypogea* (groundnut)
- *Citrus lemon* (lemon)
- *Psidium guava* (Guava)
- *-Mangifera indica* (aam)

4.9.9 Endangered Plants

The study area did not record the presence of any critically threatened species. The records of Botanical Survey of India and Forest Department also did not indicate presence of any endangered and or vulnerable species in this area.

4.9.10 Terrestrial Fauna and Ornithology

4.9.10.1Review of Secondary Published Data

Wildlife being an important strand in the complex food web in most of the forest ecosystems, its status symbolises the functioning efficiency of the entire ecosystem. The forest management therefore, cannot be isolated from wood exploration and wild life conservation in the same vulnerable vegetation complex. Just as wild flora needs special treatment for preservation and growth, wild fauna as well deserves specific conservatory pursuits for posterity. Unfortunately, our past efforts had been unscientific in rearing and persevering our valuable heritage resulting in dwindling of many interesting species, which the nature had bestowed on us. The broad spectrum of colorful fauna is fading and some species are facing extinction.

Environmental changes through deforestation, spreading urbanization and destruction of habitats have been of alarmingly high magnitute during the recent past, which has totally disturbed the balance between mortality and reproduction. Some threatened faunal forms are biologically handicapped through an imbibed low rate of reproduction by nature. Fragmentation of population also weakens the vitality of the species due to rarity and normal reproduction process is thwarted leading to extinction.

Wildlife Sanctuaries and National Parks in Study area

As per forest department of Bhilwara, and through literature survey, there are no wildlife sanctuaries and national park in 10 km and 25 km radius of the mine lease boundary.

4.9.10.2 Primary Survey

- ***Local/ Migratory Birds in Study Area***

Among the identified birds, the Indian myna, Common myna are the local migratory birds, which are observed and which are also reported by the Forest Department, The study area does not fall in the migratory bird paths.of the region. A detailed list of avifauna observed during field's visits from five sampling locations where AAQ monitoring studies were conducted is presented in **Table-4.9.14.**

TABLE-4.9.14
LIST OF BIRDS OBSERVED AT ALL SAMPLING LOCATIONS

Technical Name	English Name/ Local Name	Remarks
Acridotheres tristicus	Common myna	Observed
Alcedo athis	Common kingfisher	Observed
Anas acuta	Common Teal	Rare
Athene brama	Spotted owlet	Observed
Bubo bubo	Indian Great horned Owl	Observed
Bubulcus ibis	Cattle Egret	Observed
Caprimulgus asiaticus	Common Indian jar	Observed
Columbus livibus	Rock Pigeon	Observed
Corvus splendens	House Crow	Observed

Technical Name	English Name/ Local Name	Remarks
Egretta garzetta	Little Egret	Common
Haliastur indus	Brahmny kite	Observed
Meops phillipinus phillipinus	Blue tailed bee eater	Rare
Microfus affinis	House swift	Observed
Nectarinia asiatica	Purple sunbird	Observed
Oriolus oriolus	Indian Oriole	Observed
Passer domisticus	House Sparrow	Observed
Ploceus philippines	Weaver bird	Observed
Pycnonotus cafer	Red vented Bulbul	Observed
Pycnonotus jokokus	White browed Bulbul	Observed
Temenuchus pagodarum	Brahmny Myna	Observed
Turdoides striatus	White headed Babler	Observed

- ***Butterflies***

A total of 8 species of butterflies identified and observed during the study period. These varieties of butterflies are commonly observed species in agricultural fields and forest areas. The list of butterflies observed in the study area is presented in **Table-4.9.15.**

TABLE-4.9.15
LIST OF BUTTERFLIES OBSERVED AT ALL THE SAMPLING LOCATIONS

Order	Family	Common name	Scientific name
		Tailed jay	*Graphium agamemnon Lin.*
	Nymphalidae	Peacock pansy	*Junoria almana Lin.*
		Great eggfly	*Hypolimnas bolina Lin.*
		Common crow	*Euploea core Cramer*
		Common sailor	*Neptis hylas Moore*
	Pieridae	Common grass yellow	*Eurema hecabe Lin.*
		Emigrant	*Catopsilia sp.*
	Danaidae Satyridae	Glassy tiger	*Parantica aglea Stoll.*

- ***Mammals***

There is no major wildlife in the study area. The commonly observed or reported mammals are presented in **Table-4.9.16.**

TABLE-4.9.16
MAMMALS RECORDED IN THE STUDY AREA

Sr. No.	Common Name	Zoological Name
1	Rat	*Rattus sp.*
2	Hare	*Lepus nigricollis*
3	Hyaena	*Hyaena hyaena*
4	Jackal	*Canis auries*
5	Langur	*Presbytis entellus*
6	Monkey	*Rhesus macaca*
7	Squirrel	*Funambulus spp.*
8	Squirrel	*Funambulus palmarum*
9	Field mouse	*Rattus norvegicus*

Sr. No.	Common Name	Zoological Name
10	House rat	*Rattus rattus*
11	Bat	*Rhinolopus spp.*
12	Bat	*Hipposiderus spp.*
13	Common mongoose	*Herpestes edwardii*
14	Bandicoot	*Bandicota indica*
15	Bandicoot	*Bandicota bengalensis*
16	Common fox	*Vulpus benghalensis*
17	Blue Bull or Nilgai	*Bosephalus tragocamelus*

- ***Amphibians and Reptiles***

Frogs and snakes were present in this area. No tailed amphibians were cited in the survey. **Table-4.9.17** gives the details of different amphibians and reptiles in the study area.

TABLE-4.9.17
AMPHIBIANS AND REPTILES IN THE STUDY AREA

Sr. No.	Common Name	Zoological Name
	Amphibians	
1	Common frog	*Rana tigriana*
	Reptiles	
2	Common garden lizard	*Calotes versicolor*
3	Indian chamaeleon	*Chamaleon zeylanicus (Laurenti)*
4	Rat snake	*Boiga spp.*
5	Krait	*Bangarus spp.*
6	Cobra	*Naja naja*
7	Viper	*Vipera spp.*

4.9.10.3 Endangered Animals

A comprehensive Central Legislation namely Wild Life (Protection) Act was enforced in 1972. This law is enacted to provide protection to wild animals and for all matters related to their ancillary or incidental death. Schedule-I of this act contains the list of rare and endangered species, which are completely protected throughout the country. The list of wild animals and their conservation status as per Wild Life Act (1972) are presented in **Table-4.9.18.**

On comparison of the check list given in the Schedule-I to Schedule-V of the Wildlife Act (1972) and the list of wildlife recorded in the study area, it can be concluded that there are no major endangered animals (Mammals) in the study area and presence of schedule-II, III and IV listed animals recorded in the study area.

4.9.10.4 Wild Life Conservation

Flora and faunal data was collected from Forest Working Plans (1994-1999) of Bhilwara forest division. Detailed field observations and interactions with local villagers and local hamlet heads reveal that there is no major wildlife in study area. Presence of good number of avifauna belongs to Schedule-IV could be due to local vegeational structure developed by mine authorities in and around the mine and colony area.

The schedules of Wild life Act (1972) classify the species such as rare, endangered, threatened, vulnerable etc. According to degree of threat of extinction Schedule-I contains those species, which need topmost priority, while II, III, IV and V have lesser degree of threat. Most of the avi-fauna are listed in Schedule–IV. As per the list of avi-faunal species, these are mostly local migrant species only. As per recent forest working plans and discussion with local Forest officials, there are no migratory paths are reported from the study area.

TABLE-4.9.18
FAUNA AND THEIR CONSERVATION STATUS IN THE STUDY AREA

Technical Name	English Name/ Local Name	Distribution	Wild Life Act (1972)
Aves			
Corvus corvus	Jungle crow	Common	Sch-IV
Corvus splendens	House crow	Common	Sch-V
Turdoides striatus	White headed babler	Common	Sch-IV
Pycnonotus cafer	Red vented bulbul	Common	Sch-IV
Pycnonotus jokonus	White browed Bulbul	Common	Sch-IV
Gallus gallus	Red Jungle fowl	Common	Sch-IV
Bubo bubo	Indian great horned Owl	Common	Sch-IV
Lalage sykesi	Black headed cochoo Shrike	Common	Sch-IV
Dicrurus macrocerus	Black Drongo	Common	Sch-IV
Oriolus oriolus	Indian Oriole	Common	Sch-IV
Temenuchus pagodarum	Brahmny Myna	Common	Sch-IV
Acridotheres tristicus	Common myna	Common	Sch-IV
Ploceus Philippines	Weaver bird	Common	Sch-IV
Passer domisticus	House Sparrow	Common	Sch-IV
Cinnyris lotensis	Loten's sunbird	Common	Sch-IV
Megalaima merulinus	Indian Cuckoo	Common	Sch-IV
Hierococys varius	Common Hawk Cuckoo	Common	Sch-IV
Centropus sinensis	Crow Pheasant	Common	Sch-IV
Coryllis vaeralis	Lorikeet	Common	Sch-IV
Merops leschenaultia	Chestnut headed Bee Eater	Common	Sch-IV
Alcedo atthis	Common Kingfisher	Common	Sch-IV
Microfus affinis	House swift	Common	Sch-IV
Caprimulgus asiaticus	Common Indian jar	Common	Sch-IV
Haliastur Indus	Brahmny kite	Common	Sch-IV
Bubulcus ibis	Cattle Egret	Common	Sch-IV
Egretta garzetta	Little Egret	Common	Sch-IV
Anas acuta	Common Teal	Rare	Sch-IV
Nycteria leucopcephala	Painted stork	Observed	Sch- IV
Anas cresa	Common teal	Observed	Sch- IV
Psittacula Krameri	Rose ringed parakeet	Observed	Sch- IV
Micropterus brachyrus	RufoursWoodpecker	Observed	Sch- IV
Podiceps yuficolis	Little grebe	Observed	Sch- IV
Nectarinia asiatica	Purple sunbird	Observed	Sch- IV
Meops phillipinus phillipinus	Blue tailed bee eater	Rare	Sch-IV
Reptiles			
Calotes versicolor	Common garden lizard	Rare	Sch-IV
Chamaleon zeylanicus (Laurenti)	Indian chamaeleon	Common, villages	Sch-IV
Boiga spp	Rat snake.	Common	Sch-III
Bangarus spp	Krait.	Rare, plantations	Sch-III
Naja naja	Cobra	Rare	Sch-II
Vipera spp.	Viper	Rare	Sch-II
Butterflies			

Technical Name	English Name/ Local Name	Distribution	Wild Life Act (1972)
Papilo demoleus	Lime butterfly	Common	-
Graphium agamemnos	Tailed jay	Common	-
Papilo polymnstor	Blue mormon	Common	-
Juninia almanac	Peacock pansey	Occasional	-
Neptis hylas	Common sailor	Common	Sch-IV
Parantica aglea	Glassy tiger	Common	Sch-IV
Amphibia			
Rana hexadactyla	Frog	Common	Sch-IV
Mammals			
Lepus nigricollis	Hare	Common	Sch-III
Hyaena hyaena	Hyaena	Common	Sch-III
Jackal	Canis auries	Common	Sch-III
Langur	Presbytis entellus	Common	Sch-II
Monkey	*Rhesus macaca*	Common	Sch-II
Squirrel	Funambulus spp.	Common	Sch-IV
Squirrel	Funambulus palmarum	Common	Sch-IV
Field mouse	Rattus norvegicus	Common	Sch-IV
Common mongoose	Herpestes edwardii	Observed	SCh-II
Bandicoot	Bandicota indica	Common	Sch-IV
Bandicoot	Bandicota bengalensis	Common	Sch-IV
Common fox	Vulpus benghalensis	Observed	Sch-III
Blue Bull or Nilgai	Bosephalus tragocamelus	Common	Sch-III

4.9.11 Biodiversity of Rampura Agucha Mines

Rampura agucha mine is located at 70 km north of Bhilwara. Rampura agucha is the captive mine for HZL and is the largest and richest lead zinc deposit in the country. The mine currently produces 5.0 Mtpa of ore and has matching state of art beneficition plant, which is near to mine area. The total mine lease area is about 1200 hectates, out of which only 850 ha land is acquired. Which consists of 240.7 ha land (28% of the total area) in the form of greenbelt. HZL has continuously been developing green belt in the mine, beneficition plant and colony area.

Recently Indian Council of Aricultural Research Institute (ICAR) has classified the entire country into 129 agroclimatic zones. As per the above classification, Bhilwara district falls under southern plains of Aravalli hills with average rainfall of about 450 mm, semiarid region having red and yellow grey brown types of soils. A detailed primary survey has been conducted to assess the floric and faunistic components of the area and presented in **Table-4.9.19.** The detailed list of plant and animals species recorded are presented in **Table-4.9.20** and also surrounding areas presented in **Table-4.9.20.**

TABLE-4.9.19
PLANTS AND ANIMALS RECORDED IN RAMPURA AGUCHA MINES

Sr.No	Mine Area	Local Name
	Flora	
1	*Dalbergia sissoo*	Shisham
2	*Poincenia Regia*	Gulmohar
3	*Bambusa Arundinacea*	Bamboo
4	*Cassia Siama*	Cassia Siamea
5	*Butea frondosa*	Gadhapalas
6	*Pongamia Glabra*	Karanj
7	*Peltoforrum ferrusinum*	Peltaferrum
8	*Terminalia Arjuna*	Arjuna

Sr.No	Mine Area	Local Name
9	*Hibiscus Spp*	China Rose
10	*Nerium indica*	Kaner
12	*Aegle marmelos*	Bilpatra
13	*Moringa Pterygosperma*	Sejana
14	*Leucena leucophloe*	Subbabool
15	*Albizzia Lebbek*	Siris
16	*Euclayptus Spp*	Eucalyptus
17	*Melia Azederach*	Bakain
18	*Sesbania suevalens*	Kanui Churhel
19	*Bouganvillea Spp*	Bouganvillea
20	*Azardichta Indica*	Neem
21	*Cassia Fistula*	Amaltas
22	*Prosopis spicegera*	Kiker
23	*Parkinsonia sp*	Parkinsonia
24	*Cassia Javanica*	Cassia javanica
25	*Polyalthia longifolia*	Ashoka
26	*Orodoxia regia*	Bottle palm
27	*Ficus Religiosa*	Pipal
28	*Ficus Bengalensis*	Bad Banvan
29	*Thespesia Populeama*	Paras Pipal
30	*Casuarinas equisetifolia*	Casurina
31	*Thevetia peruviana*	Dalmoth
32	*Prosopis Julifora*	Juliflora
33	*Acacia Arabica*	Babool
34	*Callistemon Lanceolatus*	Bottle Brush
35	*Pedalium sp*	Cess Suloa
36	*Ricinus communicus*	Castor
37	*Prosopis cineraria*	Khejra
38	*Delonix regia*	Kachnar
39	*Butea Frondosa*	Dhak/Dhakara
40	*Acaca nilotica*	Acacia
41	*Millingtonia neem*	Akashneem
42	*Alstonia scholaris*	Saptparni
	Fauna	
1	*Corvus splendens*	Jungle
2	*Columbus livibus*	House crow
3	*Acridotheres tristicus*	Common myna
4	*Ploceus philippines*	Weaver's bird
5	*Alcedo atthis*	Common kingfisher
6	*Microfus affinis*	House swift
7	*Caprimulgus asiaticus*	Common Indian Jar
8	*Merops orientalis*	Common green bee eater
9	*Psittacula Krameri*	Rose ringed parakeet
10	*Nectarinia asiatica*	Purple sunbird
	Minor fauna	
1	*Herpeters edwardii*	Common mongoose
2	*Funumbulus palmarum*	Squirrel

TABLE-4.9.20
PLANTS AND ANIMALS RECORDED IN COLONY AND ITS ENVIRONS

Sr.No	Technical Name	Technical Name
	Colony area	Rampura area
1	*Citrus Lemon*	*Tamarindus indica*
2	*Carissa carandus*	*Eugenia jumbolina*
3	*Tamarindus Indica*	*Dalbergia sissoo*
4	*Euphorbia officinalis*	*Delonix regia*
5	*Carica ppaya*	*Pongamia glabra*
6	*Zyphus Mauritiana*	*Albizia lebbeck*
7	*Euginea Jambolana*	*Azadirachta indica*

Sr.No	Technical Name	Technical Name
8	*Morus Alba*	*Parkinsonia sp*
9	*Punica Granatum*	*Prosopis julifera*
10	*Psidium guava*	*Prosopis julifera*
11	*Cordia Rothi*	*Acacia nilotica*
12	*Mangifera indica*	*Butea frondosa*
13	*Annona Squamosa*	*Acacia sp*
14	*Parkinsonia sp*	
15	*Prosopis julifera*	
	Birds	
1	*Acridotheres tristicus*	*Acridotheres tristicus*
2	*Ploceus Philippines*	*Ploceus philippines*
3	*Merops leschenaulti*	*Merops leschenaulti*
4	*Alcedo atthis*	*Alcedo atthis*
5	*Microfus affinis*	*Microfus affinis*
6	*Caprimulgus asiaticus*	*Caprimulgus asiaticus*
7	*Pavo cristatus*	*Pavo cristatus*
8	*Athene brama*	*Athene brama*
9	*Alcedo athis*	*Alcedo athis*
10	*Merops orientalis*	*Merops orientalis*
11	*Nycteria leucopcephala*	*Anhinga rufa*
12	*Anas cresa*	*Nycteria leucopcephala*
13	*Psittacula Krameri*	*Anas cresa*
14	*Micropterus brachyrus*	*Psittacula Krameri*
15	*Podiceps yuficolis*	*Micropterus brachyrus*
16	*Nectarinia asiatica*	*Podiceps yuficolis*
17	*Corvus splendens*	*Nectarinia asiatica*
18	*Columbus livibus*	*Corvus splendens*
19	*Bubo bubo*	*Columbus livibus*
20	*Ploceus Philippines*	*Bubo bubo*
21	*Passer domisticus*	*Ploceus philippines*
22	*Dicrurus macrocerus*	*Passer domisticus*
23	*Oriolus oriolus*	*Dicrurus macrocerus*
24	*Caprimulgus asiaticus*	*Oriolus oriolus*
	Minor Fauna	*Caprimulgus asiaticus*
1	*Herpeters edwardii*	*Cinnyris lotensis*
2	*Funumbulus palmarum*	
		Herpeters edwardii
		Hystrix indica
		Funumbulus palmarum

As on today, about 275550 plants are planted and these are growing healthily in colony, plant and mine areas. Apart from this, a good percentage of regeneration of plants could be seen in colony and the plant area. The major plant species in the area are presented in **Table- 4.9.21**.

TABLE-4.9.21
DETAILS OF GREEN BELT

Sr. No.	Local Name/Hindi	Technical Name	No. of Saplings Planted (upto 2008-2009)
Mine lease area			
1	Shisham	*Dalbergia sissoo*	41781
2	Gulmohar	*Poinciana Regia*	9516
3	Bamboo	*Bambusa Arundinacea*	10428
4	Cassia Siamea	*Cassia Siama*	16614
5	Gadhapalas	*Butea frondosa*	50
6	Karanj	*Pongamia Glabra*	9714
7	Peltaferrum	*Peltoforrum ferrusinum*	5528
8	Arjuna	*Terminalia Arjuna*	80

Sr. No.	Local Name/Hindi	Technical Name	No. of Saplings Planted (upto 2008-2009)
9	China Rose	*Hibiscus Spp*	110
10	Kaner	*Nerium indica*	2100
11	Bilpatra	*Aegle marmelos*	150
12	Sejana	*Moringa Pterygosperma*	1100
13	Subbabool	*Leucena leucophloe*	16988
14	Siras	*Albizzia Lebbek*	18198
15	Eucalyptus	*Euclayptus Spp*	15438
16	Bakain	*Melia Azederach*	350
17	Kanui Churhel	*Sesbania suevalens*	3835
18	Bouganvillea	*Bouganvillea Spp*	1845
19	Neem	*Aeardichta Indica*	15199
20	Amaltas	*Cassia Fistula*	3872
21	Kiker	*Prosopis spicegera*	18426
22	Parkinsonia	*Parkinsonia*	6698
23	Cassia javanica	*Cassia Javanica*	20
24	Ashoka	*Polyalthia longifolia*	610
25	Bottlepalm	*Orodoxia regia*	253
26	Pipal	*Ficus Religiosa*	267
27	Bad Banvan	*Ficus Bengalensis*	133
28	Paras Pipal	*Thespesia Populeama*	1735
29	Casurina	*Casuarinas equisetifolia*	400
30	Dalmoth	*Thevetia peruviana*	100
31	Juliflora	*Prosopis Julifora*	5825
32	Babool	*Acacia arabica*	18978
33	Bottle Brush	*Callistemon Lanceolatus*	905
34	Cess Suloa	*Pedalium sp*	140
35	Castor	*Ricinus communicus*	30
36	Khejra	*Prosopis cineraria*	375
37	Kachnar	*Delonix regia*	324
38	Dhak/Dhakara	*Butea Frondosa*	2089
39	Acacia	*Acaca nilotica*	2900
40	Akashneem	*Millingtonia neem*	80
41	Saptparni	*Alstonia scholaris*	70
41	Karonda	*Carissa carandus*	286
42	Imli	*Tamaraindus indica*	460
43	Ber	*Zyphus Mauritiana*	660
44	Jamun	*Euginea Jambolana*	2000
45	Aam	*Mangifera indica*	500
46	Amla	*Euphorbia officinalis*	40
47	Ratanjot	*Jatropha Curcas*	250
		Total	**237700**
Colony Area			
1	Lemon	*Citrus Lemon*	200
2	Karonda	*Carissa carandus*	1814
3	Imali	*Tamarindus Indica*	8560
4	Amla	*Euphorbia officinalis*	710
5	Papaya	*Carica ppaya*	415
6	Ber	*Zyphus Mauritiana*	3800
7	Jamun	*Euginea Jambolana*	15641
8	Mulberry	*Morus Alba*	65
9	Pomegranate	*Punica Granatum*	250
10	Guava	*Psidium guava*	250
11	Gonda	*Cordia Rothi*	50
12	Mango	*Mangifera indica*	65
13	Custard Apple	*Annona Squamosa*	1090
14	Shisham	*Dalbergia sissoo*	2200
15	Neem	*Aeardichta Indica*	2740
		Total	**33850**
		Grand Total	**275550**

4.9.12 Summary

Detailed ecological studies were conducted to assess the present biological resources in and around mine lease area of HZL- Rampura. 320 plants species were recorded during study period. *Cassia occidentalis, Datura metal, Jatropha sp, parthenium hysterophorus, Tridax procumbens* and *Physalis minima* are the herbaceous species and *Azadirachta indica, Peltoforrum ferrusinum, Carissa spinarum, Anogeissus pendula, Phoenix aculis* and Butea monosperma of perennial vegetation and also manily dominated by Therophytes followed phanerophytes. Heavy metal content in plant leaves estimated from five locations reveals that presence of heavy metals especially for Lead and Zinc basically originated from local geological formation and also from traffic volume in study area. Primary faunal studies were conducted in five locations and no major wild life exists in study area. Literature survey and data collected from forest department reveals that there are no wildlife sanctuaries, national parks and biospheres and no migratory paths in 10 km radius.As per Indian council of Agricultural institute classification, the study area falls under southern plains of Aravalli hills with average rainfall of about 400 mm and semiarid region. About 260 hectares of land of Rampura Agucha is converted into greenbelt by planting 272000 plant species and these plants growing in good health in mine lease area, plant premises and colony areas. The detailed flora and fauna, duly authenticated, separately for core and buffer zone is furnished from the Govt. of Rajasthan and is enclosed as **Appendix-I** of **Annexure-XI**.

4.10 Land use Studies

Studies on land use aspects of eco-system play important role in identifying sensitive issues and to take appropriate action to maintain `Ecological Homeostasis in the region. The main objective of this section is to provide a baseline status of the study area in order to assess the existing environmental and social status of the study area, which could pave way for assessing the temporal changes that are likely to result after the proposed enhancement of mines and associated activities in the years to come.

4.10.1 Objectives

The objectives of land use studies are:

- To determine the present land use pattern;
- To forecast the likely changes in the land use pattern in future due to the mining and other activities in future after enhancement;
- To analyze the impacts on land use after the proposed capacity expansion of mines in the study area; and
- To give recommendations for optimizing the future land use pattern in the study area and mitigating the adverse impacts if any due to the proposed enhancement and its associated impacts.

4.10.2 Methodology

The land use of the study area is studied by analyzing the available secondary data such as the District Primary Census Handbooks of Bhilwara and Ajmer districts for the year 2001.The village-wise land use pattern of the study area is presented in **Annexure - XII.**

For computation of the land use pattern in the study area based on the village-wise land-use data given in the census records, the geographical area of all settlements covered within the study area are taken, though many villages in the peripheries of the study area are partially covered. Perfect delineation and quantification of land uses for the partially covered parts of villages in the study area is not possible, hence the entire village area is considered for the study, irrespective of its coverage within the study area circle. As per the census records, the entire geographical area of all rural settlements covered in the study area works out to about 50456 ha.

The land use is classified into four types - viz. forests, area under cultivation, culturable waste and the area not available for cultivation. The land under cultivation is further sub-divided into two types viz. irrigated and un-irrigated.

The land-use pattern of the study area based on 2001 census is given in **Table-4.10.1** and shown in **Figure-4.10.1**.

TABLE-4.10.1
LANDUSE PATTERN IN THE STUDY AREA- AS PER 2001 CENSUS

Sr. No.	Particulars	Study Area (ha)	Area (%)
1	Forest Land	266.74	0.52
2	Land under Cultivation		
	a) Irrigated Land	8208.35	16.27
	b) Un irrigated Land	17019.18	33.73
3	Culturable Waste Land	13988.43	27.73
4	Area not available for cultivation	10973.39	21.75
	Total Area	**50456.09**	**100.00**

Source: District Primary Census Hand Books – Bhilwara and Ajmer Districts, 2001

4.10.2.1 Forests

Forest occupies a small portion of the study area. Major part of the existing forest is in the study area parts of Bhilwara district followed by Ajmer district. The forest stretches of the study area are not having any defined major vegetation and are of only scattered bushes of thorny plants. The forest area in the study area is about 266 ha, which works out to only about 0.52% of the total area.

4.10.2.2 Land Under Cultivation

Altogether 25227 ha area comprising of irrigated and un-irrigated lands, is used for cultivation in the study area. This works out to about 50% of the study area, which is a moderate extent in comparison with other areas of Rajasthan state. The irrigated land is about 8208 ha and works out to be about 16.27% of the study area. Major sources of irrigation for these irrigated lands are wells, tube wells, Khari and Mansi rivers. The un-irrigated land is about 17019 ha and works out to about 33.73% of the study area.

4.10.2.3 Culturable Waste

This category of land mainly consists of the lands suitable for cultivation, which however have not been brought under cultivation at any time.

Almost one fourth of the study area falls in this category of land and admeasures about 13988 ha which works out to about 27.73% of the study area. The existing share of this category of lands in the study area indicates that the land in the study area is poorly utilized for cultivation purposes. The prevalence of drought conditions for major part of the year may be the main reason for leaving the cultivable lands unused for cultivation purposes.

4.10.2.4 Land not Available for Cultivation

The areas not covered under any of the above land use categories form this type of land use. Altogether 10973 ha land in study area is not available for cultivation. The share of this category of land in the study area works out to about 21.75% that is considerably high. The existence of HZL Rampura Agucha Mining complex, two river systems along with the reservoirs, constructed water tanks, HZL Township and other human settlements are the main reasons for higher percent of this category of land use in the study area.

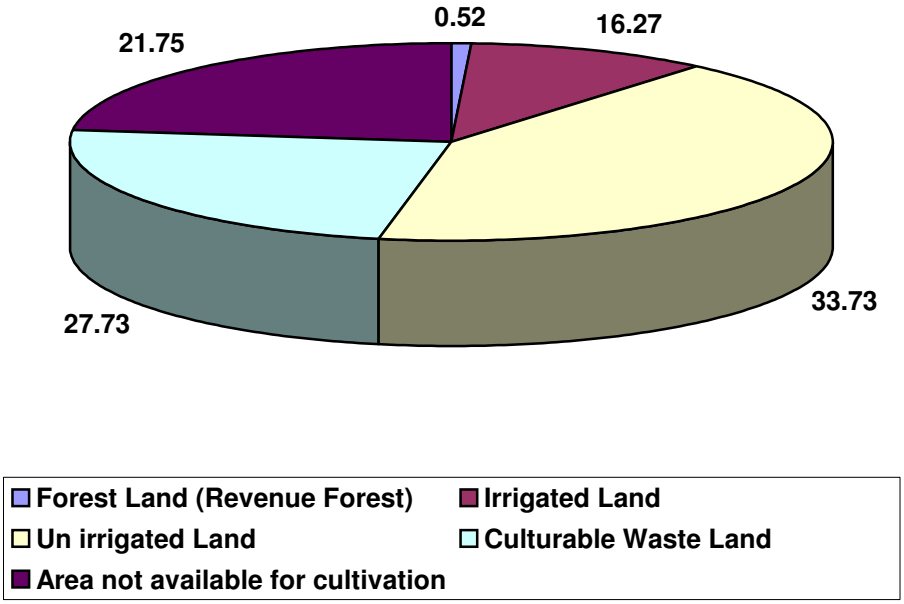


FIGURE-4.10.1
LANDUSE PATTERN - 2001 CENSUS

4.10.3 Cropping Pattern

All the soils in the culturable areas of the Rampura Agucha study area are found to be suitable for cultivation. Majority of these lands are used for cultivation depending on the intensity of monsoon as well as the availability of ground water for irrigation. The soils are more suitable for cultivation of maize, jowar, groundnuts, pulses, vegetables, small millets and oil seeds in normal rainfall conditions. Hence these crops are normally grown in the region.

During Rabi season under the irrigation facilities wheat is predominantly cultivated followed by mustard, fodder, gram and some other crops.

The details of the predominant Cropping pattern in villages adjacent to Rampura Agucha Mine is given in **Table-4.10.2.** It can be observed that the agricultural activities are highly dependent on rainfall pattern. It is observed that during the year 2003, the Rabi cultivation was almost nil due to poor rainfall in the year 2002 (only 153 mm recorded at mine) and comparatively the cultivation was better in the preceding years as the area received good rainfall.

TABLE-4.10.2
DETAILS OF PREDOMINANT CROPPING PATTERN IN VILLAGES ADJACENT TO RAMPURA AGUCHA MINES

Crops	Agucha								Bheru Khera								Barantiya				
	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2008-09	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2008-09	2002-03	2003-04	2004-05	2005-06	2008-09
KHARIF																					
Maize	257	36	--	369	347	377	356	347	46	75	76	64	72	76	88	80	110	136	138	11	150
Jawar	405	164	--	581	506	599	355	92	46	54	53	46	70	73	77	37	154	196	187	145	159
Bajra	--	--	--	7	12	9	2	-	--	--	--	--	24	22	11	-	--	2	4	--	-
Black Gram	18	5	--	151	258	188	189	277	1	6	19	36	28	32	41	41	125	125	74	53	307
Green Gram	18	12	--	20	20	26	120	35	1	12	3	10	6	5	7	33	25	77	128	304	62
Rice	6	2	--	4	--	--	--	-	--	--	--	--	--	--	--	-	--	--	--	--	-
Gingilly	--	3	--	55	50	38	135	72	1	6	4	8	4	4	6	38	30	91	94	45	48
Groundnut	5	--	--	4	2	--	--	-	6	2	--	--	--	--	--	-	--	--	--	--	-
Bhuwar	--	--	--	4	15	--	49	-	--	--	--	--	--	--	--	-	--	--	--	--	-
Cotton	131	14	--	134	105	66	100	30	42	20	18	24	20	14	6	14	50	19	18	57	17
Vegetables	131	45	--	--	--	10	--	20	43	31	2	4	--	1	--	-	--	--	--	--	-
RABI																					
Wheat	139	230	437	50	140	188	89	30	29	26	139	11	15	12	7	9	3	28	95	53	34
Jawar	12	31	12	4	12	7	18	30	1	1	4	2	--	--	--	-	1	8	30	16	-
Gram	28	--	14	--	7	6	13	-	4	--	5	--	--	1	--	-	--	10	206	26	6
Mustard	50	28	10	4	7	165	265	-	2	2	21	1	--	6	18	38	--	8	34	77	36
Taramera	1	6	7	--	6	2	18	-	--	--	4	--	--	2	2	17	--	6	21	35	2
Cumin	6	30	22	9	14	18	16	-	1	5	20	4	7	6	3	-	4	12	16	12	3
Vegetables	17	19	--	2	--	--	--	-	2	1	--	--	--	--	--	-	1	--	--	--	1

TABLE-4.10.2 (CONT...)
DETAILS OF PREDOMINANT CROPPING PATTERN IN VILLAGES ADJACENT TO RAMPURA AGUCHA MINES

Crops	Kiothia			Papari Khera				Barla				
	2000-01	2001-02	2002-03	1999-00	2000-01	2001-02	2002-03	2002-03	2003-04	2004-05	2005-06	2008-09
KHARIF												
Maize	170	156	109	--	--	18	22	61	99	66	81	62
Jawar	477	445	470	--	--	48	127	67	213	101	104	165
Bajra	1	1	1	--	--	1	--	--	--	--	--	-
Black Gram	34	116	24	--	--	51	105	--	19	10	4	17
Green Gram	56	67	38	--	--	14	2	9	49	112	224	60
Rice	18	55	30	--	--	3	--	--	--	--	--	-
Gingilly	16	52	19	--	--	4	2	8	24	70	62	23
Groundnut	--	--	--	--	--	--	--	--	--	--	--	-
Bhuwar	--	--	--	--	--	--	--	--	8	1	--	-
Cotton	23	37	62	--	--	--	--	12	10	16	10	4
Vegetables	113	17	21	--	--	--	1	--	--	--	--	-
RABI												
Wheat	288	--	--	4	3	6	--	1	7	13	19	19
Jawar	47	--	--	1	5	9	--	--	3	1	6	-
Gram	31	--	--	1	34	52	258	--	1	4	5	-
Mustard	122	--	--	2	1	5	--	--	--	9	89	29
Taramera	114	--	--	--	1	15	--	--	4	39	42	16
Cumin	49	--	--	--	--	--	--	1	1	1	1	1
Vegetables	3	--	--	1	1	1	--	--	--	--	--	-

Source: Hurda Tehsil office
Note: All values are expressed in hectares
The year 2004-05 means, Kharif crop of year 2004 and Rabi crop of 2005.

4.11 Demography and Socio-Economics

The growth of mining and industrial sectors and infrastructure developments in and around the agriculture dominant areas, villages and towns is bound to create its impact on the socio-economic aspects of the local population of the area experiencing development. The impacts may be positive or negative depending upon the developmental activity. To assess the anticipated impacts of the mining and industrial growth on the socio-economic aspects of people, it is necessary to study the existing socio-economic status of the local population, which will be helpful for making efforts to further improve the quality of life in the area under study. For assessing the prevailing socio-economic aspects of people in the study area around the existing/proposed mine, the required data has been collected from various secondary sources and analyzed.

4.11.1 Methodology Adopted for the Study

The methodology adopted for the study is based on the following:

- Review of secondary data, such as District Primary Census Statistical Hand Books of Bhilwara and Ajmer districts, 2001 and the data from National Informatics Center, New Delhi, for the parameters of demography, occupational structure of people within the study area around the existing/proposed mine;

- Conducting Focus Group discussions in the villages for eliciting the general information of the study area, to support or supplement the information collected through secondary and primary surveys.

4.11.2 Review of Demographic and Socio-Economic Profile - 2001

The sociological aspects of this study include human settlements, demography, social strata such as Scheduled Castes and Scheduled Tribes and literacy levels besides infrastructure facilities available in the study area. The economic aspects include occupational structure of workers. The information on socio-economic aspects of the study area has been collected from secondary sources, which mainly include District Primary Census Handbooks 2001 of Bhilwara and Ajmer districts, the latest census records available at the village level.

The Rampura-Agucha Mine of HZL is located in Rampura and Agucha villages of Shahpura tehsil in Bhilwara district. The study area within 10 Km around the periphery of the mine lease area is falling in tehsils of Shahpura, Hurda and Asind tehsil of Bhilwara district and Masooda and Kekri tehsils of Ajmer district. About 73 villages of Bhilwara district 8 villages of Ajmer district are covered within the study area. Most of these settlements of the study area are shown in the Study Area Map presented as **Figure-1.2 in Chapter-1.** The settlement-wise demographic data as per 2001 census is presented in **Annexure-XIII**. The salient features of the demographic and socio-economic aspects of the study area are described in the following sections.

4.11.3 Demographic Aspects

4.11.3.1Distribution of Population

As per 2001 census the study area consisted of 106424 persons inhabited in 58 villages of the study area. The distribution of population in the study area is shown in **Table-4.11.1**.

TABLE-4.11.1
DISTRIBUTION OF POPULATION IN STUDY AREA – 2001

Particulars	Study Area
No. of Households	19914
Male Population	55560
Female Population	50864
Total Population	106424
Average Household Size (Persons)	5.34
Sex Ratio	915

Source: District Primary Census Hand Books, Bhilwara and Ajmer Districts, 2001

The males and females constitute to about 52.2% and 47.8% of the study area.

4.11.3.2 Average Household Size

The study area had an average family size of 5.34 persons per household in 2001. This is a normal family size in India, however less in comparison with the other areas of Rajasthan. This normal family size could be attributed to a considerable degree of influence of HZL with migration of people with higher literacy levels who generally opt for smaller family size with family welfare measures to this study area and also due to the prevalence of single member families, a common phenomenon in mining and industrial areas.

4.11.3.3 Population Density

The density of population in the study area works out to about 156.64 persons per km^2 as per 2001 census. This lower density of population is due to the presence of more area with less number of human settlements and population.

4.11.3.4 Sex Ratio

The configuration of male and female indicates that the males constitute to about 52.2% and females to 47.8% of the total population as per 2001 census records. The sex ratio i.e. the number of females per 1000 males indirectly reveals certain sociological aspects in relation with female births, infant mortality among female children and single person family structure, a resultant of migration of industrial workers. The study area on an average has 965 females per 1000 males as per 2001 census. This ratio is considered to be lower in comparison with other states but more in comparison with the other parts of Rajasthan.

4.11.4 Social Structure

In the study area, as per 2001 census, 18.22% of the population belonged to Scheduled Castes (SC) and 4.04% to the Scheduled Tribes (ST). This indicates that about one fourth of the population in the study area belong to weaker sections and works to about 22.26% of the total population in 2001. The distribution of population in the study area by social structure is shown in **Table-4.11.2.**

TABLE- 4.11.2
DISTRIBUTION OF POPULATION BY SOCIAL STRUCTURE – 2001

Sr. No.	Particulars	Study Area
1	Scheduled Castes	19393
2	% to total population	18.22
3	Scheduled Tribes	4335
4	% to total population	4.04
5	Total SC and ST	23728
6	% to total population	22.26

Source: District Primary Census Hand Books, Bhilwara and Ajmer Districts, 2001

4.11.5 Literacy Levels

The analysis of the literacy levels in the study area reveals a lower literacy rate in the study area. The study area experienced a literacy rate of 49.65% in 2001. If this is computed only for the people of above the age group of 5 years, i.e. the school going age people, this may slightly increase the literacy rate. The distribution of literates and literacy rate in the study area is given in **Table-4.11.3.**

TABLE- 4.11.3
DISTRIBUTION OF LITERATES AND LITERACY RATES – 2001

Sr. No.	Particulars	Study Area
1	Total Literates	52840
2	Average Literacy Rate (%)	49.65
3	Male Literacy (%)	62.72
4	Female Literacy (%)	35.36
5	Male Literates	34852
6	% to Study Area Literates	32.75
7	Female Literates	17988
8	% to Study Area Literates	16.90

Source: District Primary Census Hand Books, Bhilwara and Ajmer Districts, 2001

The male literacy i.e. the percentage of literate males to the total males of the study area works out to be 62.72%. The female literacy rate, which is an important indicator for social change, is observed to be only 35.36% in the study area as per 2001 census. This indicates that there is a need for major sociological development in the region with the increase in literacy levels of both males and females.

4.11.6 Occupational Structure

The occupational structure of people in the study area is studied with reference to main workers, marginal workers and non-workers. The main workers include 10 categories of workers defined by the Census Department, which consists of cultivators, agricultural laborers, those engaged in live-stock, forestry, fishing, mining and quarrying; manufacturing, processing and repairs in household industry; and other than household industry, construction, trade and commerce, transport and communication and other services.

The marginal workers are those workers engaged in some work for a period of less than six months during the reference year prior to the census survey. The non-workers include those engaged in unpaid household duties, students, retired persons, dependents, beggars, vagrants etc.; institutional inmates or all other non-workers who do not fall under the above categories.

As per 2001 census records altogether the main workers works out to be 36.29% of the total population. The marginal workers and non-workers constitute to 6.65% and 57.05% of the total population respectively. The distribution of workers by occupation indicates that the non-workers are the predominant population. The occupational structure of the study area is shown in **Table-4.11.4.**

TABLE-4.11.4
OCCUPATIONAL STRUCTURE – 2001

Sr. No.	Occupation	Study Area	
		No.	% Population
1	Total main workers	38627	36.29
	Male	26998	25.37
	Female	11629	10.92
2	Marginal workers	7078	6.65
	Male	2068	1.95
	Female	5010	4.70
3	Non-workers	60719	57.05
	Male	26494	24.89
	Female	34225	32.16
Total Population		**106424**	**100.00**

Source: District Primary Census Hand Books, Bhilwara and Ajmer Districts, 2001

4.11.6.1Dependency Ratio

Based on the occupational structure of the study area the dependency rate of non-workers on the workers category has been estimated at 57.05, which is considered to be low or moderate while indicating that most of the people are engaged in some sort of income generating activity.

4.11.7 Infrastructure Facilities

The infrastructure and amenities available in the study area denotes the economic well being of the region. Reasonably good levels of infrastructure facilities are available in the study area, which consists of education, health care, communications, transportation, etc.

A review of infrastructure facilities available in the area has been done based on the information given in the District Census Hand Books and the data of National Informatics Center, for the year 2001. The Infrastructure facilities available in the study area are described in the subsequent sections and the village-wise available infrastructure facilities are given in **Annexure-XIII.**

4.11.7.1Educational Facilities

The educational facilities are almost evenly distributed in the area. In all, there are 94 primary schools, 35 middle schools, 14 high schools and 7 other educational institutions. All the high schools are situated in larger villages. A few smaller villages are devoid of any educational institutions. The available educational facilities in the area as per 2001 census are given in **Table-4.11.5**.

TABLE-4.11.5
EDUCATIONAL FACILITIES IN THE STUDY AREA

Sr. No.	Institution	Total
1	Educational facilities	61
2	Primary schools	94
3	Middle schools	35
4	Secondary schools	14
5	Adult Education Centers	31
6	Other Education Centers	7

Source: District Primary Census Hand Books, Bhilwara and Ajmer Districts, 2001

4.11.7.2 Health Facilities

Different types of health facilities including hospitals, dispensaries and clinics are available in the study area. The health facilities include 1 hospital, 8 primary health centers, 12 dispensaries and others as shown in **Table-4.11.6**.

TABLE- 4.11.6
HEALTH FACILITIES IN THE STUDY AREA

Sr.No.	Type of Institution	No. of Institutions in Study Area
1	Medical facilities	93
2	No. of Allopathic Hospital	0
3	No. of Ayurvedic Hospital	1
4	No. of Unani Hospital	0
5	No. of Homeopathic Hospital	0
6	Total Dispensaries	12
7	No. of Maternity and Child Welfare Center	0
8	No. of Maternity Home	0
9	No. of Child Welfare Center	0

Sr.No.	Type of Institution	No. of Institutions in Study Area
10	No. of Health Center	4
11	No. of Primary Health Center	8
12	No. of Family Welfare Center	0
13	No. of Nursing Home	0
14	No. of Registered Private Medical Practitioners	1
15	No. of Subsided Medical Practitioners	0
16	Other Medical Facilities	0

Source: District Primary Census Hand Books, Bhilwara and Ajmer Districts, 2001

4.11.7.3 Transport Facilities

The study area is served by rail and road transport facilities. All villages have paved road connections. As a whole, the study area has moderate level of communication network.

4.11.7.4 Post and Telegraphs

The study area has moderate level of Post and Telegraphic services. Altogether there were 23 Post Offices and 2 Post and Telegraphic Offices in the study area in 2001. About 13 human settlements had telephone facility in them.

4.11.7.5 Electrification

Almost all villages in the study were electrified in 2001. Electricity was supplied for domestic, agricultural, industrial and public lighting purposes. Subsequently the electric connections have been given to many other villages.

4.11.7.6 Drinking Water Facility

Water supply in the study area is mainly from wells, hand pumps followed by protected water supply system. In 2001 about 16 villages had protected water supply system. About 68 villages were served by wells and about 19 villages had tanks as the source of drinking water supply. About 74 villages were facilitated with hand pumps and bore wells for water supply.

4.11.8 Places of Historical and Tourist Importance

No important historical places or monuments or places of tourist interest are located in the study area.

5.0 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1 Identification of Impacts

The description of mining process incorporated in the existing mine and proposed expansion has been provided in Chapter-2. The description of existing environmental setting and baseline conditions has been given in Chapter-3.

This chapter presents identification and appraisal of various impacts of proposed capacity expansion (ultimate capacity of 6.15 Mtpa) of Lead-Zinc mine and (ultimate capacity of 6.5 Mtpa) of beneficiation plant in the study area based on the inventory of sources of pollution as well as the baseline environmental setting described.

Generally, the environmental impacts can be categorized as either primary or secondary. Primary impacts are those, which are attributed directly to the project and secondary impacts are those, which are indirectly induced and typically include the associated investment and changed pattern of social and economic activities by the proposed action.

The impacts have been assessed for the proposed capacity expansion of mine and beneficiation capacity assuming that the pollution due to the existing activities with their present capacities has already been covered under baseline environmental monitoring. The capacity expansion is likely to create impacts on the environment during the operation of mine & beneficiation plant, which would have long-term effects.

The operation of the proposed mine capacity expansion to 6.15 Mtpa and beneficiation capacity expansion to 6.5 Mtpa comprises various activities each of which may have an impact on some or other environmental parameters. Various impacts on the environment parameters have been studied to estimate the impacts on the environment and are discussed briefly below and elaborated in the subsequent sections.

The proposed expansion project is likely to create impact on the environment in two distinct phases:

- During the construction phase which may be regarded as temporary or short term; and

- During the operation phase which would have long term effects.

The construction and operation of the proposed project comprises various activities each of which may have an impact on some or other environmental parameters. Various impacts during the construction and operation phase on the environment parameters have been studied to estimate the impact on the environment and are discussed briefly below and elaborated in the subsequent sections.

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 study area and also to preserve the assimilative capacity of the receiving bodies.

The environmental attributes, which are likely to be affected in the region, are air, noise, water, land, biological and socio-economic environment.

The Management Action Plan aims at controlling pollution at the source level to the extent possible, with the available and affordable technology, followed by treatment measures before they are discharged.

It is to be appreciated that mining process is to a certain extent, an inevitable destructive process, but the hazards are within measurable limits, and can be ameliorated to a significant extent.

5.2 Impacts during Construction Phase

This includes the following activities related to leveling of site, construction of plants and other related structures and other related equipment.

5.2.1 Impact on Land use

Mining lease area is 1200-ha of which the land acquired for mining and industrial use is 869.5-ha. 155-ha of additional land will be acquired for disposal of waste dump including shifting of Bherukhera-I village. To accommodate pit expansion 20-ha additional land will be acquired within the mining lease during the plan period.

5.2.2 Impact on Soil

The proposed project involves construction of additional units for beneficiation plant. Earth/soft rock/hard rock will be excavated up to a depth of 2.5 to 3 m. The excavated material will be reutilized for refilling and leveling.

The soil in the project site is predominantly consists of sandy loam. The sub-strata of this area is not rocky and as such no blasting is envisaged for either leveling or during foundation work. As the site is plane and needs no grading, filling and leveling.

The construction activities will result in loss of topsoil to some extent in the plant area. The topsoil requires proper handling like separate stacking so that it can be used for green belt development. Apart from very localized construction impacts at the plant site, no significant adverse impact on soil in the surrounding area is anticipated.

For the proposed capacity enhancement in beneficiation plant, construction of foundations for plant & machinery will be done.

5.2.3 Impact on Air Quality

During construction phase, suspended particulate matter will be the main pollutant, which would be generated from the site development activities and vehicular movement on the road. Further, concentration of NO_x and CO may also slightly increase due to increased vehicular traffic movement. However, the increase in ambient concentrations of air quality will be negligible. As most of the construction equipment will be mobile, the emissions are likely to be fugitive. The dust generated will also be fugitive in nature, which can be controlled by suitable mitigation measures like sprinkling of water.

The impacts will be localized in nature and the areas out side the project boundary are not likely to have any adverse impact with respect to ambient air quality.

5.2.4 Impact on Water Resources and Quality

The peak requirement of water during construction will be about 200 m^3/day, which will be supplied from the existing water system. No ground water will be drawn, even during construction.

Further, the wastewater generation during the construction period will be basically from the sanitary units provided for the workers. This waste will be treated in a STP and treated water is used in horticulture work. Hence, there will not be any impact on the water regime due to discharge of treated wastewater.

5.2.5 Impact on Noise Levels

The major sources of noise during the construction phase are vehicular traffic, construction equipment like dozers, scrapers, concrete mixers, cranes, pumps, compressors, pneumatic tools, saws, vibrators etc. The operation of these equipment will generate noise ranging between 85-90 dB (A) near source. These noises will be generated mostly within the existing plant boundary and will be transient in nature. Due to existing green belt around the periphery of the mine lease area, these noises will be attenuated to a large extent and are not likely to have any significant impact on the nearby villages.

5.3 Impacts During Operational Phase

HZL is proposing to increase the mine production and ore treatment to a level of 6.15 Mtpa with corresponding increase in beneficiation capacity production from 5.0 Mtpa to 6.5 Mtpa. For the proposed expansion of the mine and beneficiation plant. The impacts of the existing and expansion on the environment are considered for impact assessment:

- Land use;
- Soil quality;
- Topography and climate;
- Air quality;
- Water resources and quality;

- Noise levels;
- Biology;
- Traffic load; and
- Infrastructural facilities.

5.4 Impact on Topography and Climate

5.4.1 Impact on Topography

The proposed capacity expansion project will be carried out in the existing mine pit only. The topographical changes have already occurred during existing mining activities and the topographical changes have already stabilized. There will not be any change in the existing mine pit size and will remain same till the end of the mine. The number of overburden dumps (Site-1, Site-2, Site-3 and Site-4) will be increased proportionately to store additional overburden envisaged due to proposed expansion project. The additional overburden dump will be located within the acquired mine lease area to accommodate the overburden till end of mine life. The height of the tailing dam will be increased to accommodate the additional quantity of the tailings. This would happen irrespective of the proposed project due to existing mining activity. Further, additional facilities for beneficiation will be installed adjacent to beneficiation plant. Hence, there will be slight impact on the topographical changes however they will be minor in nature.

5.4.2 Impact on Climate

5.4.2.1Temperature

The average monthly minimum and maximum temperatures are being monitored at the mine site and are also analyzed based on the data from nearest IMD station (Ajmer). The trend of temperatures shows a regular cyclic pattern. The temperature pattern indicates a regional behavior and will not be affected by proposed capacity expansion of mine and beneficiation plant as there will not be any significant thermal emissions. Any local temperature hikes due to operation of additional mining machinery and blasting will be marginal and will be moderated by the surrounding plantation.

5.4.2.2Rain fall

The average annual rainfall in the region is 557 mm as per IMD (Ajmer) data and 450 mm (annual average) recorded at Rampura-Agucha mine by HZL. Any changes in the pattern of rainfall will be on a regional scale because of cumulative reasons. The capacity enhancement of mining operations and plant is not expected to have any adverse effect on the rainfall pattern of the area.

5.4.2.3Wind Speed

The wind speeds in any area are dependent on the generation of elevation and depressions in the region. There are no significant topographical changes, which will have impact on wind speed. Even though there will be an increase in the over

burden dumps and tailing pond, this is not likely to obstruct the wind speed and wind flow pattern.

5.4.2.4Humidity

The relative humidity in the area is not likely to change because of capacity enhancement of the mining and plant activities, as it will not cause any changes in the prevailing temperatures and rainfall of the region. The existing and proposed green belt is likely to have a moderating effect on the local climate.

5.5 Impact on Land use

Mining lease area is 1200-ha of which the land acquired for mining and industrial use is 869.5-ha. 155-ha of additional land will be acquired for disposal of waste dump including shifting of Bherukhera-I village. To accommodate pit expansion 20-ha additional land will be acquired within the mining lease during the plan period.

5.6 Impact on Air Quality

5.6.1 Impacts from Beneficiation Plant (Point Source)

In the proposed expansion project, no stacks will be added in the beneficiation plant. The newly added primary crusher uses dust suppression system where water is added in mist form at different fall points to suppress dust.

A new dedusting system comprising of either Venturi Scrubber & one dust slurry pump has been installed at coarse ore stockpile area.

Filter cake discharges having a moisture content of 8-9% moisture are carried to respective stockpiles. Concentrate handling will be contained by mechanized handling. The concentrate carrying trucks, which is another source of dust, will be covered by tarpaulin to arrest the dust. Further, the concentrate will be having about 8-9% of moisture, which will be in a semi-dry condition.

5.6.2 Impacts due to Mining Activities (Area Source)

The expansion capacity will be achieved by opencast and underground mining methods. Thus, the emissions in terms of dust will be comparatively less and will be confined to mine area only.

In the proposed expansion project, wet drilling will be adopted and thus the likelihood of dust generation from drilling activities will be very negligible.

The dumping and grading operations will generate the dust. However, by changing the dumping procedures, the dust generation can be reduced.

The contribution to air pollution from the existing fleet is already captured in the monitoring. The likely contribution from the additional fleet plying on the haul roads will be confined to the mine area only and will not have any adverse impact on the community.

There will be marginal increase in terms of dust load and gaseous emissions. However, incremental contributions will be confined to the mine area only and will not have any adverse impact on the outside community.

The off site traffic mainly includes trucks, which are used to transport zinc concentrate and other consumables. The additional daily traffic will be about 75 trucks.

The contribution of NOx and CO concentrations from the proposed additional traffic is very less compared to the background maximum concentration and hence their impact will be insignificant.

Additional equipment such as three excavators of 30-34 m^3 capacity, two dumpers of 95 tonnes capacity, twenty four dumpers of 177 to 218 tonnes capacity, seven drill machines of 165-200mm), two drill machine of 115 mm capacity will be added. Further, two more track dozers (410 HP), one motor grader and one RT dozer will be added.

The drilling and blasting pattern will remain same. However, the blast size will increase proportionately to match the production.

The area sources include mine pit, drilling, blasting, hauling, loading/unloading and stockpiles.

The dust emissions from the above areas will be fugitive in nature and will be maximum during summer season when the wind velocities are likely to be high and will be almost negligible during the monsoon season. The dust emissions are likely to be confined to the mine premises only.

There will not be any lateral increase in the mine pit size. The expansion capacity will be achieved by going vertically deep into the existing mine pit. Further, the depth of operating bench is at 170-m from ground level at present and the ultimate depth of mining at the last bench will be 372-m from ground level at the end of mining. Thus, the emissions in terms of dust will be comparatively less and will be confined to mine pit only.

In the proposed expansion project, wet drilling will be adopted and thus the likelihood of dust generation from drilling activities will be very negligible.

There will be a marginal increase in the blasting frequency during the expansion. The blast size will be appropriately enhanced to match the production. Blasting will contribute to dust and Oxides of Nitrogen. However, the dust generated due to blasting is instantaneous and prevails only in the quarry area and has been observed to dissipate within half an hour after the blasting.

The blasting is carried out regularly between 2 pm to 3 pm during the daytime when normally low wind conditions prevail and temperature inversions are not likely to occur.

Thus, even though there will be an increase in the blast size, the incremental dust concentrations will be minimum owing to the precautions adopted during the blasting and time of the blasting. However, additional mitigatory measures have been described to further reduce the dust generated during blasting.

The gaseous emissions like Oxides of Nitrogen from the blasting activity will be instantaneous and will prevail for shorter duration. Hence, the impact due to blasting will be instantaneous and there will not be any long-term adverse impacts.

Similarly, the excavator operations, loading and unloading operations will cause dust generation. During the expansion programme, three more excavators of 30-34-m^3 capacity will be added to match the expansion. However, the bucket size will be big (30-34-m^3) requiring less number of buckets for filling the dumpers. Thus, this will reduce the operational period of excavator and in turn reduce the dust generation. The dust generated will be confined to the area of operation of the excavator and will not have any adverse impact on the community. The gaseous emissions from these operations will also be negligible and limited to the mine pit only.

Concentrate handling will be another source of dust generation. However, this will be contained by mechanized handling of concentrate. The concentrate carrying trucks, which is another source of dust, will be covered by tarpaulin to arrest the dust. Further, the concentrate will be having about 8-9% of moisture, which will be in a semi-dry condition.

⇒ *Pollution at the Over Burden Dumps*

The dumping and grading operations at the dump sites are also another source of dust generation. There will be generation of dust while dumping the over burden and movement of dumpers. However, by changing the dumping procedures, the dust generation can be reduced. The over burden can be dumped by giving less aerial lift and grading can be done by gradual dozing. This will help in reduction of dust generation.

- ***Details of Mathematical Modelling***

Prediction of impacts on air environment has been assessed by employing, **USEPA Fugitive Dust Model (FDM).**

➢ **Impact from Mining Operations**

Prediction of impacts on air environment has been assessed by employing, **USEPA Fugitive Dust Model (FDM)** dispersion mathematical model.

Fugitive Dust Model is a computerized air quality model specifically designed for computing concentration and analysis of the dispersion of fugitive dust. The sources may be point, line or area sources. The model is generally based on the well-known Gaussian Plume formulation for computing concentrations, but the model has been specifically adapted to incorporate an improved gradient-transfer

deposition algorithm. Gravitational setting velocity and a deposition velocity are calculated by FDM for each class. Concentration and deposition are computed at all user-selectable receptor locations.

For the short-term simulations, the concentrations were estimated around 445 receptor points including village receptors are chosen to obtain an optimum description of variations in concentrations over the site in 10-km radius and AAQ locations covering 16 directions.

- ***Model Input Data***

The modelling has been carried to predict the impacts of the mining operations using the input as given in **Table-5.1**.

TABLE-5.1
EMISSION FACTORS USED

Sr. No.	Activity	Units	Emission Factors used for Modelling
1	Excavators on OB	g/sec	29.0
2	Bulldozing on OB	g/sec	0.4
3	Trucks/ Dumpers dumping OB	g/sec	10.4
4	Drilling Activity	g/sec	0.4
5	Blasting	g/sec	0.1
6	Vehicle movement while loading	g/km/sec	2.69
7	Dumper loading	g/sec	0.0018
8	Wind erosion	$g/m^2/sec$	0.0001

- ***Meteorological Data***

The hourly meteorological data at site during winter is converted to the mean hourly meteorological data as specified by CPCB and the same has been used in the model. In absence of site specific mixing depths, mixing depths published in "Spatial Distribution of Hourly Mixing Depths over Indian Region" by Dr. R.N.Gupta has been used.

- ***Presentation of Results***

For the short-term simulations, the concentrations were estimated for receptor points chosen to obtain an optimum description of variations in concentrations over the mine site in 2-km radius for modelling of particulate sources from mining activity. Concentration of 55.7 $\mu g/m^3$ resulted at about 500-m in NE from the mine pit (within the mine lease area). The incremental Ground level concentrations are shown in **Figure-5.1**.

- ***Overall Impact due to the Mine***

As discussed above, there will be increase in terms of dust load due to mining operations. However, it can be noted that most of the activities are to be operated below ground. The above surface activities too cause insignificant emissions and will

be confined to the lease area only and will not have any adverse impact on the outside community.

5.6.3 Impact of off-Site Traffic on Air Quality

The offsite traffic will be resulted due to movement of trucks outside the ML area to outside smelters carrying concentrate. It is estimated that about 175 trucks per day will move out of ML area to smelters. Hence, only these trucks are considered for modeling.

The air quality predictions have been carried out by using the air quality model CALINE-4 developed by California Department of Transportation. The model is based on Gaussian diffusion equation and uses a mixing zone concept to characterize pollutant dispersion over the roadway.

- ***Details of CALINE-4***

CALINE-4 is a dispersion model that predicts pollutant impacts near roadways. Its purpose is to help planners protect public health from the adverse effects of excessive CO exposure.

CALINE-4 is a simple line source Gaussian plume dispersion model. The user defines the proposed roadway geometry, worst-case meteorological parameters, anticipated traffic volumes, and receptor positions. The user must also define CO emission factors for each roadway link.

CALINE-4 is a graphical windows-based user interface, designed to ease data entry and increase the on-line help capabilities of CALINE-4. The CALINE-4 setup program is self-contained with both programs (the CALINE-4 interface and the CALINE-4 dispersion model), so the user only needs to complete a single installation step.

- ***Details of Pollutants***

To account for the effect of the diurnal variations in model inputs (vehicular emissions and meteorological conditions), the averaging time for model predictions has been restricted to 60 minutes. The averaging time is so selected because the primary meteorological factors that influence the air quality predictions i.e. wind speeds and directions do not remain steady for longer time periods. Also, during the peak traffic hours, the traffic volumes typically show significant variations over periods longer than one hour.

Due to averaging time of 60 minutes, the project impacts on air quality are essentially assessed based on one hourly standard for CO. NOx levels however have been developed for peak traffic conditions and compared with WHO standard of 400 $\mu g/m^3$ for hourly average.

HC was not modeled since its limits are not specified for ambient levels in the Environment Protection Act. In the absence of Indian standards for HC, the predictions could not have been interpreted meaningfully.

FIGURE-5.1
GROUND LEVEL INCREMENTAL CONCENTRATIONS

- ***Emission Standards***

The emission standards for Indian vehicles as proposed by the Indian Institute of Petroleum (IIP) have been used to provide the emission factors for the different vehicle types. Emission factors after accounting for the vehicle speeds are as specified in **Table-5.2**.

TABLE-5.2
EMISSION FACTORS FOR VEHICULAR IMPACT PREDICTIONS

*All values are given in gm/km/vehicle**

Vehicle -->	Trucks	
	CO	NOx
Emission rate	10.67	18.97

**: to be multiplied by 1.6 for converting into gm/mile for use in CALINE-4*

- ***Details of Rupaheli Village Road***

The width of the existing village road is 10.0-m, which connects Agucha-Mine and Rupaheli village near NH-79. For model computations, Right Of Way (ROW) of 9 m excluding 0.5 m shoulders on either side of the road has been considered for perusal of violations of standards and accordingly receptor locations have been chosen to account for its location with respect to edge of ROW.

The traffic mainly includes trucks, which are used to transport zinc concentrate and other consumables. Hence, only heavy traffic is considered in assessing the impact of traffic on approach road from National Highway via Rupaheli Road to Rampura Agucha mines. The total traffic after expansion of the project is presented in **Table-5.3**.

TABLE-5.3
TOTAL TRAFFIC AFTER EXPANSION NEAR RAMPURA AGUCHA MINE GATE

Material	Total Traffic
Concentrates & Consumables	175 Trucks /day
Total Traffic (To & From Plant)	350 Trips /day
	15 Trips /hour

The additional daily traffic will be about 75 trucks after the proposed capacity expansion project. Hence, additionally total 150 truck trips will be moving to and from the plant in a day i.e. 6 truck trips per hour. The concentrations of CO and NOx due to the present traffic have been arrested in the baseline ambient air quality monitoring. Hence the impacts on air quality have been predicted only for the additional traffic after expansion project.

Results and Discussion for Traffic Impact

The predicted CO and NOx concentrations from vehicular traffic are presented in **Table-5.4.**

The general observation from **Table-5.4** reveal that the maximum NOx and CO concentration of 12.7 μg/m^3 and 9.4 μg/m^3 occurs at 20-m from the edge of the road for Stability Class-A. The concentrations for other stability classes are observe to be less. The concentrations of NOx and CO are observed to be well within the permissible limit.

TABLE-5.4
PEAK HOURLY PREDICTED INCREMENTAL CONCENTRATIONS

Distance from the Edge of the Road (m)	Incremental Pollutant concentrations (μg/m^3)	
	NOx	CO
20	12.7	9.4
40	11.0	8.1
60	8.7	7.1
80	6.5	5.3
100	4.2	3.3
125	3.1	2.1
150	2.8	1.5

5.7 Impact on Soil

Predictions of the environmental impact of the mining activities on surface soil are based on the nature of activities, extent of the area covered and associated aspects of environmental concern. The lead-zinc ore is confined to the mine lease area only. The dust generated during mining operation is confined to mine pit only, since the dust constitutes the heavier particles, which tend to settle immediately. Further, the waste dumps are provided with adequate slope to prevent erosion and fugitive dust generation due to wind. This again would be depositing on nearby areas only. On account of various associated activities, there will be increased vehicular traffic on these areas. Generation of particulate emissions is therefore, of primary concern in this project.

In mining operation, solid waste generated is non-hazardous in nature. Hence, the soil quality in the vicinity is not expected to be affected due to mining operation. The tailings generated from the beneficiation plant will be routed to the tailing pond, which is lined by clayey soil. The metal content in the tailings will be further reduced due to the better metal recovery in the expansion project. Thus, there will not be any adverse impact on the soil quality due to the built in precautions adopted in the tailing pond.

The existing and proposed greenbelt plantation in the mine lease area acts as an effective insulation of nearby areas against dust escaping from the active mining sites. No effluent is discharged out side the premises and completely utilized in process.

5.8 Impact on Water Resources

5.8.1 Impact on the Water Source-Banas River

The water requirement for the proposed facility will be met from the existing radial well at Banas river bed located at a distance of 60-km from the mine site.

The existing water requirement of the mine and Beneficiation Plant is 11700-m^3/day. Due to technological improvements in the flotation, there will not be additional water requirement in the proposed expansion project. Hence, there will not be impact on the water resources due to the proposed expansion project.

5.8.2 Impact of Mining on Surface Water Regime

At present, the mining activity is confined to the mining lease area of 1200 ha, which was originally a flat land. The mining lease area does not have any major streams and there is no stream flowing in the mining area requiring any diversion. The present mining pit will have the same opening area in future also and will not obstruct any surface drainage. With the future mining operation being confined to the present mining pit, surface water resources are not affected, as it does not disturb the drainage pattern.

It is therefore apparent that there is hardly any impact of mining on the surface water regime. The surface water is not pumped or utilized anywhere in the lease area for any purpose. The rainfall collected in the mine pit during the monsoon season will be pumped out and used for green belt and the balance if any will be routed to the water reclamation pond for subsequent use in the plant. The impact due to this is marginal and the proposed expansion will not add any further adverse impact.

5.8.3 Impact of Mining on Ground Water

The ground water assessment studies carried out in core zone (lease area) indicates that there is surplus exploitable ground water potential of 0.389 mcm as there is hardly any ground water withdrawal in the lease area. The operating depth of the mine is about 170-m below land surface, there is a limited accumulation of 250 m^3/day in the mining pit. Limited quantity of rain water gets collected during the rainy season due to direct precipitation. Although, the depth to water table during post monsoon season period in the area surrounding mining pit is around 8-m below the land surface as observed in the two open wells in the lease area, there is hardly any seepage in the mining pit due to very low hydraulic conductivity.

It is therefore concluded that there will be hardly any impact of mining on ground water regime even by taking the mining depth up to 372-m and there will be hardly any ground water accumulation in the mining pit due to low hydraulic conductivity in the crystalline metamorphics at such a deeper depth.

Similarly, there will not be any impact on the ground water resources of buffer zone due to mining activity confined to limited area of 1.2-sq.km as the hydraulic conductivity of the BGC is very low and influence of pumping/with drawl is confined to very limited area. More over the buffer zone is not critically exploited so its ground water resources are not under any stress.

The status of ground water development in core and buffer zones being within the safe limits, i.e. the long term ground water recharge being more than the present ground water withdrawal, the static ground water reserves are safely preserved

and are not depleted either due to mining activity in the core zone or due to well irrigation by the cultivators in the buffer zone. The fluctuation of water table during last 18 years, as observed by state and central ground water agencies, during its key well monitoring programme, has not shown any declining trend during the pre or post monsoon periods indicating that all along, the ground water discharge has never exceeded ground water recharge. The fluctuations are due to fluctuations in the rainfall and not attributable to mining activities.

5.9 Impact on Water Quality

5.9.1 Surface Water Quality

Proper control measures are taken to prevent the flow of suspended matter from the mine and dump to surrounding water bodies. The present operations of mining activity are based on zero discharge condition. No wastewater is discharged outside the premises. The wastewater generated in the mine and beneficiation plant is routed to water reclamation pond. Garland drains followed by pond for collection of storm water are provided to route the storm water run-off from waste dump to water reclamation pond. The reclaimed water is recycled back to beneficiation plant for utilization. The same system will be adopted even after proposed expansion project. The proposed additional hydro-cyclones will enhance the recovery of water.

The plantation on the over burden dump has prevented the soil erosion during monsoon season. Garland drains are maintained and monitored properly. Water is not discharged outside the plant premises and hence, no adverse impact on surface water quality due to the proposed expansion is anticipated.

5.9.2 Impact on Ground Water Quality

The potential sources for ground water contamination are:

a] Tailing dam; and
b] Run- off water from mine premises including monsoon run-off.

The tailings, which are in slurry form, generated in the process of ore beneficiation contain residual quantities of metals. Tailing dam is lined with impervious soil to prevent the possibility of percolation of water into ground. The supernatant water from the tailing dam is recycled back to the beneficiation plant for reuse.

HZL had constructed observation wells in down and up stream of the tailing dam. The water quality in monitoring wells indicates the presence of metals well below the permissible limits.

Further, during the expansion project the metal recovery is going to improve in the beneficiation plant thus further reducing the metal content in the tailings.

The run-off water is collected through garland drains around the waste dump and mine area in a sump and pumped to water reclamation pond for reuse. Hence, there is no possibility of ground water contamination.

5.9.2.1Impact of Tailing Dam on Ground Water

The tailings contain the traces of lead and zinc ore. After the expansion project, due to increased metal recovery in the beneficiation plant, the zinc and lead concentration is going to be much less. HZL regularly monitors the water quality in the piezometers to assess the seepages from tailing dam. The concentration of lead and zinc metals are below the permissible limit. Thus, it can be inferred that the impact of tailing dam and overburden dumps on the ground water quality is insignificant.

The topography of the study area is almost plain. The Rampura-Agucha mine is located between two water basins at slightly higher elevation. The north of the study area falls in Khari river basin and south of study area falls in Mansi river basin. The flow of the ground water is towards north, north-east, south and south-east direction.

The pre-project water quality monitored by WS Atkins is compared with water quality monitored by HZL and VIMTA.

A] Pre - Project Scenario

WS Atkins conducted water quality monitoring in year 1988. These results represent pre-project scenario when mine was not in operation. The pre-project water quality of Khari river basin and Mansi river basin with respect to Lead and Zinc is given in **Table-5.5** and **Table-5.6**.

TABLE-5.5
PRE-PROJECT WATER QUALITY (KHARI RIVER BASIN)

Concentrations are expressed in mg/l

Locations	Seasons							
	Pre-Monsoon		Monsoon		Post-Monsoon		Winter	
	Pb	Zn	Pb	Zn	Pb	Zn	Pb	Zn
Khari river	<0.01	0.01	0.03	0.28	0.07	0.01	0.02	0.03
Deolia	<0.01	0.01	0.02	0.12	<0.01	<0.01	0.05	0.03
Kothiyan	0.01	0.02	0.02	0.005	0.02	Nil	0.02	0.01
Paprikhera	0.01	0.05	0.03	0.14	<0.01	0.04	0.04	Nil
Hurda	0.01	0.01	0.07	0.08	0.04	0.01	0.04	Nil
Paprikhera tank	-	-	0.02	0.07	0.04	0.04	-	-
Agucha- Gulabpura Road side	0.01	0.01	0.01	0.02	0.06	0.08	0.03	Nil

Source : (WS Atkins)

TABLE-5.6
PRE-PROJECT WATER QUALITY (MANSI RIVER BASIN)

Concentrations are expressed in mg/l

Locations	Seasons							
	Pre-Monsoon		Monsoon		Post-Monsoon		Winter	
	Pb	Zn	Pb	Zn	Pb	Zn	Pb	Zn
Nai Arwar (tank)	<0.01	0.16	0.13	0.13	0.07	0.37	0.02	0.35
Bherukhera	0.01	0.02	0.06	0.63	<0.01	0.021	0.05	Nil
Chainpura	-	-	0.24	0.079	0.06	3.2	0.07	Nil
Amarantiya	<0.01	0.01	0.02	0.079	0.07	0.02	0.06	0.02
Agucha village supply	0.02	0.02	0.03	0.05	0.09	0.02	0.05	Nil
Agucha tank	-	-	0.06	0.06	0.07	0.01	0.03	Nil
Arwar dam	-	-	0.07	0.07	0.03	0.03	0.05	Nil

Source : (WS Atkins)

B] During Project (monitored by HZL)

HZL is regularly monitoring the water quality in the study area. The water samples are collected every season. The water quality results with respect to Lead and Zinc are given in **Table-5.7** and **Table-5.8**.

TABLE-5.7
POST-PROJECT WATER QUALITY (KHARI RIVER BASIN)

Concentrations are expressed in mg/l

Location	Season	Param-eter	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Kothiyan	Pre Monsoon	Lead	0.018	0.023	0.015	0.016	0.016	.014	0.015	0.014	0.015	0.015
		Zinc	0.019	0.07	0.07	0.21	0.17	0.16	0.15	0.15	0.16	0.14
	Monsoon	Lead	0.018	0.015	0.02	0.02	0.014	0.015	0.015	0.014	0.014	0.014
		Zinc	0.10	0.06	0.15	0.21	0.17	0.13	0.13	0.16	0.15	0.14
	Post Monsoon	Lead	0.022	0.02	0.02	0.02	0.015	0.015	0.012	0.015	0.015	0.013
		Zinc	0.22	0.084	0.15	0.15	0.17	0.15	0.14	0.16	0.15	0.14
	Winter	Lead	0.016	0.014	0.02	0.014	0.017	0.015	0.014	0.015	0.015	0.014
		Zinc	0.02	0.11	0.12	0.17	0.15	0.14	0.16	0.15	0.15	0.14
Latha well	Pre Monsoon	Lead	0.02	0.017	0.02	0.009	0.018	0.016	0.015	0.015	0.015	0.014
		Zinc	0.014	0.07	0.11	0.20	0.19	0.15	0.11	0.16	0.14	0.14
	Monsoon	Lead	0.022	0.014	0.014	0.020	0.018	0.018	0.016	0.016	0.014	0.014
		Zinc	0.22	0.10	0.14	0.13	0.13	0.15	0.17	0.17	0.15	0.15
	Post Monsoon	Lead	0.03	0.021	0.021	0.020	0.017	0.015	0.017	0.015	0.013	0.015
		Zinc	0.11	0.07	0.16	0.13	0.17	0.16	0.15	0.16	0.14	0.15
	Winter	Lead	0.016	0.016	0.021	0.015	0.016	0.015	0.015	0.014	0.014	0.015
		Zinc	0.824	0.08	0.21	0.11	0.16	0.16	0.16	0.16	0.14	0.14
Kothiyan dam	Pre Monsoon	Lead	0.015	0.019	0.017	0.019	0.014	0.017	0.016	0.015	0.015	0.014
		Zinc	0.03	0.05	0.12	0.20	0.17	0.18	0.15	0.16	0.16	0.14
	Monsoon	Lead	0.018	0.017	0.019	0.017	0.017	0.017	0.016	0.016	0.015	0.014
		Zinc	0.10	0.11	0.13	0.21	0.18	0.14	0.14	0.17	0.14	0.14
	Post Monsoon	Lead	0.04	0.021	0.019	0.016	0.018	0.017	0.014	0.015	0.015	0.014
		Zinc	0.03	0.084	0.17	0.14	0.018	0.017	0.014	0.16	0.15	0.14
	Winter	Lead	0.015	0.023	0.02	0.016	0.017	0.016	0.015	0.014	0.015	0.014
		Zinc	0.016	0.11	0.12	0.12	0.14	0.15	0.15	0.16	0.15	0.14
Paprikhera	Pre Monsoon	Lead	0.024	0.021	0.014	0.015	0.015	0.015	0.016	0.016	0.013	0.015
		Zinc	0.025	0.21	0.20	0.20	0.16	0.16	0.15	0.15	0.15	0.14
	Monsoon	Lead	0.019	0.016	0.015	0.014	0.013	0.017	0.015	0.015	0.015	0.016
		Zinc	0.19	0.16	0.14	0.17	0.20	0.15	0.16	0.16	0.15	0.14
	Post Monsoon	Lead	0.018	0.020	0.017	0.018	0.016	0.019	0.014	0.014	0.014	0.015
		Zinc	0.08	0.117	0.22	0.10	0.18	0.16	0.13	0.15	0.13	0.15
	Winter	Lead	0.015	0.017	0.014	0.015	0.014	0.015	0.014	0.014	0.015	0.014
		Zinc	0.015	0.019	0.20	0.15	0.15	0.15	0.14	0.15	0.13	0.14

TABLE-5.8
POST-PROJECT WATER QUALITY (MANSI RIVER BASIN)

Concentrations are expressed in mg/l

Location	Season	Parameter	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Bherukhera	Pre Monsoon	Lead	0.022	0.02	0.015	0.016	0.018	0.013	NA	0.016	0.014	0.014
		Zinc	0.025	0.06	0.18	0.21	0.15	0.18	NA	0.18	0.15	0.15
	Monsoon	Lead	0.027	0.016	0.015	0.016	0.018	0.013	NA	0.015	0.014	0.013
		Zinc	0.24	0.10	0.12	0.21	0.17	0.14	NA	0.15	0.15	0.14
	Post Monsoon	Lead	0.03	0.021	0.018	0.011	0.015	0.014	0.019	0.015	0.016	0.014
		Zinc	0.11	0.06	0.16	0.19	0.14	0.17	0.20	0.17	0.14	0.14
	Winter	Lead	0.02	0.017	0.022	0.017	0.015	NA	0.016	0.014	0.013	0.015
		Zinc	0.02	0.06	0.14	0.11	0.14	NA	0.17	0.16	0.14	0.14
Agucha village well inside Agucha dam	Pre Monsoon	Lead	0.018	0.022	0.02	0.014	0.016	0.013	0.015	0.015	0.014	0.014
		Zinc	0.20	0.06	0.09	0.24	0.20	0.18	0.15	0.15	0.15	0.14
	Monsoon	Lead	0.019	0.01	0.019	0.014	0.015	0.016	0.016	0.015	0.016	0.015
		Zinc	0.22	0.06	0.11	0.16	0.16	0.14	0.15	0.16	0.15	0.12
	Post Monsoon	Lead	0.015	0.02	0.011	0.014	0.018	0.017	0.014	0.015	0.015	0.013
		Zinc	0.10	0.037	0.11	0.11	0.18	0.16	0.13	0.15	0.15	0.17
	Winter	Lead	0.016	0.019	0.017	0.016	0.016	0.015	0.016	0.017	0.013	0.013
		Zinc	0.02	0.02	0.17	0.14	0.15	0.14	0.16	0.16	0.13	0.16
Near Agucha dam (Inside HZL Boundary)	Pre Monsoon	Lead	0.015	0.019	0.014	0.019	0.015	0.013	0.014	0.014	0.014	0.015
		Zinc	0.015	0.07	0.12	0.22	0.16	0.15	0.14	0.13	0.14	0.14
	Monsoon	Lead	0.034	0.014	0.012	0.017	0.017	0.016	0.014	0.014	0.015	0.015
		Zinc	0.12	0.08	0.11	0.19	0.20	0.14	0.15	0.14	0.15	0.14
	Post Monsoon	Lead	0.025	0.032	0.020	0.016	0.013	0.015	0.015	0.014	0.014	0.015
		Zinc	0.05	0.017	0.14	0.20	0.19	0.16	0.16	0.16	0.15	0.14
	Winter	Lead	0.019	0.011	0.022	0.014	0.016	0.014	0.013	0.014	0.015	0.015
		Zinc	0.02	0.04	0.022	0.15	0.18	0.15	0.014	0.14	0.15	0.14

Source: HZL-Rampura Agucha Mine

5.10 Impact of Solid Waste

- **Waste Dumping**

Open Pit

The Rampura Agucha mine has almost a flat topography with a general surface elevation of 390 mRL. There are four earmarked sites to store the overburden i.e. Site-1, Site-2, Site-3 and Site-4. Existing active dump area is located on northern side of the mine. Top elevation of current dump area is 435 mRL. Waste generated by mining is being dumped at pre decided sites in ultimate dump configuration of 4*10-m lifts for minimum land degradation. Each lift has angle of 45^0 and overall final slope of approximately 27^0. This overall slope angle is kept to limit the increase in surface air velocity and dust entrainment and to aid stability.

In the proposed expansion dumping area will expand towards north & northwest as well as in height with the progress of mine-life. Looking to the expanded open pit and substantial increase in generation of waste, a waste dump of height 100-m has been proposed with following parameters, subject to approval.

- Individual Lift: 20 m
- Overall slope angle: 27^0
- Individual bench angle: 40^0
- Berm Width:19.3-m

The waste rock generated from the mining will be dumped in the earmarked overburden dump yards with proper stabilization and plantation. The physico-chemical analysis of the waste rock indicates that the waste is non-hazardous in nature and not likely to cause any adverse impacts.

The following areas are presently available for accommodating waste:

- Current Dump Area;
- Tailing Dam Bund (Height to be raised upto 51-m in lifts);
- Bund / wall around pit of 5 to 10-m height & 30-40-m wide at top is approx. 392.86 Million Tons; and
- Main dump area (north of the pit)

To accommodate the balance waste quantity and expansion of the pit over the life of the mine, additional land of approx. 155 ha is required, which will be acquired from the lease boundary.

Use of higher capacity dump trucks in waste handling, more compaction over the year is anticipated, which will further enhance the waste dumping capacity. The proposed dumping sites site for sub grade mineral dump. Density of waste in-situ is 2.73 t/m^3 whereas the density of waste in waste dump after compaction becomes 2.201 t/m^3. In the proposed plan period, waste will be dumped at main waste dump, outer periphery of the tailing dam and safety bund around pit. Year wise dumping plan for the plan period is given in **Table-5.9**. These sites are sufficient to take care of waste disposal during the plan period. Due care is taken in all respect for its confinement like the provision of dump stabilization by vegetation on ultimate non-moving ends. A section of the waste dump is shown in **Figure-5.2**. The photograph of existing waste dump rehabilitation site is shown in **Figure-5.3**. The proposed three year plan of waste dump is shown in **Figure-5.4**.

TABLE-5.9
YEAR WISE SCHEDULE OF OVER BURDEN DUMPING FOR THE PLAN PERIOD IS GIVEN AS BELOW

All figures are in Million Tons

Plan Period	Particular	Waste Dump	Tailing Dam	Bund Prep.	Total
	Area to be occupied (ha)	**357.40**	**189.60**	**25.0**	**572.0**
	Total Capacity	**580.3**	**73.4**	**7.1**	**660.8**
	Capacity until (31.03.08)	**93.2**	**32.5**	**5.1**	**130.8**
	Capacity Available as on 01.04.08	**487.1**	**40.9**	**2.0**	**530.0**
Year 1	Year 2008-09	19.60	16.90		36.50
Year 2	Year 2009-10	73.01	9.79		82.80
Year 3	Year 2010-11	87.14	14.26		101.40
Year 4	Year 2011-12	85.32		2.02	87.34
Year 5	Year 2012-13	80.38			80.38
	Grand Total	**345.45**	**40.95**	**2.02**	**388.42**

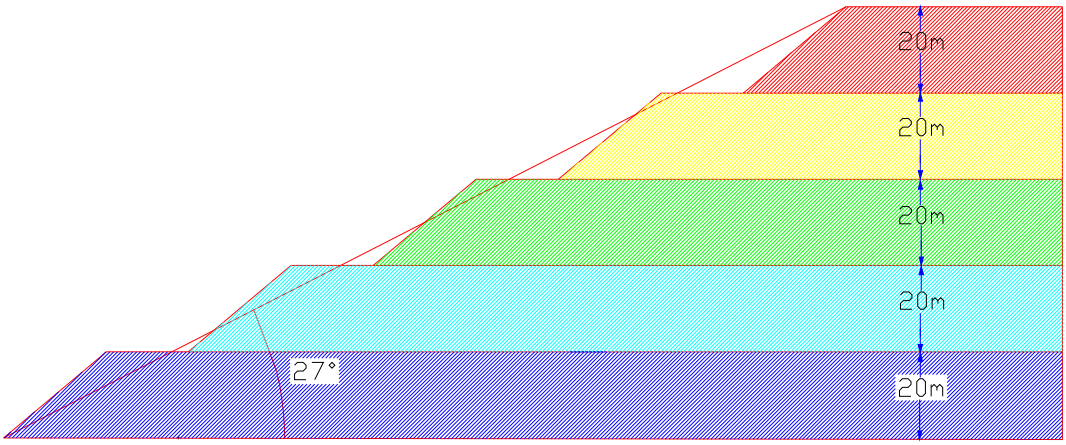


FIGURE-5.2
WASTE DUMP TYPICAL SECTION



FIGURE- 5.3
PHOTOGRAPH OF EXISTING WASTE DUMP REHABILITATION SITE

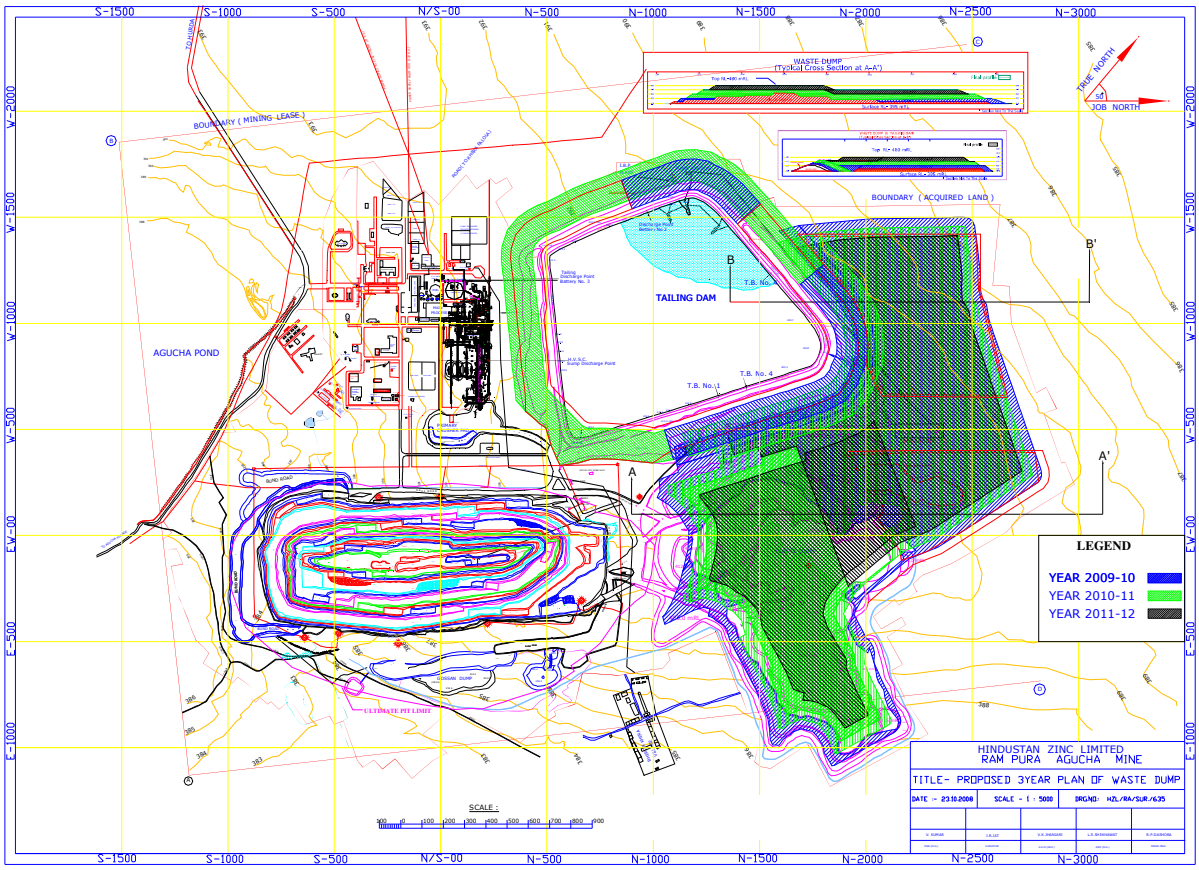


FIGURE-5.4
PROPOSED 3 YEAR PLAN OF WASTE DUMP

- **Underground**

Very little waste rock will get produced from underground as compared to open pit mining. All the initial developmental waste rock generated in first 5 years (about 1 Million Tons) for developing the Decline, shaft, footwall drives, ventilation shafts etc, will be accommodated in the existing waste Dump at surface. Subsequent developmental waste rock will be disposed off in stoped out areas in underground itself.

- **Tailing Disposal**

The tailing is stored in a specially constructed Tailing Impoundment Area. The tailing dam is lined at bottom with top impervious soil & with sand inside of the walls & with top impervious soil on all the sides to avoid percolation of water to the underground. The material for construction of the tailing dam consists of mine waste. The tailing disposal has pipeline on three sides of the dam. After neutralization with lime the thickened tailing is pumped through a tailing line and discharged into the tailing dam. A pumping station has been built in the Northwest corner of the dam and water is reclaimed through wells provided in this area of the dam.

With the expanded capacity of the mine, the tailing dam height is proposed to be raised up to 51m height to accommodate all the tailings generated during the life of the mine. The initial ground level at the tailing dam was 392.5mRL. In the first phase, tailing dam of 6m height was constructed from 392.5 to 398.5mRL. In the second phase, tailing dam height was raised from 398.5 to 404.50 mRL. The third phase height raising of the tailing dam was completed from 404.50 to 410.50 mRL during 2002.The 4th Phase of height raising was completed from 410.50 mRL to 419.5 mRL during 2006-07. The 5th Phase of height raising is under progress from 419.5 to 425.5 mRL.

A pumping station is installed in the Northwest corner of the dam and water is reclaimed through wells provided in this area. Water in the tailing dam is allowed to settle down, then it is reclaimed on continuous basis and pumped to reclaim water reservoir for re-use in the process. No water is allowed to escape outside the dam. The quality of the water in the piezometer wells around the impoundment area is regularly monitored.

5.10.1 Environmental Studies on Tailing Dam

Environmental impact studies conducted by various recognized agencies on tailing dam are given in **Table-5.10** and the summary of studies are detailed below:

TABLE-5.10
LIST OF ENVIRONMETNAL STUDIES ON IMPACT OF TAILING DAM

Sr. No.	Study	Name of Agency
1	Review of Geological Stability of Tailing Dam (April- 2000)	Dr. A.B. Roy, Emeritus Fellow, Deptt. of Geology, MLS University, Udaipur
2	Study the structural safety aspect of tailing dam and also examine impact of blasting on existing dams in the area. (Nov. 2002)	Central Water and Power Research Station, Pune
3	Evaluation of tailing disposal at Rampura Agucha Mine (July 1998)	National Environmental Engineering Research Institute, Nagpur
4	Stability of tailing dam by using ground penetrating Radar and seismic Exploration Methods (July 2000)	National Institute of Rock Mechanics KGF Karnataka
5	Assessment of Aquifer Vulnerability at Rampura Agucha Mine (Jan. 2006)	National Environmental Engineering Research Institute, Nagpur
6	Identify the birds species at tailing dam site and suggest the plan to develop the area as refuge (July 2000)	Bombay Natural History Society, Mumbai

Geological Stability of Tailing Dam

(Dr. A.B. Roy, Emeritus Fellow, Deptt. of Geology, MLS University, Udaipur)

A study was undertaken to assess the geological stability of the Tailing dam site at the Rampura-Agucha Mine in view of its projected enhanced capacity. Particular emphasis of the investigation was on the study of geological microstructures of the Tailing Dam, and reassessment of observation on suspected seepage due to intense jointing shears.

The rock types, which underlie the Tailing Dam site and its immediate neighbour hood include banded granite gneiss and metasedimentary, units, like garnet-biotite-sillimanite gneiss, calc-silicate rocks, amphibolites and pegmatites. The rocks are generally massive, poorly jointed, and show a high-grade metamorphic character.

The major geological structure in the immediate neighbourhood of the Tailing Dam site is a ductile shear zone, which because of its formation at great depth, is characterized by strongly developed foliation and lineation. Unlike a brittle shear zone or fault planes, there is no dislocation plane in this ductile shear zone. Joints are rare, and most of these are mineral-filled, which made the rocks least susceptible to dislocation of any sort. Fabric of rocks including those of the mylonites is characteristically metamorphic lacking any matrix material.

Exposed sections in the mine as well as the available dug-well sections in the immediate neighbourhood of the tailing dam site, indicate that either the soil cover is absent or its presence is very negligible, say within a few meters (maximum about 3-4 meters).

The nature of rocks as prevailing in the area, and the fact that an impervious layer was laid at the base of the tailing dam, reduce the possibility of percolation of water through the base of the tailing dam to the minimum.

The massive character of the bedrock, the thin soil cover and the irregular nature of the soil bedrock contact, make the foundation quite sustainable for any high structures like the tailing dam with its enhanced capacity.

A study on stability of Agucha Irrigation Tank, Tailing dam and Arwar dam during blasting activities at Rampura Agucha mines
(Central Water and Power Research Station –Pune)

From the past data it has been found that the maximum charge weight per delay varies between 60 kg and 680 kg. for a maximum charge of 680 kg, the expected vibration level at a distance of 500 m, which is minimum distance between the mining area and both the Agucha Irrigation tank and the tailing dam, is found to be 6.5 mm/s. this is well within the safe level of 15 mm/s. Further, the blast vibrations recorded on the top of the Arwar dam at a distance of about 6.9 km are found to be less than the ambient vibration level (0.40 mm/s). Thus, the safety and stability of the Arwar dam is considered to be unaffected by the ongoing mining activities (blasting, at Rampura Agucha mine. It is finally considered that the presently used charge weight per delay (60 to 680 kg) are safe for all three dams viz. Sarei, Agucha and Arwar.

Evaluation of tailing dam disposal at Rampura Agucha Mine
(National Environmental Engineering Institute (NEERI), Nagpur)

The surface soil cover all along the traverses around the tailing pond show very low resistivity values mostly around 10 ohm meters. This low resistivity may be caused due to the presence of dumped material or contamination resulting through the seepage of filtrate from the pond. This low resistivity zones may be either due to a highly fractured/shear zone or faults which act as conduits to the ground water flow.

Stability of Tailing Dam *(NIRM)*

The survey work has shown the presence of two shear bands and at least one or two mylonite bands in the subsurface below the tailing dam. Their dip and strike matches with the regional trend of the strata in the mining areas. On analyzing the strength properties, and other engineering properties of rock mass, it is found that the tailing dam should be stable with future expansion plan for raising its height by another 30m. there is no threat of ground slippage or other modes of failure due to any prominent weakness in the subsurface. However, as a precautionary measure, we recommend to analyze the seepage flow rate and quality of discharge periodically so as to gather a wider database for stability evaluation.

Assessment of Aquifer Vulnerability-January 2006
(National Environmental Engineering Institute (NEERI), Nagpur)

Considering the possibility of groundwater contamination due to disposal of tailings in tailing dam, HZL sponsored a study on assessment of aquifer vulnerability due to tailing disposal operations at Rampura Agucha. The major conclusions and recommendations of the study are as follows:

- The assessment of present practice of tailing disposal at Rampura Agucha revealed that, layers of impervious earth have been provided at the bottom of the tailing dam during various phases of construction. Further, about 50 to 60% water from the tailing dam is collected and recycled back to the process while major portion of the remaining waste gets evaporated due to arid climatic conditions.

- The assessment of geological and hydro-geological information at the Rampura Agucha site and its surrounding indicate that the principal aquifer of the area is banded gneissic complex located about 8 to 10 m below ground level. Due to the impervious nature of the BGC the hydraulic conductivity of the aquifer is very low indicating poor groundwater potential in the area.

- The assessment of aquifer vulnerability at Rampura Agucha area using DRASTIC model indicates that the Rampura Agucha area falls under low to moderate category of aquifer vulnerability.

- The assessment of groundwater quality around the tailing dam indicates that high concentrations of certain parameters in the groundwater viz. TDS, Sulphates, cadmium and iron irrespective of their location (upstream or downstream of tailing dam) could be due to the hydrogeological setup of the area. Further, no direct correlation could be established between the tailing dam and the groundwater quality.

- Thus, an overall conclusion could be drawn from the study that the tailing dam at Rampura Agucha had been constructed at a site which has low to moderate groundwater pollution potential. The present practice of tailing management at Rampura Agucha does not pose significant danger to the existing groundwater resources in the area.

- However, keeping in view the long-term operation of the tailing dam, it is recommended that the Rampura Agucha should continue to monitor the groundwater quality around the tailing dam regularly. Besides the existing groundwater monitoring locations, additional piezometers, especially in the downstream of the tailing dam may be installed by Rampura Agucha.

Identifying the birds species at tailing dam site and suggestions
(Bombay Natural History Society)

Heavy metals are usually associated with fine sediments in the aquatic environment. It is therefore likely that the high metal concentrations in the fish are initiated by metals entering the tank via the air borne dust of mining

operations, the material of the tank bund or the anthropogenic sources. The fish would ingest the metals either by their feeding method of reworking the sediments (carp) or by consuming invertebrates that are themselves deposit feeders. Since metals tend to accumulate in the environment, the metals burden within a closed system such as Agucha tank would continue to increase over a long period of time until some critical concentration is reached.

The water quality data as provided by the HZL for the tailing dam also show very high figures of metal concentrations. The metal concentrations are much higher than the acceptable limits of IS standards for discharge into inland surface waters. Since the technical purpose of having tailing dam in this mine is to store the waste received due to the mining activities in the form of a slurry and recycle the clear water for the mining activities rather than discharge it, no water treatment besides the treatment of lime for neutralization of water is given to the slurry. There has not been any systematic studies done to document the micro and macro aquatic fauna inhabiting the tailing dam and further on to analyze the deposition of metals in their tissues. However, by considering average consumption of 2 kg of fish by an individual Pelican every day and with the available figures of zinc and lead deposition in the tissues of fishes that were collected from Agucha tank, we do not recommend the tailing dam of the Rampura – Agucha mine to be developed as a Bird Refuge.

Measures taken to ensure the stability of the Tailing dam

The existing tailing dam having surface area of 130ha. And height 24-m with 3-m filter bed i.e. total height is 27-m from ground level (392.5 mRL to 419.5 mRL) The tailing dam was made of waste rocks with soil lining and rip – rap of stone. There is provision of raising the sidewalls for future capacity enhancement. While designing the dam many parameters were taken into account like rainfall in the area, earthquake history etc. The present dam is very stable with adequate capacity. The photograph showing construction of tailing dam is shown in **Figure-5.5.**

To ensure the stability of the tailing dam, following proactive measures are taken.

a. Inspection of the tailing dam for seepage etc.
b. IISc- Banglore has approved the construction design of the tailing dam upto the height of 41 m and approval for final design for 51-m height tailing dam will be taken before actual construction.
c. To further ensure the stability of the tailing dam, various Scientific studies had been carried out, which are as under.

a. To review the geological stability of the tailing dam, a study was conducted by Dr. A.B. Roy in April 2000. The study reveals that foundation of the tailing dam is quite sustainable for its enhance capacity.
b. To review the structural stability of the tailing dam, in year 2000 a study was conducted by National Institute of Rock Mechanics KGF Karnataka by using "ground Penetrating Radar and seismic Exploration Methods '' and the survey did not find any threat to the stability of the tailing dam in the wake of future expansion plan.

c. To review the structural safety aspect of the tailing dam and also examine the impact of blasting on it, a study was conducted from M/s. Central Water and Power Research Station (CWPRS), Pune in the year 2003. The study reveals that the tailing dam is stable against the blast vibrations generated due to the blasting.

Additional measures, disaster management plan & emergency plan are in place.

In the proposed expansion, there will be a separate tailing disposal system. Although disposal of tailing will be done at the same tailing pond mentioned above.

Generation and Stacking of Subgrade Mineral

Ore containing material in excess of 15% non-sulfide Zinc are the sub-grade mineral which are to be segregated and stock piled separately as gossan. Out of total 1.6 Million Tonnes of gossan, 1.490 million tonne of gossan has already been mined out and stacked at pre defined location. However, the existing gossan dump will be relocated at suitable appropriate location as the present area will be utilized for the proposed expanded pit. At present 110,000 Million Tonnes of sub-grade material (gossan) at the grade of 1.98% Pb (Total), 10.03% Zn (Total), 0.57% Pb (Non sulphide) and 8.80% Zn (Non sulphide) has been dumped within the mine. This material is expected to be excavated during the proposed plan period, which will be stacked separately at designated site of gossan.

Generation and Stacking of Top Soil

The soil cover in the mining area varies from 0.3 to 0.8 m with an average of 0.55 depth. As on 01.04.2008 total 549565.5 m^3 of top soil was generated by mining activities. All the topsoil generated till date has been used for the lining of tailing dam and vegetation on matured ends of waste dump. The topsoil, which generated in initially development phase was stored properly in 2.0-ha land on north side of the mine pit and used for green belt development particularly on waste dump and also in tailing dam embankment whenever raising of tailing dam was done. The mine will continue to preserve topsoil whenever encountered and utilize it for revegetation and other useful activities. The fresh breakage of ground takes place only at a very slow rate since strike length of ore body is limited and majority of which has already opened. Development / production of ore body mostly take place in depths.

The rate of yearly generation of the top soil for proposed plan years will be as given in **Table-5.11**.

TABLE-5.11
YEARLY GENERATION OF TOPSOIL FOR PROPOSED PLAN YEARS

	Year	Quantity generated (M^3)
Year 1	2008-09	0
Year 2	2009-10	0
Year 3	2010-11	126088
Year 4	2011-12	56434
Year 5	2012-13	0
	Total	**182522**

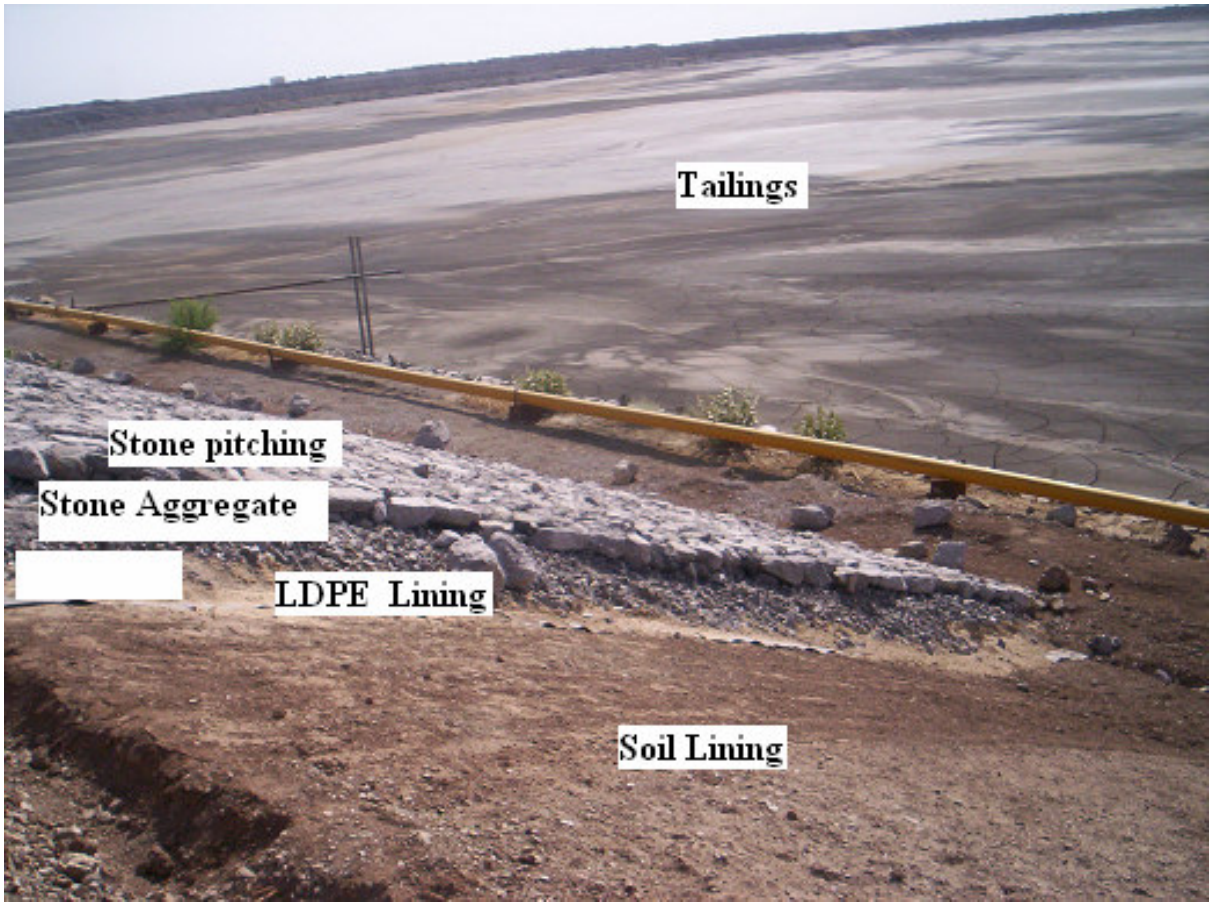


FIGURE-5.5
CONSTRUCTION OF TAILING DAM

The topsoil will be utilized for stabilization of waste dump, slopes of tailing dam and to generate the green belt in surroundings of waste dump and mine area.

Management of Solid Waste from Beneficiation Plant

The waste generated from the beneficiation plant is tailings (5.2 Mtpa), Empty discarded containers of NaCN (6400 No.s/annum) and waste oil (1,85,000 lt/annum). These are hazardous in nature and shall be handled as per hazardous waste handling Rules and guidelines.

- The tailings shall be disposed in the tailing pond. The designed capacity of existing tailing dam up to 51 m height is to accommodate tailings generated from ore treatment till the end of mine life;
- During the proposed expansion, the metal (lead and zinc) recovery from the beneficiation plant will be improved; and
- Waste Oil shall be sold to re-refiners approved by Pollution Control Board and MoEF.

5.11 Impact on Noise Levels and Ground Vibrations

With the mining operations, deployment of machinery, drilling and blasting, excavation and transportation of ore and men are expected to generate the noise levels. However, the nearest settlement is about 800-m (Bherukhera hamlet in South-East direction) from actual mining pit the expected additional noise levels will be insignificant and have significance only from the occupational health point of view.

There will be few additional equipment added during capacity expansion. The source noise levels of these equipment will be maintained at <85 dB(A). Similarly, the blasting will be controlled such that the peak particle velocities will remain within acceptable range even after expansion programme and there will not be much adverse impact with respect to vibrations.

5.11.1 Impact due to Mining Equipment

During the proposed expansion programme, additional machinery will be added in the mine and Beneficiation Plant. The additional equipments and noise levels are presented in **Table-5.12**.

TABLE-5.12
LIST OF ADDITIONAL MINING EQUIPMENTS AND NOISE LEVELS

Sr. No.	Name of Equipment	Proposed [additional]		Noise Levels
		No.	Capacity	dB(A)
1	Dumper	18	177-218 T	<85
2	Drill for pre-splitting	2	115 mm	<85
3	Track Dozer	2	318 HP	<85
4	Excavator F/E	3	30-40 m^3	<85
5	Track Dozer	2	>510 HP	<85

The noise levels of the mining equipment will be maintained less than <85 dB(A) at the operator level. The equipment suppliers will comply with these specifications with respect to noise.

5.11.2 Impact due to Ground Vibrations

Blasting, in addition to loosening the hard strata, generates ground vibrations and instantaneous noise. Ground vibration from mine blasting may be expressed by amplitude, frequency and duration of blast. The variables, which influence ground vibrations are:

1. Controllable; and
2. Non-controllable.

The non-controllable variables include: general terrain, type and depth of overburden and wind. The controllable variables include: type of explosive, charge per delay, delay interval, direction of blast progression, burden, spacing and specific charge and coupling ratio. When an explosive charge is fired in a hole, stress waves propagate radially in all directions and cause the rock particles to oscillate. This oscillation is felt as ground vibration. The vibrations are measured as the Peak Particle Velocity (PPV). The noise levels and vibrations are instantaneous and depend upon the maximum charge per delay.

Monitoring of ground vibrations due to blasting at the mining area, is regularly done by HZL. Fixed monitoring stations have been located at strategic sites like Agucha village, Bherukhera village and tailing dam. The peak particle velocity at these locations has been observed to be about 3-mm/sec with the current level of blasting.

The proposed expansion programme, the blasting frequency will remain same with about 10-15% escalation. The blast size will increase to match the enhanced production.

In the existing mining project, about 25-30 blasts are performed in the mine per month. This may increase by 10-15% during the expansion programme to achieve the increased excavation required for expansion. However, the maximum charge per delay will be restricted to 500 kg even after proposed expansion.

The peak particle velocities after the expansion programme will remain in the same acceptable range even after expansion programme and there will not be much adverse impact with respect to vibrations.

5.11.3 Blast Induced Noise & Vibrations

Blasting contributes to noise pollution and vibration. The intensity of the vibration and noise depends upon the maximum charge per delay during blasting. Blasting causes ground vibrations that travel through the ground in the form of energy waves away from the blast or point of initiation of the charge.

In the proposed expansion programme, the frequency will be marginally (about 10-15%) increased and the blast size will be proportionately increased to achieve

increased excavation. However, there will be no increase in the maximum charge per delay, which will be restricted to 500 kg.

- Improvement in blasting by using:
  - Blasting software (JK Simblast)
  - Videography and analysis of each blast
  - Monitoring of vibrations for each blast
  - Use of Non-electric and electronic initiation system
  - Minimising "Maximum Charge Per Delay"

- Blast optimisation by expertise of:
  - CIMFR
  - NIRM
  - Tim Hagan (Australia)

- Further upgraded technology of the blasting shall be undertaken to further reduce the blast-induced noise and vibrations. ; and
- Minimizing secondary blasting by using rock breaker.
- Pre split drilling will be introduced in the expansion phase for further reduction in blast vibrations.

5.11.4 Impact on Air Over Pressure (AOP)

Air Over Pressure (AOP) is the energy transmitted from the blast through the atmosphere in the form of pressure waves. These waves consist of a wide range of frequencies, some of which are audible known as noise while rest of the energy is inaudible frequencies of less than 20-Hz.
Scatter of AOP depends on many variables such as direction and velocity of wind, stemming and topography.

The measured AOP at near by villages are in the range of 95 to 105 dB(A) depending upon the maximum charge per delay and distance of the blast from the monitoring site. The noise level measured during blasting at Bherukhera the nearest village is ranged from 82 to 100 dB(A). However, it is very instantaneous in nature and only once during the day. Thus, this does not cause any adverse impact on the community, as it is not a continuous exposure.

In the proposed expansion, during blasting maximum charge per delay will be restricted to 500 kg as in the existing mining and with a marginal increase in the blasting frequency. There will not be any significant change after the expansion project.

5.11.5 Noise Generated from Beneficiation Plant

In beneficiation plant, noise is generated mainly at the ore crushing; sizing and screening units. The existing noise levels near the equipment source are ranging from 65-90 dB(A). The noise levels due to the current operations have already been covered under the baseline monitoring. The additional equipment and their expected noise levels at the source level are given in **Table-5.13**.

TABLE-5.13
NOISE DUE TO BENEFICIATION PLANT (ADDITIONAL EQUIPMENT)

Sr. No.	Particulars	Additional	Noise Level dB(A)
1	Primary Crusher	0	<85.0
2	SAG mill	1	<85.0
3	Ball Mill	1	<85.0
4	Lead rougher/Sca.Cells	7	<85.0
5	Lead cleaner cells	8	<85.0
6	Zinc Rougher/ Sca. Cells	8	<85.0
7	Zinc Cleaner cells	12	<85.0
8	Pressure Filter	4	90.0
9	Air Blower	2	90.0
10	Air compressors	4	<85.0

5.11.6 Noise Dispersion from the Project

The noise generation from the beneficiation plant and mine will be from various sources which will be originating from various locations within the plant and mine area. For the purpose of noise dispersion, it is assumed that all the noise generating sources from the mining pit and beneficiation plant as different sources. For the purpose all the additional mining equipment have been taken into account. The dispersion of these noise sources and the impact of the same on the outside community are computed by using the model.

5.11.6.1 Noise Impact Analysis on Community

The predicted noise levels at mine boundary as obtained by modeling are presented in **Table-5.14.**

TABLE-5.14
PREDICTED NOISE LEVELS AT MINE BOUNDARY

Sr. No.	Plant Boundary	Baseline Noise level at Boundary	Predicted Incremental Noise Levels	Resultant Noise Levels at Mine Boundary
		dB(A)	dB(A)	dB(A)
1	North	55.3	37.0	55.4
2	Northeast	55.2	42.0	55.4
3	East	51.7	42.0	52.1
4	Southeast	51.2	36.0	51.3
5	South	54.4	36.0	54.5
6	Southwest	56.8	36.0	56.8
7	West	60.2	41.0	60.3
8	Northwest	56.3	41.0	56.4

From the above table, it is observed that higher noise levels will be confined to work zone areas only. It can be seen that noise levels get diffused rapidly with distance. The predicted incremental noise levels at the mine boundary will be in the range of 37 to 42 dB(A). Agucha village is situated at about 2.0 km from the source in the south direction. The background noise levels recorded at this place is 61.3 dB(A) during day time and 47.6 dB(A) during night time. The proposed capacity expansion of mining will not add significantly to the current monitored levels at Agucha. Similarly, at Bheruh-khera village the observed day time noise levels are

51.8 and night time 42.1 dB(A). Hence, the impact on noise levels due to proposed expansion project will be insignificant.

5.12 Subsidence-Prediction and Prevention

The mining method is the other major component of subsidence that influences its environmental impact. The subsidence created by stope mining is usually the result of unintended cave-ins, inadequate support, pillar robbing, mining too close to the surface, and eventual collapse of the workings over time as the inevitable consolidation of the strata takes place. Most often subsidence is limited to the hanging wall side of underlying stopes. In many ca-ses, the degree of surface subsidence that occurs from stope mining is both isolated and relatively minor.
A number of geologic and mining parameters can affect the magnitude and extent of subsidence. These include the thickness of extracted materials; overlying mining areas; depth of mining; dip of mining zone; competence and nature of mined and surrounding strata; near surface geology; geologic discontinuities; fractures and lineaments; in-situ stresses; degree of extraction; surface topography; ground water (including water elevation and fluctuation); mine area; method of mining; rate of advance; backfilling; time; and structural characteristics

A detailed study is being carried out on the ground stability at Rampura Agucha mine, using both Empirical and Numerical modelling method. The objective of the study is to find out if there is a possibility of any sort of physical disturbance of the ground surface in the mining area due to the mining activity below ground.

Subsidence prediction study and shaft & Raise Pillar Design at RA Mine is being done by CIMFR (Central Institute of Mining and Fuel Research) Dhanbad.

5.12.1 Subsidence Management Plan

Regular monitoring of subsidence at the surface shall be carried out.

Surface subsidence shall be monitored in the area at the nodes of grid formed by lines at 100 m interval. The readings shall be recorded at 3 months interval. Locations having subsidence greater than 0.25 mm shall be carefully looked into and the subsidence survey shall be carried out at those locations on monthly basis.

5.13 Impact on Flora and Fauna

5.13.1 Impact on Flora

The area is devoid of any forest in the study area of 10-km radius. The region does not show much diversity. There is no suitable habitat for the occurrence of ecologically important flora in the area.

5.13.1.1 Impact on Terrestrial Ecology

The entire mine lease area is a non-forest area. The land surrounding the mine lease area is a barren land with sparse vegetation. This may be due to the

prevailing arid climatic conditions. There are no endangered species of flora reported or observed in the vicinity of the plant or mine.

The proposed expansion does not involve any tree felling since capacity enhancement is carried in present mining pit. Hence, there will not be any impact on the existing vegetation or flora.

The impact on terrestrial ecology would be primarily due to emission of pollutants like SPM, NOx and SO_2. SO_2 in low doses may have beneficial impacts on plants, but produces adverse effects in high doses.

In the present project, adequate stack heights and dust control measures like water sprinklers etc. are provided. As described in the air quality section above, the contribution of SPM, NOx and SO_2 due to operation of the mine is insignificant and the resultant AAQ levels are well within the AAQ standards. The dust and gaseous emissions from the mine and beneficiation plant will be confined to the mine lease area only. Therefore, the impact of these emissions on the surrounding agro-ecosystem will not be adverse.

Extensive plantation comprising of pollutant resistant species are undertaken in and around the project site which has served as not only pollution sink but also as noise barrier. Under the Greenbelt development program, HZL has planted wide variety of species, which can be termed as beneficial impact. Various agencies have been given the contract of plantation and its maintenance under the supervision of Horticulturist. This has ensured very good survival rate of plants, which is about 80 to 90 %.

5.13.2 Impact on Fauna

As described above the area is devoid of any forest or vegetative cover. There are no endangered species of fauna reported or observed in the vicinity of the plant and mine. The land surrounding the plant and mine is barren. There are no records of any fauna of significance in the area. The fauna which is present is of very common species and available near almost all human settlements. Thus, no adverse impact on the fauna is envisaged due to the mining activity. Further, the fauna in the region have been habituated for the noise from the blasting and other mining activities. The proposed expansion project, the noise levels from blasting and other operations are not going to escalate significantly. Hence, no adverse impact is likely on fauna because of the expansion project.

5.13.3 Impact on Aquatic Ecology

The plant is based on zero discharge. Every possible measure is taken to ensure that no water is discharged out of the mine premises. Garland drains are available followed by pond for collection of storm water particularly for few initial rains, which carries more load of contamination. Hence contamination of surface water is not anticipated. Hence the impact on aquatic ecology is insignificant.

5.14 Impact on Traffic Density

With the proposed expansion project the traffic is likely to increase on the existing road network during the operation phase on Rupaheli road. The impact of the traffic is assessed on the basis of adequacy of the existing road network.

The traffic study was conducted to know the existing traffic volume and the data is presented in Chapter-4. The proposed estimated traffic was superimposed on the existing traffic to assess the adequacy of the road.

5.14.1 Traffic due to Proposed Project

It has been considered that the peak daily vehicle traffic after the proposed project would be about 665 trucks per day (100 heavy vehicles) i.e. 1485 PCU (Passenger Car Unit) during operation per day. The total traffic will be on the road connecting Rampura Agucha mines and Rupaheli road only. The details of proposed traffic are presented in **Table-5.15**.

TABLE- 5.15
EXISTING AND PROPOSED TRAFFIC ON RUPHELI VILLAGE ROAD

Type of Vehicles	No. of Vehicle	PCU/Day
Existing Traffic		
2/3 wheeler	124	62
Cars	100	100
Trucks & Heavy Motor Vehicles	266	798
Additional traffic due to Proposed Expansion Project		
Trucks	175	525
Total	**665**	**1485**

(PCU Factors: Light Duty Vehicles=1.0, Trucks/Buses/tractors=3.0, 2/3 Wheelers=0.5)

5.14.2 Adequacy of the Existing Road network

To assess the traffic volume on the Rupaheli road, traffic count study was conducted at a junction where Rampura-Agucha road joins the National Highway (NH-79). The traffic coming from and going to Agucha was counted. The present level of traffic has been converted to Passenger Car Units (PCU) at all the locations as per the conversion factors stipulated by Indian Road Congress (IRC).

With present level of traffic and the increase in existing traffic due to the project, adequacy of road/highway during operational phase has been estimated by comparison with the recommendations stipulated by Indian Road Congress (IRC). The IRC recommendations on traffic capacity are presented below in **Table-5.16.**

TABLE-5.16
RECOMMENDATIONS ON TRAFFIC CAPACITY - IRC

Sr. No.	Category of Road	Maximum PCU/day
1	Two lane roads (7-m) with earthen shoulders	15,000
2	4-lane highway with earthen shoulders	35,000

In assessment of road adequacy, growth of natural traffic other than HZL traffic has not been considered. The road has been recently strengthened and widened to 7-m width. Thus the present road is adequate for the future increased traffic volume.

5.15 Impact on Socio-Economic Aspects

There is a general perception that any project may have more adverse effect as compared to beneficial effect. However, in case of Rampura-Agucha Mine every possible measures have been taken to ensure that the life of the people doesn't get affected adversely.

5.15.1 Rehabilitation and Resettlement

In the proposed expansion project, no additional land is required. Hence, there are no rehabilitation and resettlement issues are involved.

5.15.2 Impact on Human Settlement

Some of the villages near the existing mine have been benefited directly or indirectly by the project. There has been lot of improvements in infrastructural facilities like supply of tap water, deepening of well, construction of road (Bherukhera-Agucha road), construction of water tanks (Bherukhera, Agucha and Paprikhera) villages. Such type of community welfare measures will be continued in the future also.

5.15.3 Impact on Population Growth

The population density would not increase further due to capacity enhancement since the existing man power is utilized.

5.15.4 Impact on Social Status

The study area is predominantly a rural area. Due to the Government's policy of giving more opportunities in employment to the weaker sections, population of the study area is benefited.

5.15.5 Impact on Health Care Facilities

The health care facilities in the study area are good as per census 2001. HZL has set up one hospital in the township for their employees. The nearby village residents can also avail these facilities in case of emergency. The proposed expansion may not put any additional pressure on the local health facilities.

6.0 ENVIRONMENT HEALTH AND SAFETY MANAGEMENT PLAN

6.1 Corporate Philosophy of HZL

HZL has a corporate philosophy of sustainable development. In order to properly manage its activities for environmental protection, an 'Environmental Management Division' was set up. The EMD at various levels and locations have experts in the fields of Environmental Engineering, Environmental Science, Environmental Management, Wastewater Treatment and Horticulture. EMD involves in implementation of all necessary measures to protect environment in the environs of its various units in India. Each unit has separate well-equipped environmental cell, which regularly monitors various environmental parameters in and around the units.

Rampura-Agucha Mine is an ISO 9001, ISO 14001 & OHSAS 18001 and SA-8000 certified unit. **HZL** Environment, HSE in Nutshell, Occupational Health, Safety, Security and Community Policy; HSE Organogram and Corporate HSE Governance System are presented below:

EHS at HZL

EHS is driven by its Policy and overseen by EHS Committee.

- EHS policy at Company level as well as unit level
- EHS Committee at Company level

EHS System is in place

- Management information system (MIS)
- EHS Business Plan
- Integrated Management System (ISO 9001, ISO 14001 & OHSAS 18001)
- Social Accountability (SA 8001)

Modern Environment Laboratory, well equipped and versatile

Micro meteorological observatory, online stack and ambient monitoring

Qualified/ Specialized EHS team which works closely with operation team

Focused R&Ds being done in association with premier research institutes with the objectives of environment improvements.

Training on environmental awareness and in house EHS magazine 'Saath Saath' and 'Apna HSE Web Portal'

Elaborate MIS on key performance indicators is in place and sustainability development report prepared under Global Reporting Initiative.

External EHS audits are being done by reputed agencies.

Winner of several Environment and Safety Awards.

Hindustan Zinc Limited

ENVIRONMENT, OCCUPATIONAL HEALTH, SAFETY, SECURITY AND COMMUNITY POLICY

HZL believes in sustainable development in harmony with nature and accordingly, is committed to the effective management of health, security and safety of all its employees, protecting its surrounding environment and making a contribution to the development of the local community.

This commitment encompasses efficient use of natural resources, protection of assets and provision of a safe workplace with support systems for zero harm to the environment.

Accordingly, HZL will strive to :

- Maintain management systems for health, safety, security, environment and the community that are in compliance with law and consistent with world-class standards like ISO 14001, OHSAS 18001.
- Develop a working culture conducive to continuous improvements in performance without compromising with safety, security and health of its employees and its commitment to develop in harmony with nature.
- Develop employees through training and leadership.
- Conserve natural resources through efficient use.
- Work with communities to contribute to their development.
- Institute and update systems to report progress with high standards of reporting integrity.

Date : 13th December, 2005
Place : Udaipur

M.S. Mehta
CEO & Whole-time Director

Corporate HSE Governance System

HZL HSE Committee
(Company Level)

HSE Team
(Unit level)

Operation team
(Unit level)

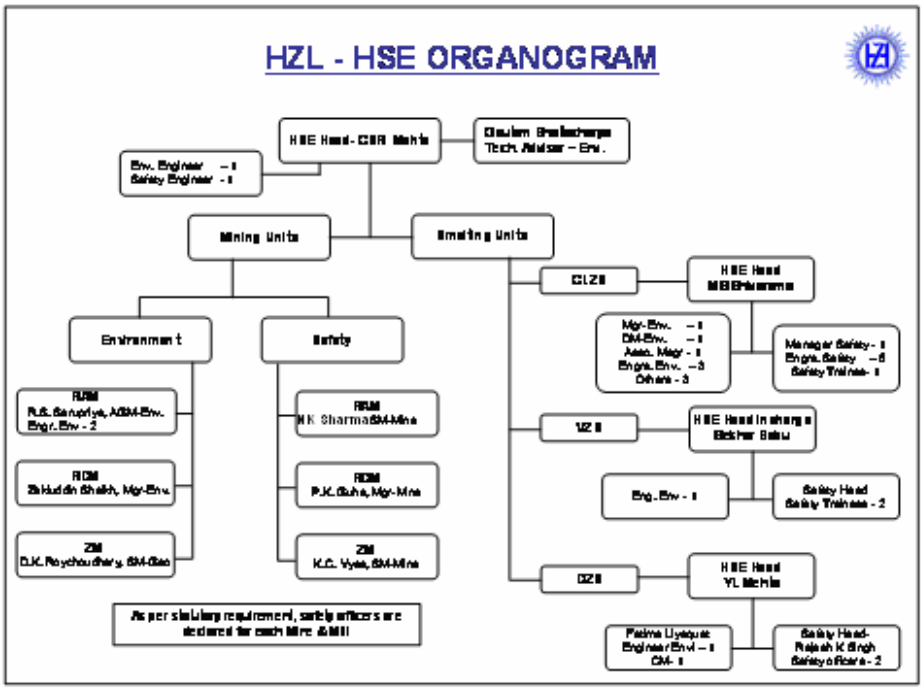
Objectives

- To periodically (at a frequency not less than once in a quarter) review HSE performance of the Company
- To give direction to efforts & resources deployed for HSE initiatives.
- To set & review targets for HSE performance.
- To review & report to the Board of Directors, the performance of the Company with respect to HSE management.

Committee Members

- Mr. M.S. Mehta, Chairman
- Mr. S.L. Bajaj
- Mr. R.K. Bansal
- Mr. Akhilesh Joshi
- Mr. CSR Mehta (Ex-officio member as Head of HSE function for HZL)
- Mr. Hitendra Bhuptawat (Secretary)

HZL - HSE ORGANOGRAM



6.2 Environment Management Plan

The mining development in the study area needs to be intertwined with judicious utilization of non-renewable resources of the study area and within the limits of permissible assimilative capacity. The assimilative capacity of the study area is the maximum amount of pollution load that can be discharged into the environment without affecting the designated use and is governed by dilution, dispersion and removal due to physico-chemical and biological processes. The Environment Management Plan (EMP) is required to ensure sustainable development in the study area (10-km) of the mine site, hence it needs to be an all encompassive Plan for which the mine authorities, Government, Regulating agencies like Pollution Control Board, Indian Bureau of Mines (IBM), Department of Mines and Geology, Director General Mine Safety (DGMS) and Department of Mines and Geology (DMG) working in the region and more importantly the affected population of 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 mining and plant activities. 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 study area and also to preserve the assimilative capacity of the receiving bodies.

The environmental attributes, which could be affected in the region are land use, topography, water resources, water quality, soil, air quality, socio-economic status and ecology and these have been identified in Chapter-5 (Anticipated Environmental Impacts).

The Management Action Plan aims at controlling pollution at the source level to the possible extent with the available and affordable technology followed by treatment measures before they are discharged.

In addition to the mine and plant specific control measures, the proposed expansion of mine and plant should follow the progressive land reclamation measures and overburden management and phase-wise afforestation along with the production of lead-zinc ore.

6.3 Air Pollution Management

The potential sources of air pollution arising from the mining are drilling, blasting, crushing, overburden waste dumps, haul roads, combusting of fuel oil and transportation of ore in the vicinity. Similarly, the air pollution sources from the beneficiation plant are crushing and grinding of ore.

Air pollution caused by mining and beneficiation plant activities can be classified into the following categories:

- Gaseous pollutants [Nitrogen Oxides, Sulphur Dioxide and Carbon Monoxide]; and
- Suspended Particulate Matter.

From a perusal of contents highlighted in Chapter-4, it is observed that RPM, SO_2 and NOx at all the ambient air quality locations are well within the permissible limits. Only Total Suspended Particulate Matter has been observed to be occasionally exceeding the permissible limits at some of the locations although this is attributable to the arid nature of the region.

Similarly, the particulate concentrations in all the stacks attached to the Primary and secondary crushers, stack attached to DG sets and Fine Ore Bin (FOB) are observed to be well within the prescribed standards.

The impacts due to the proposed expansion project are discussed in Chapter-5. The mitigation measures being implemented in the existing project (5.0 Mtpa) will be continued in the proposed expansion also. The existing mitigation measures for 5.0 Mtpa capacities have been discussed in Chapter-2.

6.3.1 Proposed Mitigation Measures

The additional measures recommended are:

- Increasing the frequency of the water sprinkling on haul roads and active mining face;

  The existing set-up has 3 water sprinklers of 28-m^3 capacity each and two 40 KL. In addition, an automatic water sprinkling system has been installed on permanent haul roads. The present frequency of water sprinkling is once every hour during summer and once every two hours during other seasons like winter and post-monsoon season. The frequency shall be increased and will be extended as per the mine development;

- Use of wetting chemicals at mine haul roads for dust suppression;

- Additional plantation on waste dumps and near tailing dam shall be carried out; and gaps shall be filled up in the existing greenbelt to improve the vegetation density;

- Additional truck / tyre washing system will be installed near the concentrate stock yards for washing of concentrate sticking on truck tyres;

- In order to control dust generation during blasting, drill cuttings shall be removed before the blasting operation. This will further reduce the dust generation;

- The over burden can be dumped by giving less aerial lift and grading can be done by gradual dozing. This will help in reduction of dust generation on the waste dumps while dumping the waste;

- Water sprays shall be sprayed on coarse ore stock piles for reducing dust generated during dumping of ore from the tripper conveyors;

- Well equipped workshop for the regular maintenance of vehicle and machineries in order to control emissions; and

- The concentrate carrying trucks should be covered with tarpaulin to prevent any possibility of dust generation as per the present practice.

6.4 Water Pollution Management

The mining project requires continuous supply of water for various purposes during mining, vegetation, beneficiation of ore *etc.* apart from drinking water supply. Present water requirement is met from radial well at Banas riverbed, which is about 60-km away from the mining area.

The impacts due to the proposed expansion capacity project have been addressed in Chapter-5.

It has been observed that the impact on water resources will be marginal by taking the mining depth to 372-m as there will be hardly any ground water accumulation in the mining pit due to low hydraulic conductivity. The ground water fluctuations observed in this region are attributable to rainfall fluctuations and not attributable to mining activities.

There is no additional water requirement in the proposed expansion project. Hence, the impact on the water resources is not envisaged.

In the proposed capacity expansion, the tailings will be stored in the existing tailing dam. Water recovered from the tailing dam shall be recycled to the beneficiation plant.

There will not be any discharge of wastewater outside mine/mill premises and zero discharge condition will be maintained. Hence, no adverse impact on surface water quality due to the proposed expansion is anticipated.

The existing mitigation measures for 5.0 Mtpa capacities have been discussed in Chapter-2. These measures will be continued after proposed expansion also.

6.4.1 Proposed Mitigation Measures

The additional measures recommended are:

- Improvements in dumper cleaning system at Heavy Vehicle Service Center (HVSC) including oil trap;

- Optimization of existing Sewage Treatment Plants in the Residential area with provision for recycling of treated effluent to increase the water recovery and reduce the fresh water consumption;

- Optimization of existing Sewage Treatment Plants in the industrial area with provision for recycling of treated effluent to increase the water recovery and reduce the fresh water consumption;

- High rate thickeners will be installed to improve the water recovery from tailing and concentrates;
- Use of evaporation retardant chemicals at tailing dam; and
- Use of flocculants in the thickeners to improve water recovery.

These measures while minimizing further the probability of water pollution, will also help in reducing fresh water consumption even beyond the envisaged water consumption @ 0.50 m^3/Million Tonne of ore treated in the beneficiation plant.

6.5 Noise and Vibrations

The impacts on noise levels due to the capacity expansion project are given in Chapter-5. Additional equipment will be added during capacity expansion. The source noise levels of these equipment will be maintained at <85 dB(A). Similarly, the blasting will be controlled such that the peak particle velocities will remain within acceptable range even after expansion programme and there will not be much adverse impact with respect to vibrations.

The incremental noise levels due to mining and mill at the mine boundary will be in the range of 35 to 40 dB(A) and these will be insignificant.

The mitigation measures with respect to existing plant 5.0 Mtpa capacity will be continued after the proposed expansion project also.

6.5.1 Proposed Mitigation Measures for Noise Control

In addition to the existing mitigation measures, following additional measures are proposed:

- Equipments to be procured will have the noise emission optimal for their design/operation. Proper maintenance/working shall be done to keep the equipment in good health;

- Improving the existing greenbelt to attenuate the noise level. The proposed green belt details are discussed in Section-6.7; and

- Further, all the guidelines and precautions specified by DGMS will be strictly adhered to in order to control the noise levels.

6.5.2 Blast Induced Noise & Vibrations

Blasting contributes to noise pollution and vibration. The intensity of the vibration and noise depends upon the maximum charge per delay during blasting. Blasting causes ground vibrations that travel through the ground in the form of energy waves away from the blast or point of initiation of the charge.

In the proposed expansion programme, the frequency will be marginally (about 10-15%) increased and the blast size will be proportionately increased to achieve increased excavation. However, there will be no increase in the maximum charge per delay, which will be restricted to 500 kg.

- Further upgraded technology of the blasting shall be undertaken to further reduce the blast-induced noise and vibrations. ; and
- Minimizing secondary blasting by using rock breaker.

- Pre split drilling will be introduced in the expansion phase for further reduction in blast vibrations.

6.6 Solid Waste Management

The presently practiced mitigation measures for the existing 5.0 Mtpa capacity are given in chapter-2. These measures shall be continued after the proposed expansion project also.

The impacts due to solid waste from the proposed capacity expansion are given in Chapter-5.

The waste rock generated from the mining will be dumped in the earmarked overburden dump yards with proper stabilization and plantation. The physico-chemical analysis of the waste rock indicates that the waste is non-hazardous in nature and not likely to cause any adverse impacts.

The tailings from the beneficiation plant will be routed to the tailing pond. Due to improved metal recovery in the plant, the tailings are likely to have less metal concentrations after expansion.

The empty discarded containers of NaCN from the beneficiation plant will be de-contaminated and sold as a scrap after making unusable by puncturing. The waste oil will be sold to authorized re-refiners.

6.6.1 Management of Overburden Waste/Sub-Grade Material and Reclamation

The over all waste rock generation is 10.8 times the ore production rate. However, on year to year basis the ratio may vary/ Over the life of open pit, a total approximately 203.40 million tonnes waste shall be generated out of which approximately 158.05 million tones can be accommodated at the four dumping sites i.e. Site-1, Site-2, Site-3 and Site-4. Balance shall be utilized in construction of tailing dam embankment.

Top elevation of current dump area is 435 mRL. Waste generated by mining is being dumped at pre decided sites in ultimate dump configuration of 4*10-m lifts for minimum land degradation. Each lift has angle of 45^0 and overall final slope of approximately 27^0. This overall slope angle is kept to limit the increase in surface air velocity and dust entrainment and to aid stability.

In the proposed expansion dumping area will expand towards north & northwest as well as in height with the progress of mine-life. Looking to the expanded open pit and substantial increase in generation of waste, a waste dump of height 100-m has been proposed with following parameters, subject to approval.

- Individual Lift: 20 m
- Overall slope angle: 27^0
- Individual bench angle: 40^0
- Berm Width:19.3-m

Waste disposal will have same configuration with existing practice of 4 x 10 m benches in ultimate position with top mRL of 435 m & overall slope angle of 27^0. Mine is dumping presently at Site-1 and tailing dam. Due care is taken in all respects for the stability of the dump like the provision of dump stabilization by vegetation on ultimate non-moving ends. The year wise overburden-dumping schedule upto life of the mine is given in **Table-6.1.**

The following areas are presently available for accommodating waste:

- Current Dump Area;
- Tailing Dam Bund (Height to be raised up to 51-m in lifts);
- Bund / wall around pit of 5 to 10-m height & 30-40-m wide at top; and
- Net dumping capacity available as on 01.04. 2009 in the newly designed waste dump (up to 100 m ht. within the acquired boundary)

To accommodate the balance waste quantity and expansion of the pit over the life of the mine, additional land of approx. 155 ha is required, which will be acquired from the lease boundary.

Use of higher capacity dump trucks in waste handling, more compaction over the year is anticipated, which will further enhance the waste dumping capacity. The proposed dumping sites site for sub grade mineral dump. Density of waste in-situ is 2.73 t/m^3 whereas the density of waste in waste dump after compaction becomes 2.201 t/m^3. In the proposed plan period, waste will be dumped at main waste dump, outer periphery of the tailing dam and safety bund around pit.

TABLE-6.1
YEARWISE HANDLING OF OVERBURDEN WASTE

All figures are in Million Tonnes

Plan Period	Particular	Waste Dump	Tailing Dam	Bund Prep.	Total
	Area to be occupied (Ha.)	250.40	189.60	-	440.00
	Total Capacity	443.08	73.43	7.14	523.65
	Capacity until (31.03.09)	112.79	49.38	5.12	167.29
	Capacity anticipated as on 01.04.09	330.29	24.05	2.02	356.36
Year 1	Year 2009-10	73.01	9.79	-	82.80
Year 2	Year 2010-11	87.14	14.26	-	101.40
Year 3	Year 2011-12	85.32	-	2.02	87.34
	Grand Total	**245.47**	**24.05**	**2.02**	**271.54**

The total overburden dump capacity of 158.05 million MT is available to store the total 157.63 million MT of overburden generated till end of the mine life.

The mitigation measures for the existing and new dumpsites shall cover the following:

- Overall slope of 27^{o} and maximum height of 40-m is maintained to give proper stability to the dump;
- Waste is stacked systematically in layers and leveled by dozer;
- After reaching the benches to their ultimate location, plantation shall be done. The details of stage wise plantation and area wise plantation and the type of species to be planted on the over burden dumps is given in subsequent Sections.
- Construction of garland drains around the dump so that surface run off from the dump is collected in a sump and pumped to water reclamation pond; and
- Regular maintenance of the garland drains constructed around the solid waste dump to collect the surface run off.

6.6.2 Management of Solid waste from Beneficiation Plant

The waste generated from the beneficiation plant is tailings, Empty discarded containers of NaCN and waste oil. These are hazardous in nature and shall be handled as per hazardous waste handling Rules and guidelines.

- The tailings shall be disposed in the tailing pond. The existing tailing pond is adequate to take the additional load; the details of the tailing pond are already discussed in Chapter-2;
- During the proposed expansion, the metal (lead and zinc) recovery from the beneficiation plant will be improved; The Pb content in tailings will decrease from 0.50% to 0.40% and Zinc content will decrease from 1.42% to 1.25%; hence the metal content in the tailings shall be further less;
- Empty discarded containers of NaCN shall be de-contaminated and made un-usable by puncturing before selling as scrap; and
- Waste Oil shall be sold to re-refiners approved by Pollution Control Board and MoEF.

6.7 Greenbelt Development

HZL initiated the greenbelt development program in the year 1988-89 on a very large scale. The lease hold area was totally barren land prior to the establishment of the mine. The intensive plantation by HZL has changed the look of the area. The total 1200-ha of mining lease area consists of non-forestland with semi-arid climatic conditions. The acquired land for mining activities is 869.5 ha.

The greenbelt development program under eco-plan started by planting 5000 numbers of saplings covering an area of 4.5 ha in the year 1988-89. Since then the program has been implemented with great enthusiasm and dedication. So far about 260-ha of land has been brought under this program and about 2,72,000 number of plants have been planted with a survival rate of more than 80%. Plantation is done along the roads, on the periphery of mining pit area, near waste dump, near beneficiation plant and near administration building. In addition to this about 35,000 numbers of plants are planted in township covering an area of 33.5 ha of land.

The massive plantation has been done under this program and wide varieties of species are planted.

6.7.1 Details of Greenbelt

The plantation and green belt development in waste land will improve the aesthetic look, check soil erosion, make the ecosystem more complex and functionally more stable, make the climate more conducive and restore water balance. It can also be employed to bring areas with special problems under vegetal cover and prevent further land deterioration.

Natural Colonizers

In open cast mine waste and waste dumps slopes, grasses, such as *Cynodon sp*, and hedges, such as *Cyperus sp*, have been found growing on mine spoils preferably with moisture. *Typha sp*. Cyperus and also *Cynodon sp* are the only plants to naturally colonize the edges of drainage of tailing dams.

Establishment of Vegetation on Waste Dumps and Slopes

Natural succession in such hostile mined areas is very often very slow, but can be achieved through self-sustaining vegetative cover by using these pioneer species. Restoration is an ecological process, which needs the pioneer species. Lower groups of plants are often first to appear. Grasses may form the first stage growth. Early colonizers also include legumes, and other nitrogen fixing plants or ectomycorrhizal trees. These may improve the site through their root system and the resultant organic matter gradually changes the texture of soil for further succession.

Succession of plants depends upon the availability of seed. Transplanting may be preferred if direct seeding becomes difficult. Factors inhibiting succession include acidity, heavy metal toxicity, drought and lack of nutrients. The recommended precautions for restoration of natural vegetation are (i) avoid cover crops and widespread use of fertilizer; (ii) establish perennials in a nursery; (iii) use long brushwood and return topsoil; and (iv) plant the seedlings in the undergrowth along with balanced slow release fertilizer near the seedling. However, heavy initial application of fertilizer is commonly used where the establishment of cover or plantations is desired.

Use of Fertilizers

Restoration of natural fertility is a very long drawn process without external intervention, whereas establishing the vegetation with fertilizer can quickly restore the fertility. Only slow release fertilizers should be preferred.

Use of Micro-Organisms and other soil living Organisms

The use of algae, lichens and mosses in stabilization of tailings and other over burden accelerates the establishment of higher species. These micro-organisms are important for recycling the nutrients. Inoculating with suitable, improved micro flora including mycorrhiza, which are not sensitive to heavy metal concentrations, is one of the important techniques. Bacteria and fungi may be helpful in breaking down the available organic matter and establishing the green pioneers. The sludge can be used as organic manure to provide proper texture and micro flora to the soil and to build up topsoil. It allows grasses to establish, and with good cultural practices and management, the yields of pastures, fodder and cereals favourably compare with the yields from normal soils. Introducing earthworms, termites and other soil living insects into the cycle of reclamation to improve the rate of incorporation of organic matter and porosity in soil has been suggested as a possibility in building up the topsoil.

Selection of Species

The selected species should be able to quickly grow and effectively stabilize and improve the soil and environment, besides being economically useful. On extreme sites, such as the mine spoils, the range of plants is limited due to the toxicity. Mixtures of grasses rather than woody perennials can be sown with advantage as the grasses have short cycles of life and cover the area quickly. These often establish best with legumes or in established leguminous stands.

Eragrostis curvula, Cynodon sp in dry regions are grasses which tolerate low fertility and provide quick cover. *C. gayana* along with *Cenchrus ciliaris* and *Cynodon dactylon* is useful as a summer cover on treated tailing dams. *C.gayana, C.ciliaris* and *Panicum maximum* grow well on clayey coal spoils with high pH and low content of nitrogen and phosphorus. *E.curvula* a short lived perennial, useful as a nurse, germinates easily and grows fast with a good root system and tolerates acids spoils and perform better than other grasses. *Agrostis tenuis* and *Festuca ovina* are particularly suited to acid metalliferous spoils containing lead, zinc and copper. A. *stolonifera, F. ruba* and *Plantato lanceolata* are suited to calcareous, metalliferous soils. *Anthoxanthum odoratum* tolerates zinc rich wastes.

Time of Plantation

In general, trees are planted at the beginning of the rains. As the trees are benefited from the seasonal rains, so it is advised to avoid planting during the dry season as this will require heavy watering. It is advantageous to plant trees on cloudy days.

Preparation of Plantation Area

Planting site will be cleared from all wild vegetation. This will help in surveying the land for assessing its resources and weak points. Suitable soil and water conservation measures will be adopted, if required.

Since planting area is large, it should be divided into blocks inter-linked by paths laid out in such a way that every tree is accessible for all post plantation care.

Spacing between Trees

A tree requires sufficient space below and above the ground to spread its roots and branches. However, spacing varies with the type of tree, soil fertility, availability of moisture and purpose of plantation.

Marking and Digging of Pits

The location of each pit will be marked according to the design and distance of plantation. The size of the pits varies with type of trees. While digging the pit, care will be taken to place the top soil on one side and bottom soil on the other side. Dug out soil and pit would be exposed to weather for two to three months.

After exposing to the weather pit would be filled two-third to three-fourth height with a mixture of top soil and well rotten farmyard manure.

Criteria for selection of Species

Species to be selected should fulfill the following specific requirements of the area.

- Tolerance to specific conditions or alternatively wide adaptability to eco-physiological conditions;
- Rapid growth;
- Capacity to endure water stress and climatic extremes after initial establishment;
- Differences in height and growth habits;
- Pleasing appearance;
- Providing shade;
- Large bio-mass and leaves number to provide fodder and fuel;
- Ability of fixing atmospheric Nitrogen; and
- Improving waste lands.

Raising of Seedlings in Nursery

Seedlings should be raised in nurseries. Adequate number of surplus seedlings should be available considering a 10% mortality in seedlings. Healthy seedlings should be ready for transfer to permanent location before rainy season.

Preparation of pits and preparing them for transfer of seedlings

- Standard pit size would be 1 m x 1 m x 1 m;
- The distance between pits would vary depending on their location;
- The pits should be filled using good soil from nearby agricultural fields (3 parts) and farm yard manure (1 part);
- Rhizobium commercial preparation (1 kg/1000 kg);
- BHC powder, if the soil inhabits white ants (Amount variable); and
- The pits should be watered prior to plantation of seedlings

Recommended Species for Plantation

Based on climate and soil characteristics of the study area, some species are recommended for plantation. The climate of the region is extreme, where there is less rainfall as well as extreme heat and soil temperature is very high in summer. Hence, in order to have a ground cover, some fast growing species, which do not require watering, have been recommended for mass plantation. However, experimental trial should be conducted for the suitability and sustainability of the recommended species. The detailed list of recommend plantation species for waste dumps and peripheral plantation are presented in **Table-6.2.**

TABLE-6.2
RECOMMENDED PLANTATION SPECIES
FOR WASTEDUMPS AND PERIPHERAL PLANTATIONS

Sr. No.	Name of Plant Species	Local Name	Distribution and Growth Rare
	Grasses		
1	*Agrostis tenuis*	Grass	Stabilization of slopes, fast growth
2	A. *stolonifera*	Grass	Stabilization of slopes, fast growth
3	*F. ruba*	Grass	Stabilization of slopes, fast growth
4	*Agave Americana*	Agave	Waste land and slow growth
5	*Appluda mutica*	Grass	Grass
6	*Eragrostis curvula,*	Grass	Stabilization of slopes, fast growth
7	*Cynodon* spp	Grass	Stabilization of slopes, fast growth
8	*Cymboopogon flefxuosus*	Grass	Fast growth
9	*Cyanodon dactylon*	Grass	Fast growth
10	*Yucca gloriosa*	Agave	On slopes, fast growth
11	*Sansevera suevalens*	Agave	On slopes, fast growth
	Tree Species with Nitrogen Fixing Capacity		

Sr. No.	Name of Plant Species	Local Name	Distribution and Growth Rare
1	*Acacia nilotica*	Acacia	Barren lands and Medium growth
2	*Aegle marmelos*	Bel	Barren land and medium growth
3	*Albizia chinensis*	Safed siris	Barren lands and Medium growth
4	*Albizia lebbek*	Siris	Medium growth
5	*Albizia procera*	Kala siris	Medium growth
6	*Alstonia scholaris*	Saptarni	Shrub
7	*Anogeissus pendula*	Dhokara	Medium growth
8	*Azadirachta indica*	Neem	Medium growth
9	*Bambusa arundanacea*	Bamboo	Medium growth
10	*Bauhinia racemosa*		Medium growth
11	*Butea monosperma*	Gadha palas	Medium growth
12	*Delonix regia*	Kachnar	Fast growing
13	*Dendrocalamus strictus*	Bamboo	Medium growth
14	*Emblica officinalis*	Amla	Medium growth
15	*Mangifera indica*	Aam	Medium growth
16	*Melia azadirachta*	Bakain	Medium growth
17	*Moringa oleifera*	Drumstick	Fast growing
18	*Pithocolobium dulce*	Jungle jelebi	Medium growth
19	*Sesbania sesban*	Kanui churthel	Medium growth
20	*Ziziphus jujuba*	Ber	Medium growth
21	*Ziziphus mauritiana*	Ber	Medium growth
22	*Dalbergia sisoo*	Sisham	Fast growth
23	*Millingtonia hartensis*	Akashneem	Fast growth
24	*Leucena leucophloe*	Sabubal	Fast growth
25	*Peltoforrum ferrussinum*	Copper pod	Fast growth
26	*Parkinsonia aculeulata*	Pakinsonia	Medium growth
27	*Pongamia pinnata*	Karanj	Medium growth
28	*Cassia fistula*	Amaltas	Fast growth

As part of the expansion programme, extensive plantation will be carried out on the non-active areas and matured areas of the overburden dump and peripheral areas of the mine pit. The schedule of plantation along with number of trees to be planted is given in **Table-6.3** & **Table-6.4** and the greenbelt is shown in **Figure-6.1**.

TABLE- 6.3
PROPOSED PLANTATION SCHEDULE

Year	Area (ha)	No. of Trees
Plantation on Overburden Dump		
Year 1 (2008 – 2009)	0	0
Year 2 (2009 – 2010)	0	0
Year 3 (2010 – 2011)	4.8	3900
Year 4 (2011 – 2012)	4.7	3800
Year 5 (2012 – 2013)	7.9	6300
Total	**17.4**	**14000**

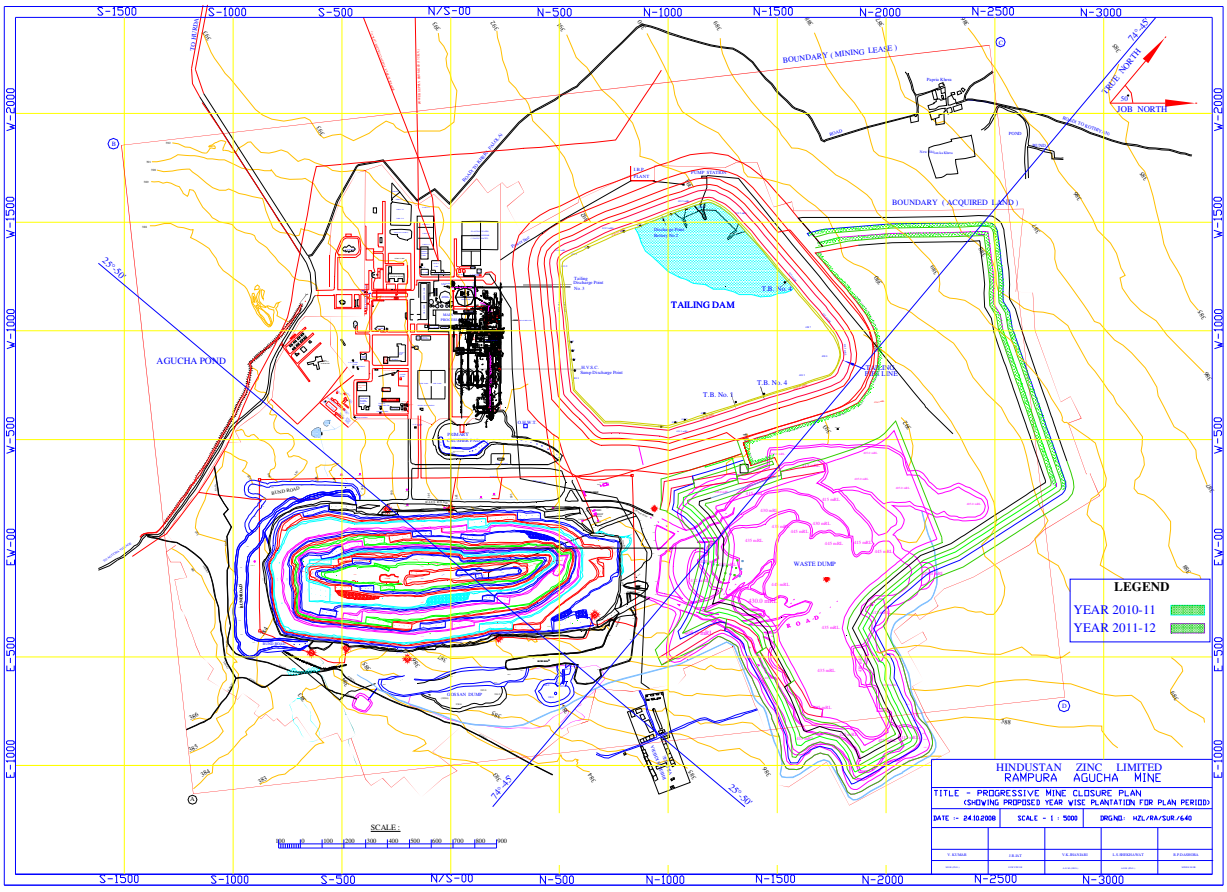


FIGURE-6.1
PROGRESSIVE MINE CLOSURE PLAN SHOWING GREENBELT

TABLE-6.4
PROPOSED YEAR WISE GREENBELT DEVELOPMENT PROGRAM

Year	Area (ha)	No. of Trees
2008 – 2009	2.0	2000
2009 – 2010	3.0	3000
2010 – 2011	5.0	4000
2011 – 2012	5.0	4000
2012 – 2013	8.0	6000
Total	**23.0**	**19000**

With the proposed green belt, plantation density will be about 800 plants/ha. It is recommended to increase the survival rate and further adopt gap filling plantation in the existing green belt stretches.

6.8 Steps to be taken to Improve Socio-Economic Conditions

The socio-economic conditions in the study area indicate the quality of life of the people. The important indicators which decide the quality of life and required to be improved for better living conditions are literacy levels, improved occupational structure, industrial development, infrastructure facilities, transportation, communication linkages, land development and improvement in cropping pattern.

6.8.1 Occupational Health Care

HZL has built one hospital in the township under the existing mining project. The facilities of this health care center are extended to the people residing in the vicinity in case of emergency. This hospital will be adequate even after the proposed expansion project also. Hence, new health center is not proposed in the expansion of the project.

Under employee's welfare and occupational health following studies are being conducted by HZL.

- 20% employees are examined for Periodical Medical Examination (PME) every year (about 120 to 150 every year);
- No case of Occupational lung disease detected so far;
- Audiometry is done during the PME and no case of noise induced hearing loss detected so far;
- Spirometry for pulmonary function test is done during PME. The results are within normal limits so far; and
- Lead analysis in blood samples is also done during the PME. The results indicate that the lead content in all the samples collected is less than 10 μg/100 ml.

It is recommended that HZL shall continue this and extend the programme to also cover the additional manpower after expansion.

6.8.2 Educational Facilities

One school in the township is already built for the employees' children. The school facilities are also extended to the children of near by villagers. This may be continued in future also after the proposed expansion.

6.8.3 Employment

The percentage of persons already employed from Bhilwara district is 78% and from Rajasthan state is 97%. HZL has so far provided jobs to 137 land losers.
In proposed capacity expansion project, local skilled people shall be given preference during recruitment of the additional man power.

6.9 Community Development

HZL has carried out various community development projects in the surrounding villages benefiting the population. The projects undertaken since the year 1991 are listed in **Table-6.5.**

TABLE-6.5
LIST OF PROJECTS UNDERTAKEN

Year	Development Activity	Expenditure (Rs.)
1991-2001	Water supply to nearby villages	35,30,523
	Construction / providing water supply system, bore well, hand pumps and pipelines	10,31,906
	Construction / repair works of roads, school, hospital and Govt. buildings	74,40,839
	Draught relief works (fodder camp)	22,94,436
	Earthquake relief works (Gujarat)	29,74,173
	Misc. Welfare works	8,29,923
	SUB TOTAL	**1,81,01,800**
Apr.2001 - Mar. 2005	Water supply to nearby villages	13,34,955
	Construction / providing water supply system, bore well, hand pumps and pipelines	3,53,266
	Construction / repair works of roads, school, hospital and Govt. buildings	5,35,530
	Draught relief works (fodder camp)	18,53,185
	Flood relief expenses	31395
	Donation to District Industries Center, Bhilwara for State level Udyog Mela	50000
	Donation to eye camp in Agucha village	21000
	Donation to Bharat Vikas Parishad fr Mukti Dham, Gulabpura	10000
	Misc. Welfare works	3,78,561
	SUB TOTAL	**45,67,892**
2005-06	2 medical camps 1 Health awareness camp Support for eye camp	1,09,800
	Prize distribution at a cultural function, in which 11 schools participated	2,93,000

Year	Development Activity	Expenditure (Rs.)
	Prize distribution in Hurda school for sports competition Storage facility in the primary school Participation in Udyog Mela	
	Contribution towards the Govt. scheme of mid-day meal for school children	1,500,000
	Construction of rain water harvesting culvert Water pipeline in Bherukhera-I Water through tankers to Agucha village Sweet distribution in schools	32,000 72,612
	Installation of water cooler in Agucha Installation of water cooler in Kothiyan Repair and renovation of school building Construction of village road	69,000
	SUB TOTAL	2,076,412
Grand Total		**2,47,46,104**
Year	**Development Activity**	**Expenditure**
2006-07	Health medical camp etc	4,19,551
	Education	17,96,827
	Sustainable livelihood	68,000
	Bio investment:	1,16,180
	Water harvesting	25,42,000
	Social forestry	20,000
	Infrastructure Development	5,90,682
	Social Mobilization	6,49,659
	SUB TOTAL	**62,02,899**
2007-08	Health medical camp etc	2,40,000
	Education	1,17,84,000
	Sustainable livelihood	1,25,000
	Bio investment:	49,50,000
	Agriculture and animal husbandry	3,75,000
	Social Mobilization	3,00,000
	Infrastructure Development	8,50,000
	SUB TOTAL	**1,86,24,000**
2008-09	Health medical camp etc	4,40,000
	Education	86,65,000
	Sustainable livelihood	2,00,000
	Bio investment:	50,000
	Agriculture and animal husbandry	5,50,000
	Social Mobilization	7,50,000
	Infrastructure Development	10,50,000
	SUB TOTAL	**1,17,05,000**
TOTAL		**6,12,78,003**

In addition to the above, HZL has earmarked about Rs.20 Lakhs for the next financial year for community development. The funding for community development projects shall be continued in the future also under proposed capacity expansion project.

6.10 Post Project Monitoring Schedule

The mitigation measures suggested in Chapter-4.0 have to be implemented so as to reduce the impact on environment due to the operation of enhanced mining and plant activities. In order to facilitate easy implementation, mitigation measures have to be phased as per the priority of implementation.

The monitoring of various environmental parameters is necessary which is a part and parcel of the environmental protection measures. Monitoring is as important as that of control of pollution since the efficacy of control measures can only be determined by monitoring. A comprehensive monitoring program keeping in line with the existing monitoring strategy is being conducted by HZL. The existing monitoring programme shall be upgraded to meet the requirements of expansion programme. Environmental attributes monitored in and around the mine lease area are given below:

- **Air Pollution and Meteorological Aspects**

Presently, HZL is monitoring ambient air quality every week in villages Agucha, Bherukhera and Kothiyan besides three locations in the mine lease area. The parameters monitored are SPM, RPM, SO_2 and NOx.

All the existing stacks are monitored for particulate matter emission every week. The dustfall rate is measured in the mining area.

HZL has installed automatic weather station to record meteorological parameters like wind speed, wind direction, temperature, relative humidity etc. The parameters are recorded continuously at one-hour interval.

It is further recommended to monitor the ambient air quality monitoring twice a week as per the CPCB guidelines. Further, adequate monitoring equipment shall be procured to meet the requirements.

- **Water and Wastewater Quality**

HZL has constructed monitoring wells around the tailing dam and over burden dump to assess the impact on the ground water quality. The samples from these wells are collected and analyzed for the heavy metal concentration like lead, zinc, iron and cadmium. Besides this, HZL also collects water samples every month from the dug wells and bore wells located in the near by villages to assess the impact of the mining activity. The same will be continued.

- **Noise Levels**

The noise levels are recorded every month in mining area and mill area. The vibration levels are also recorded during blasting. It is further recommended to monitor the ambient noise levels in near by villages especially Bherukhera, Agucha and New Rampura villages. Further, it is recommended to monitor noise during the blasting time at least once in a week or as per the frequency suggested by DGMS.

- **Soil Characteristics**

The soil samples are collected from Eight locations around the mine area and analyzed for lead, zinc, cadmium, iron and pH. The sampling is done once each in pre-monsoon and winter season. This shall be continued during the expansion project also.

- **Ecology**

It is recommended to monitor metal content in vegetation in the surrounding villages. The metals shall cover Lead, Zinc and Cadmium. The monitoring shall be done at least twice in a year (Post monsoon and Summer).

The recommended Post Project Monitoring includes the consent conditions specified by RSPCB is outlined in **Table-6.6**.

TABLE-6.6
MONITORING SCHEDULE FOR ENVIRONMENTAL PARAMETERS

Sr. No.	Particulars		Monitoring Frequency	Duration of Sampling	Important Monitoring Parameters
1	**Air Pollution and Meteorology**				
	Air Quality				
	A	**Ambient Air Quality Monitoring**			
		1: Mine Pit 2: Magazine 3: Plant Main Gate; 4: Near by villages (Agucha, Kothiyan and Bherukhera)	Twice in a week	24 hours continuously	Suspended particulate matter, RSPM, SO_2 , NO_x , CO, Pb, Zn, Fe and Cd
	B	**Dust fall**			
		1: Mine area (Mine pit, Laboratory, Magazine and Main Gate)	Every month except monsoon season	One month	Total Dustfall concentration and heavy metals like Pb, Zn, Fe and Cd.
	C	**Meteorology**			
	a	Meteorological data to be monitored at the site.	Daily	Continuous with automatic weather station	Wind speed and direction, temperature, rainfall, relative humidity
	D	**Stack Monitoring**			
		Primary Crusher; Secondary Crusher,DG sets and FOB stack	Once in a week	Iso-Kinetic	SPM, Heavy metals (Pb, Zn, Fe, Cd) and SPM, SO2 and NOX in DG sets
2	**Water and Wastewater Quality**				
	A]	**Industrial/Domestic**			
	1	Mine pit water	Once in a month	Grab sampling	As per EPA guide lines, 1986
	2	Beneficiation Plant, tailing dam water, reclaim water and seepage water)	Once in a month	Grab	As per EPA guidelines, 1986
	3	Drain & Sump Water	monthly	grab	Oil & Grease

Sr. No.	Particulars		Monitoring Frequency	Duration of Sampling	Important Monitoring Parameters
		(HVSC, Tailing dam)			
	4	Plant drinking water	weekly	grab	As per IS:10500
	5	Run-off water in rainy season (drains and waste dumps)	3 consecutive rainfalls	grab	Pb, Zn, Fe and Cd
	6	Colony Sewage	Monthly	grab	BOD, Total Solids, TDS and SS
	B]	**Water Quality in the Study Area**			
	i)	Surface water: 1) Agucha tank 2) Paperikhera pond 3) Kothiyan Devnadi	Once in a month	Grab	As per the parameters specified under IS:2296 (Class-C)
	ii)	Ground water: 1) 10 monitoring wells surrounding the tailing dam and mine 2) 17 Dug wells surrounding the mine lease area	Once in a month Once in a month	Grab Grab	As per the parameters specified under IS:10500
3	**Industrial Noise Levels**				
	1	Near the blasting/drilling site	Monthly	-	Noise levels in dB(A)
	2	Near crushing plant	Monthly	8 hr continuous with one hr interval	Noise levels in dB(A)
	3	Along the Haul road for transportation noise	Monthly	8 hr continuous with one hr interval	Noise levels in dB(A)
4	**Ambient Noise Levels**				
		1. Agucha village 2. Near by villages	Seasonally	8 hr continuous with one hr interval	Noise levels in dB(A)
5	**Soil Characteristics**				
	1	Near waste dump	Pre monsoon and Post monsoon	One grab sample	pH, Salinity, Heavy metals and NKP
	2	Near gossan dump			
	3	Near Paperikhera			
	4	Near Agucha village			
	5	Bherukhera village			
6	**Ecology**				
	1	Two Villages	Post Monsoon, Summer	Leaf and stem samples	Pb, Zn and Cd
7	**Occupational Health**				
		Blood Lead Analysis	Once in Five years	-	All the employees

6.11 Infrastructure for Environmental Protection

The mine has a full fledged environmental cell to supervise and implement the environmental related issues. This is supported by a fully equipped laboratory to carry out the analysis. The environmental cell has the following manpower on regular basis. The Unit head supervises the monitoring activities. Assistant General

Manager (AGM) is in-charge to co-ordinate the monitoring activities. The environmental Management cell is depicted in **Figure-6.2.**

Associate General Manager (Environment)

Qualified Chemical Engineer with 20 years of experience in Environmental monitoring and pollution control is responsible for implementing and monitoring the environmental attributes. He also acts as a liaison officer between the HZL and regulatory agencies like RSPCB, MoEF etc.

Engineer (Environment)

Qualified engineer will be responsible for all the environmental aspects.

Chemist

Post Graduate in Chemistry and a qualified chemist to carry out the analysis of various samples. Besides, adequate supporting staff is also available.

The above infrastructure set-up will be adequate for the proposed capacity expansion also.

6.12 Post Project Monitoring Equipment

6.12.1 Monitoring Equipment and Consumable

a) Air Quality and Meteorology

Following equipment and consumable items are available with the environmental cell to implement the monitoring program.

- Respirable Dust Sampler (4 no.)
- Stack Monitoring kit (2 no.)
- CO Monitor (1 no.)
- Weather station (automatic recording) (1 Set)
- Spectrophotometer (visible range) (1 no.)
- Single pan balance (1 no.)
- Relevant chemicals as per IS:5182 (Lumpsum)
- Personal sampler (1 no.)

In addition to the above, the following equipment shall be procured to meet the frequency requirement of capacity expansion project. These include:

- Respirable Dust samplers : 1 nos.
- Chemical/Glass ware : Lumpsum

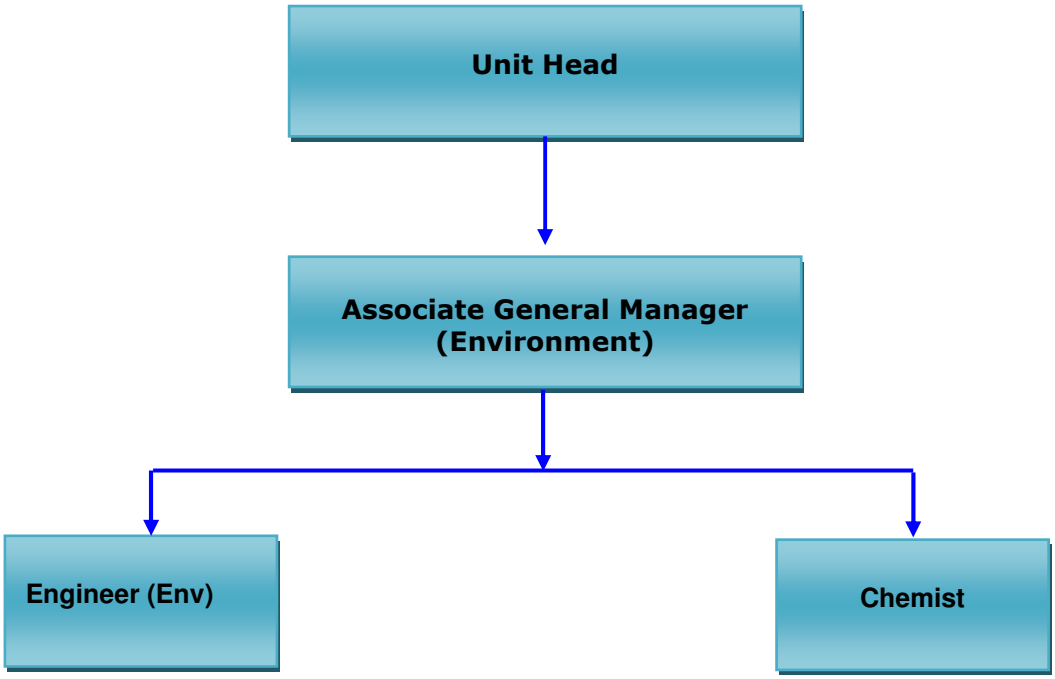


FIGURE-6.2
ENVIRONMENTAL MANAGEMENT CELL

b) Water and Waste Water Quality

The sampling should be done in jerry cans as per the standard procedures laid down by IS: 2488. Following equipment are available with the environmental cell:

- BOD incubator
- Refrigerator
- Oven
- Stop watch
- Thermometer
- pH meter
- Distilled water plant
- Atomic Absorption Spectrophotometer
- X- ray Fluorescence
- Relevant chemicals and Glasswares

c) Noise Levels

The environment cell has sound level meter to record noise levels in different scales like A, B and C with slow and fast response options and vibration meter.

d) Soil Characteristics

The environment cell has soil samplers (auger) to collect soil samples. The samples are being analyzed in house (Plant Laboratory).

6.13 Budgetary Allocation for Pollution Control

The capital cost of the proposed expansion project will be Rs. 882 Crores. The budgetary allocation for the pollution control and monitoring equipment is given below in **Table-6.7.**

TABLE-6.7
BUDGETARY ALLOCATION FOR POLLUTION CONTROL

Sr. No.	Particulars	Capital Cost (Rs. Lakhs)
1	Desliming Hydro-cyclones	100
2	Dust collection system for FOB	50
3	Water sprinkleron inside roads	300
4	Dumper cleaning system with oil trap	50
5	Laboratory equipment	10
6	Greenbelt	300
7	Dust Suppression Chemical on Haul Roads	100
Total Expenditure		**910**

The plantation capital cost is given in **Table-6.8** & **Table-6.9.**

TABLE- 6.8
PROPOSED PLANTATION SCHEDULE

Year	Area (ha)	No. of Trees	Total Cost (Rs)
Plantation on Overburden Dump			
Year 1 (2008 – 2009)	0	0	0
Year 2 (2009 – 2010)	0	0	0
Year 3 (2010 – 2011)	4.8	3900	1170000
Year 4 (2011 – 2012)	4.7	3800	1140000
Year 5 (2012 – 2013)	7.9	6300	1890000
Total	**17.4**	**14000**	**4200000**

TABLE-6.9
PROPOSED YEAR WISE GREENBELT DEVELOPMENT PROGRAM

Year	Area (ha)	No. of Trees	Total Cost (Rs)
2008 – 2009	2.0	2000	600000
2009 – 2010	3.0	3000	900000
2010 – 2011	5.0	4000	1200000
2011 – 2012	5.0	4000	1200000
2012 – 2013	8.0	6000	1800000
Total	**23.0**	**19000**	**5700000**

7.0 RISK ASSESSMENT AND DISASTER MANAGEMENT PLAN

7.1 Introduction

The existing facilities and proposed additions at Rampura-Agucha mine have been discussed in Chapters-2 and 3. The type of fuel used and storage capacity are also discussed. The fuels used are LSHS and HSD. The Heavy Earth Moving Machinery (HEMM) is operated on HSD and DG set is operated on LSHS. No additional storages are being created during expansion.

The details of raw material and fuel storages are given in **Table-7.1** in subsequent section.

Hazard analysis involves the identification and quantification of the various hazards (unsafe conditions) that exist in the plant. On the other hand, risk analysis deals with the identification and quantification of risks, the plant equipment and personnel are exposed to, due to accidents resulting from the hazards present in the plant.

Hazard and risk analysis involve very extensive studies and require a very detailed design and engineering information. The various hazard analysis techniques that may be applied are hazard and operability studies, fault-tree analysis, event-tree analysis and failure and effects mode analysis.

Risk analysis follows an extensive hazard analysis. It involves the identification and assessment of risks the neighboring populations are exposed to as a result of hazards present. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of population etc. Much of this information is difficult to get or generate. Consequently, the risk analysis is often confined to maximum credible accident studies.

The common terms used in Risk assessment and Disaster Management are elaborated below:

"*Risk*" is defined as a likelihood of an undesired event (accident, injury or death) occurring within a specified period or under specified circumstances. This may be either a frequency or a probability depending on the circumstances.

The term **"*Hazard*"** is defined as a physical situation, which may cause human injury, damage to property or the environment or some combination of these criteria. **"*Hazardous substance*"** means any substance or preparation, which by reason of its chemical or physico-chemical properties or handling is liable to cause harm to human beings, other living creatures, plants, micro-organisms, property or the environment.

"*Hazardous process*" is defined as any process or activity in relation to an industry, which may cause impairment to the health of the persons engaged or connected therewith or which may result in pollution of the general environment.

"*Disaster*" is defined as a catastrophic situation that causes damage, economic disruptions, loss of human life and deterioration of health and health services on a

scale sufficient to warrant an extraordinary response from outside the affected area or community. Disasters occasioned by man are factory fire explosions and release of toxic gases or chemical substances etc.

"*Accident*" is an unplanned event, which has a probability of causing personal injury or property damage or both.

"*Emergency*" is defined as a situation where the resources outpass the demand. This highlights the typical nature of emergency "it will be after experience that enough is not enough in emergency situations. Situations of this nature are avoidable but it is not possible to avoid them always.

"*Emergency preparedness*" is one of the key activities in the overall management. Preparedness, though largely dependent upon the response capability of the persons engaged in direct action, will require support from others in the organization before, during and after an emergency.

The subsequent sections addresses, the identification of various hazards and risks in an mining operations and the Beneficiation Plant, which gives a broad identification and risks involved in the plant and process operations. Based on the risk estimation for fuel and chemical storage Disaster Management Plan (DMP) has been presented.

7.2 Scope of the Study

The principal objective of the present risk assessment is to identify and quantify the major hazards and the risk associated with various operations in the mine and beneficiation plant, which may lead to emergency consequences (disasters) affecting the public safety and health. Based on this information, an emergency preparedness plan is to be prepared to mitigate the consequences. The study aims to analyze the risk associated with the following scenarios in mine and beneficiation plant.

i) Various process associated with hazards; and
ii) Raw materials and Products storages for the plant.

The risk assessment study covers the following:

- Identification of potential hazard areas;
- Identification of representative failure cases;
- Visualization of the resulting scenarios in terms of fire (thermal radiation) and explosion;
- Assess the overall damage potential of the identified hazardous events and the impact zones from the accidental scenarios;
- Assess the overall suitability of the site from hazard minimization and disaster mitigation points of view;
- Furnish specific recommendations on the minimization of the worst accident possibilities; and
- Preparation of broad Disaster Management Plan (DMP), On-site and Off-site Emergency Plan, which includes Occupational and Health Safety Plan.

7.3 Hazard Identification

7.3.1 Introduction

Identification of hazards in a manufacturing unit is of primary significance in the analysis, quantification and cost effective control of accidents involving chemicals and process. A classical definition of hazard states that hazard is in fact the characteristic of system/plant/process that presents potential for an accident. Hence, all the components of a system/plant/process need to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident.

Typical schemes of predictive hazard evaluation and quantitative risk analysis suggest that hazard identification step plays a key role **(Figure. 7.1)**. Estimation of probability of an unexpected event and its consequences form the basis of quantification of risk in terms of damage to property, environment or personnel. Therefore, the type, quantity, location and conditions of release of a toxic or flammable substance have to be identified in order to estimate its damaging effects, the area involved, and the possible precautionary measures required to be taken. The following two methods for hazard identification have been employed in the study:

- Identification of major hazardous units based on Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 of Government of India (GOI Rules, 1989); and

- Identification of hazardous units and segments of plants and storage units based on relative ranking technique, viz. Fire-Explosion and Toxicity Index (FE&TI).

7.3.2 Identification of Major Hazardous Units

7.3.2.1 Classification of Major Hazardous Substance

Hazardous substances may be classified into three main classes: Flammable substances, Unstable substances and Toxic substances. Flammable substances require interaction with air for their hazard to be realized. Under certain circumstances the vapours arising from flammable substances when mixed with air may be explosive, specially in confined spaces. However, if present in sufficient quantity such clouds may explode in open air also. Unstable substances are liquids or solids, which may decompose with such violence so as to give rise to blast waves. Finally toxic substances are dangerous and cause substantial damage to life when released into the atmosphere. The ratings for a large number of chemicals based on flammability, reactivity and toxicity have been given in NFPA Codes 49 and 345M.

The fuel and chemical storage in the plant are given in **Table-7.1.** Hazardous characteristics of the major flammable materials are employed in different process units are listed in **Table-7.2.** The existing storages wiil be utilized and no additional fuel storages are envisaged.

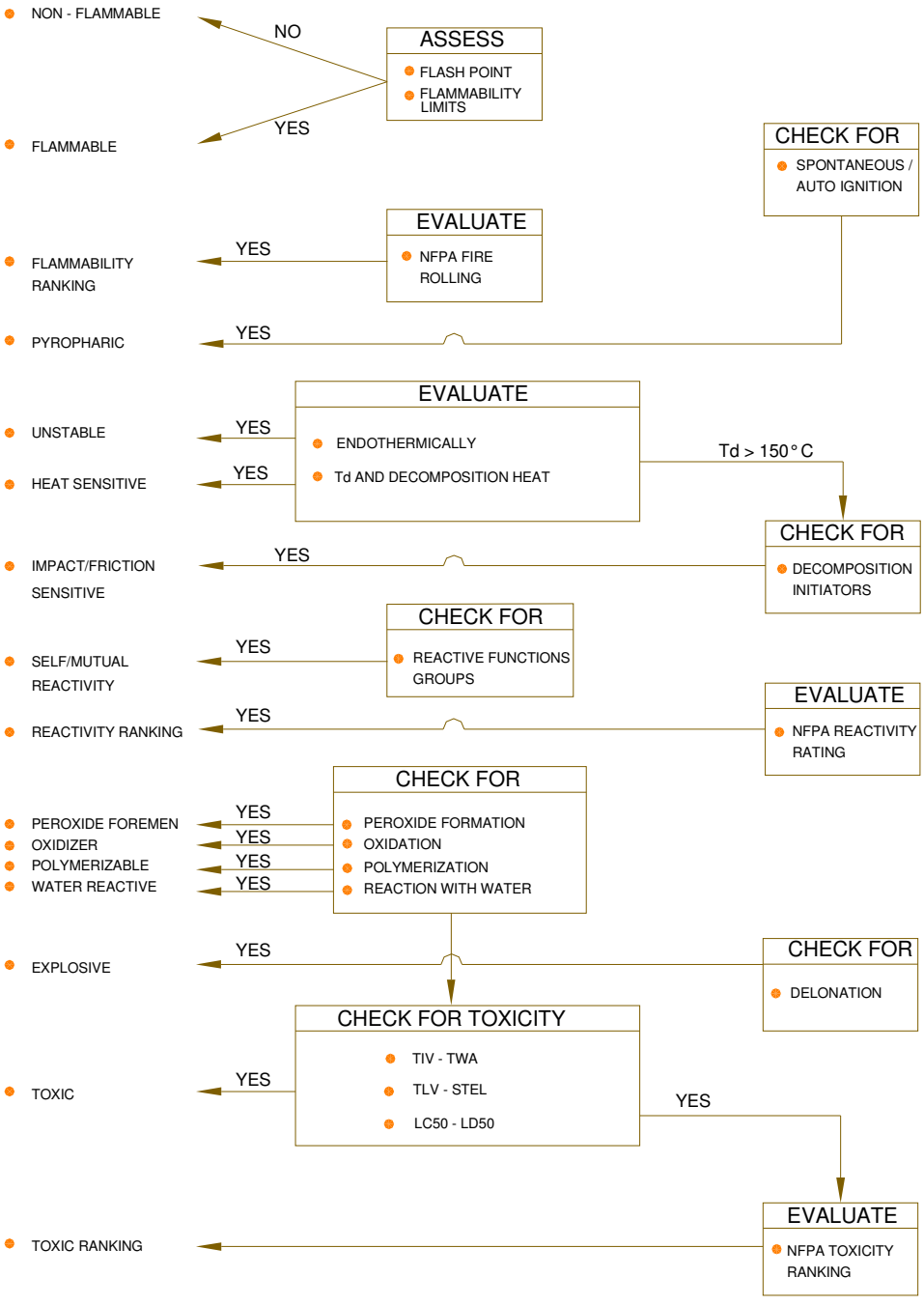


FIGURE-7.1
PROTOCOL FOR IDENTIFICATION OF HAZARDS

TABLE-7.1
CATEGORY WISE SCHEDULE OF PROPOSED STORAGE TANKS

Sr. No.	Material	No. of Tanks	Storage Capacity (each storage or total??)	Classification
1	Sodium Cyanide	Drums	25T	Hazardous
2	Copper Sulphate	Bags	150 T	Hazardous
3	Methyl Isobutyl Carbinol (MIBC)	Drums	25 T	Flammable
4	HSD (Mane Gate)	1	16KL	Flammable
5	HSD (Mine Gate)	1	66 KL	Flammable
6	HSD (Near DG set)	1	54.5 KL	Flammable
7	LSHS	1	500 KL	Flammable
8	Lubricating oil	Drums	80 KL (Total)	Flammable
9	Magazine	3	90 T	Flammable

TABLE-7.2
PROPERTIES OF FUELS/CHEMICALS USED AT THE PLANT

Chemical	Codes/Label	TLV (mg/m^3)	FBP	MP	FP	UEL	LEL
			°F			%	
Sodium Cyanide	Hazardous	5.0	-	1045	563.7	-	
Copper Sulphate	Hazardous	1.0	-	230	456	-	-
MIBC	Flammable	50	268	--	106.0	5.5	1.0
HSD	Flammable	5.0	130	-	200	0.6	7.5
LSHS	Flammable	5.0	338	-	38	7.5	0.6
Lubricating oil	Flammable	5.0	680	-	400	0.2	4.5

TLV : Threshold Limit Value FBP : Final Boiling Point
MP : Melting Point FP : Flash Point
UEL : Upper Explosive Limit LEL : Lower Explosive Limit

7.3.2.2Identification of Major Hazard Installations Based on GOI Rules, 1989

Following accidents in the chemical industry in India over a few decades, a specific legislation covering major hazard activities has been enforced by Govt. of India in 1989 in conjunction with Environment (Protection) Act, 1986. This is referred here as GOI rules 1989. For the purpose of identifying major hazard installations the rules employ certain criteria based on toxic, flammable and explosive properties of chemicals.

7.3.2.3Analysis of Units of Different Processes

A systematic analysis of the fuels and their quantities of storage has been carried out, to determine threshold quantities as notified by GOI Rules, 1989 and the applicable rules are identified and are summarized in **Table-7.3**.

TABLE-7.3
APPLICABILITY OF GOI RULES TO CHEMICAL STORAGE

Sr. No.	Name of the chemical/Fuel/oil	Listed in schedule	Stored	Storage capacity	Threshold qty(T) for application of rules	
					5,7-9,13-15	10-12
1	Sodium Cyanide	1(2)	drums	25 T	-	-
2	Copper sulphate	1(2)	bags	150 T	-	-
3	Methyl Iso butyl carbinol (MIBC)	Not listed	Drums	25 T	-	-

Sr. No.	Name of the chemical/Fuel/oil	Listed in schedule	Stored	Storage capacity	Threshold qty(T) for application of rules	
					5,7-9,13-15	10-12
4	HSD (Main Gate)	3(1)	3	16 KL	25 t	200t
5	HSD (Mine Gate)	3(1)	3	66 KL	25 t	200t
6	HSD (Near DG set)	3(1)	3	54.5 KL	25 t	200t
7	LSHS	3(1)	1	500KL	25T	200T
8	Lubricating Oil	1(2)	DRUMS	80KL	25T	200T

7.3.3 Fire Explosion and Toxicity Index (FE & TI) Approach

Fire, Explosion and Toxicity Indexing (FE & TI) is a rapid ranking method for identifying the degree of hazard. The application of FE & TI would help to make a quick assessment of the nature and quantification of the hazard in these areas. However, this does not provide precise information. Respective Material Factor (MF), General Hazard Factors (GHF), Special Process Hazard Factors (SPH) are computed using standard procedure of awarding penalties based on storage handling and reaction parameters. Before hazard indexing can be applied, the installation in question should subdivided into logical, independent elements or units. In general, a unit can logically be characterized by the nature of the process that takes place in it. In some cases, the unit may consist of a plant element separated from the other elements by space or by protective walls. A plant element may also be an apparatus, instrument, section or system that can cause a specific hazard. For each separate plant process, which contains flammable or toxic substances, a fire and explosion index F and/or a toxicity index T may be determined in a manner derived from the method for determining a fire and explosion index developed by the Dow Chemical Company.

i) FE & TI Methodology

Dow's Fire and Explosion Index (F and E) is a product of material factor (MF) and hazard factor (F3) while MF represents the flammability and reactivity of the substances, the hazard factor (F3), is itself a product of general process hazards (GPH) and special process hazards (SPH). An accurate plot plan of the plant, a process flow sheet and Fire and Explosion Index and Hazard Classification Guide published by Dow Chemical Company are required to estimate the FE & TI of any process plant or a storage unit.

ii) Computations and Evaluation of Fire and Explosion Index

The Fire and Explosion Index (FEI) is calculated from -

FEI = MF x (GPH) x (SPH)

The degree of hazard potential is identified based on the numerical value of FEI as per the criteria given below :

FEI Range	**Degree of Hazard**
0-65	Light
65-95	Moderate
95 and above	Severe

7.3.3.1Toxicity Index (TI)

The toxicity index is primarily based on the index figures for health hazards established by the NFPA in codes NFPA 704, NFPA 49 and NFPA 345 m..

7.3.3.2Classification of Hazard Categories

By comparing the indices FEI and TI, the unit in question is classified into one of the following three categories established for the purpose **(Table-7.4)**.

TABLE-7.4
FIRE EXPLOSION AND TOXICITY INDEX

Category	Fire and Explosion Index (FEI)	Toxicity Index (TI)
I	FEI < 65	TI < 6
II	65 < or = FEI < 95	6 < or = TI < 10
III	FEI > or = 95	TI > or = 10

Certain basic minimum preventive and protective measures are recommended for the three hazard categories.

7.3.3.3Evaluation of Fire and Explosion Index at HZL

Based on the GOI Rules 1989, the hazardous fuels and chemicals used by the mine and mill were identified. Fire and Explosion are the likely hazards, which may occur due to the fuel and chemical storage. Hence, Fire and Explosion index has been calculated for in plant storage. Detailed estimates of FE&TI are given in **Table-7.5.**

TABLE-7.5
FIRE EXPLOSION AND TOXICITY INDEX FOR STORAGE FACILITIES

Sr. No.	Chemical/ Fuel	Total Quantity	F&EI	Category	TI	Category
1	HSD (Main Gate)	16 KL	25.6	Light	-	-
2	HSD (Mine Gate)	66 KL	25.6	Light	-	-
3	HSD (DG set)	54.5 KL	25.6	Light	-	-
4	LSHS	500 KL	25.6	Light	-	-
5	MIBC	25 T	57.4	Light	-	-
6	Sodium Cyanide	25 T	50.3	Light	23.2	Light
7	Copper Sulphate	150 T	27.0	Light	12.5	Light
8	Lubricating oil	80 KL	15.0	Light	-	-

7.4 Visualization of MCA Scenarios

7.4.1 Introduction

A Maximum Credible Accident (MCA) can be characterized, as an accident with a maximum damage potential, which is still believed to be probable.

MCA analysis does not include quantification of the probability of occurrence of an accident. Moreover, since it is not possible to indicate exactly a level of probability that is still believed to be credible, the selection of MCA is somewhat arbitrary. In

practice, the selection of accident scenarios representative for an MCA-Analysis is done on the basis of engineering judgment and expertise in the field of risk analysis studies, especially accident analysis.

As an initial step in this study, a selection has been made of the processing and storage units and activities, which are believed to represent the highest level of risk for the surroundings in terms of damage distances. For this selection the following factors have been taken into account:

- Type of compound viz. flammable or toxic;
- Quantity of material present in a unit or involved in an activity; and
- Process or storage conditions such as temperature, pressure, flow, mixing and presence of incompatible materials.

In addition to the above factors the location of a unit or activity with respect to adjacent activities is taken into consideration to account for the potential escalation of an accident. This phenomenon is known as the domino effect. The units and activities, which have been selected on the basis of the above factors are summarized, accident scenarios are established in Hazard Identification studies, while effect and damage calculations are carried out in Maximum Credible Accident Analysis studies.

7.4.2 Methodology

Following steps are employed for visualization of MCA scenarios:

- Chemical inventory analysis;
- Identification of hazardous processes in individual units;
- Identification of chemical release and accident scenarios;
- Analysis of past accidents of similar nature to establish credibility to identified scenarios; and
- Short listing of MCA Scenarios.

7.4.3 Common Causes of Accidents

Based on the analysis of past accident information, common causes of major chemical plant accidents are identified as:

- Poor house keeping
- Improper use of tools, equipment, facilities
- Unsafe or defective equipment facilities
- Lack of proper procedures
- Improvising unsafe procedures
- Failure to follow prescribed procedures
- Jobs not understood
- Lack of awareness of hazards involved
- Lack of proper tools, equipment, facilities
- Lack of guides and safety devices
- Lack of protective equipment and clothing

7.4.4 Failures of Human Systems

An assessment of past chemical accidents reveals human factor to be the cause for over 60% of the accidents while the rest are due to other plant component failures. This percentage will increase if major accidents alone are considered for analysis. Major causes of human failures reported are due to:

- Stress induced by poor equipment design, unfavorable environmental conditions, fatigue, etc.;
- Lack of training in safety and loss prevention;
- Indecision in critical situations; and
- Inexperienced staff being employed in hazardous situations.

Often, human errors are not analyzed while accident reporting, and accident reports only provide information about equipment and/or component failures. Hence, a great deal of uncertainty surrounds analysis of failure of human systems and consequent damages.

7.4.5 Short Listing of MCA Scenarios

Based on the storage quantities and properties of the chemicals, the hazard identification has been done and given as follows for carrying out MCA analysis studies.

- Pool fire due to vessel rupture/leakage and accumulation;
- Toxic dispersion due to gas/vapour leaks or pool evaporation; and
- General fire hazards.

7.4.6 Conclusion

Results of FE & TI analysis show that the storage of chemicals and fuels fall into *Light category* of FEI, with light toxicity index.

7.5 Hazard Assessment and Evaluation

7.5.1 Introduction

Preliminary hazards analysis is based on the philosophy "PREVENTION IS BETTER THAN CURE". How safe are the operations? Safety is relative and implies freedom from danger or injury. But there is always some element of danger or risk in anything we do or build. When a chemical process facility is considered safe? This calls for identification of hazards, quantification of risk and further suggest hazard mitigating measures, if necessary.

The purpose of the preliminary hazards analysis is to identify early in the design process the potential hazards associated with, or inherent in a process design, thus eliminating costly and time consuming delays caused by design changes made later. This also eliminates potential hazard points at design stage itself.

Hence preliminary hazards analysis is more relevant when a plant is at design/construction stage. This technique, applied early in the project life cycle, helps to eliminate hazards and, thus to avoid costly design modifications later. This analysis fortifies the proposed process design by incorporating additional safety factors into the design criteria.

7.5.2 Methodology

An assessment of the conceptual design is conducted for the purpose of identifying and examining hazards related to feed stock materials, major process components, utility and support systems, environmental factors, proposed operations, facilities, and safeguards.

7.5.3 Preliminary Hazard Analysis (PHA)

In the existing plant, LSHS in a mixture with air is burnt to convert its chemical energy into heat for generation of power. The liberated heat is converted into steam for generation of power. HSD is mainly used for operation of heavy earth moving machinery, vehicles etc. A preliminary hazard analysis is carried out initially to identify the major hazards associated with the plant **(Table-7.6 and Table-7.7).**

TABLE-7.6
PRELIMINARY HAZARD ANALYSIS FOR PROCESS AND STORAGE UNITS

Equipment	Process	Potential Hazard	Resolution
HSD, LSHS and Lubricating Oil Storage			
Fire/Explosion	Storage Vessel	Formation of an explosive atmosphere outside storage vessel due to : - Faulty safety valve - Corroded vessel - Over pressure	Dyke walls to be provided with a provision of fire detectors in the tank storage. Safety valve, vessel corrosion protection, pressure and temperature gauge, and sprinkler system are provided. CO_2 type fire extinguishers with adequate fire hydrant system are provided.
Generator	Converts mechanical energy electrical energy.	Mechanical hazards and fire hazards in i) LSHS oil system ii) Cable galleries iii) Short circuits	Proper layout of equipment/machinery in accordance to National/International codes
Combustors	Burns HSD and LSHS	Fire Hazards	Fire detectors are provided. CO_2 type fire extinguishers with adequate fire hydrant system are provided.
MIBC Storage			
Fire/Explosion	Drums	Formation of an explosive atmosphere outside storage due to	Keep the drums in shaded area with good ventilation, corrosion protection, foam type fire extinguishers are provided near storage area

Equipment	Process	Potential Hazard	Resolution
		-corroded drum -over pressure	
Chemical Storage Room			
Fire/ Explosion	Stored chemicals	Formation of an explosive atmosphere inside the room due to : -improper handling of containers -spills from damaged containers -solvent vapour	Provide ventilation fans, dyke walls for each type of material to be stored, temperature and pressure gauges. CO_2 type fire extinguishers with adequate fire hydrant system is to be provided.
Mining Activity			
Blasting	Over charging of explosive	Flying fragments of blasting material will be encountered. Dust and Noise Pollution.	Fix time and days for blasting. Use appropriate charge as required. Clear the area before blasting.
Subsidence	This parameter is not applicable since this is a opencast mine.		
Accidents due to Trucks and Dumpers	Movement of vehicles	Accidents due to movement of dumpers, trucks and other heavy machinery. Mainly due to mechanical failures and human errors	Mine working should be done under supervision. Maintain vehicles. Broad signs should be provided. Provide training, education for mine personnel.
Magazine	Storage of explosives	Fire & Explosion	The location should be isolated from the other activities

TABLE-7.7
PRELIMINARY HAZARD ANALYSIS FOR THE WHOLE PLANT IN GENERAL

PHA Category	Description of Plausible Hazard	Recommendation	Resolution
Environmental factors	If there is any leakage and eventuality of source of ignition.	--	All electrical cables should be of specified standards and all motors starters etc. should be of Flame Proof. Necessary precautions should be taken to prevent any source of sparks.
	Highly inflammable nature of the chemicals may cause fire hazard in the plant	A well designed fire protection including Alcohol foam, protein foam, dry powder, CO_2 extinguisher should be provided.	Fire extinguisher of small size and big size should be provided at all potential fire hazard places. In addition to the above, fire hydrant network should also be provided.

7.5.4 Maximum Credible Accident Analysis (MCAA)

Hazardous substances may be released as a result of failures or catastrophes, causing possible damage to the surrounding area. This section deals with the

question of how the consequences of the release of such substances and the damage to the surrounding area can be determined by means of models.

It is intended to give an insight into how the physical effects resulting from the release of hazardous substances can be calculated by means of models and how vulnerability models can be used to translate the physical effects in terms of injuries and damage to exposed population and environment. A disastrous situation is general due to outcome of fire, explosion or toxic hazards in addition to other natural causes, which eventually lead to loss of life, property and ecological imbalance.

Major hazards posed by hazardous chemical storage can be identified taking recourse to MCA analysis. MCA analysis encompasses certain techniques to identify the hazards and calculate the consequent effects in terms of damage distances of heat radiation, toxic releases, vapour cloud explosion, etc. A host of probable or potential accidents of the major units in the complex arising due to use, storage and handling of the hazardous materials are examined to establish their credibility. Depending upon the effective hazardous attributes and their impact on the event, the maximum effect on the surrounding environment and the respective damage caused can be assessed. **Figure-7.2** depicts the flow chart for MCA analysis. The MCA analysis involves ordering and ranking of various sections in terms of potential vulnerability. Inventory analysis and Fire Explosion and Toxicity Index (FE&TI) are two techniques employed for hazard identification process **(Figure- 7.3)**.

7.5.5 Damage Criteria

The damage criteria due to a accidental release of hydrocarbon from HSD,LSHS and lubricating oil, toxic vapour release from MIBC arise primarily from fire and explosion. Sodium Cyanide and Copper sulphate has not been considered for MCAA as the chemicals fall under Non flammable categories. Contamination of soil or water is not expected as these liquids/gas would vaporize slowly and would not leave any residue as it happens with spillage of crude oil. The vapors from these fuels are not toxic and hence no effects of toxicity are expected.

Since HSD and LSHS are volatile product, fixed roof tanks are provided for its storage, similarly MIBC and lubricating oil are stored in drums. The fire on-situation would occur if the radiation intensity is high on the peripheral surface of the tank/stored drum leading to increase in internal tank/drum pressure. Pool fire would occur when stored material is collected in the dyke or storage area due to leakages and gets ignited.

Thermal radiation may cause various degrees of burn on human bodies. Moreover, their effects on inanimate objects like equipment, piping or vegetation also need to be evaluated to assess the impact. **Tables-7.8** and **Table-7.9** tabulate the damage effect due to thermal radiation intensity.

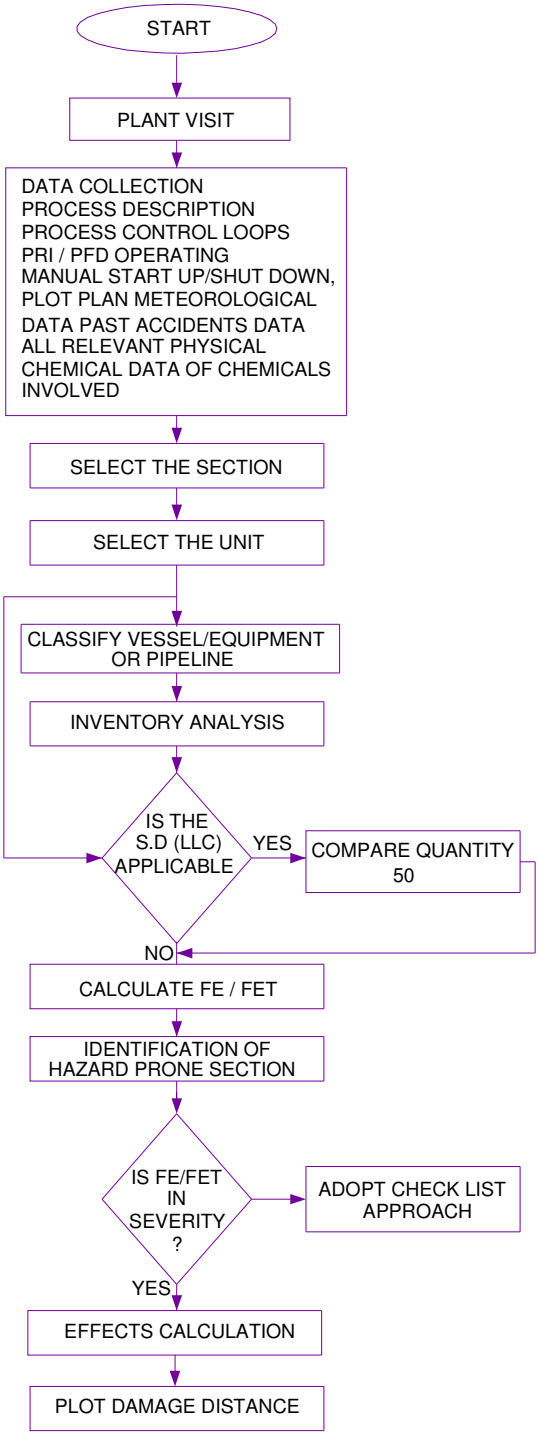


FIGURE- 7.2
FLOW CHART FOR MCA ANALYSIS

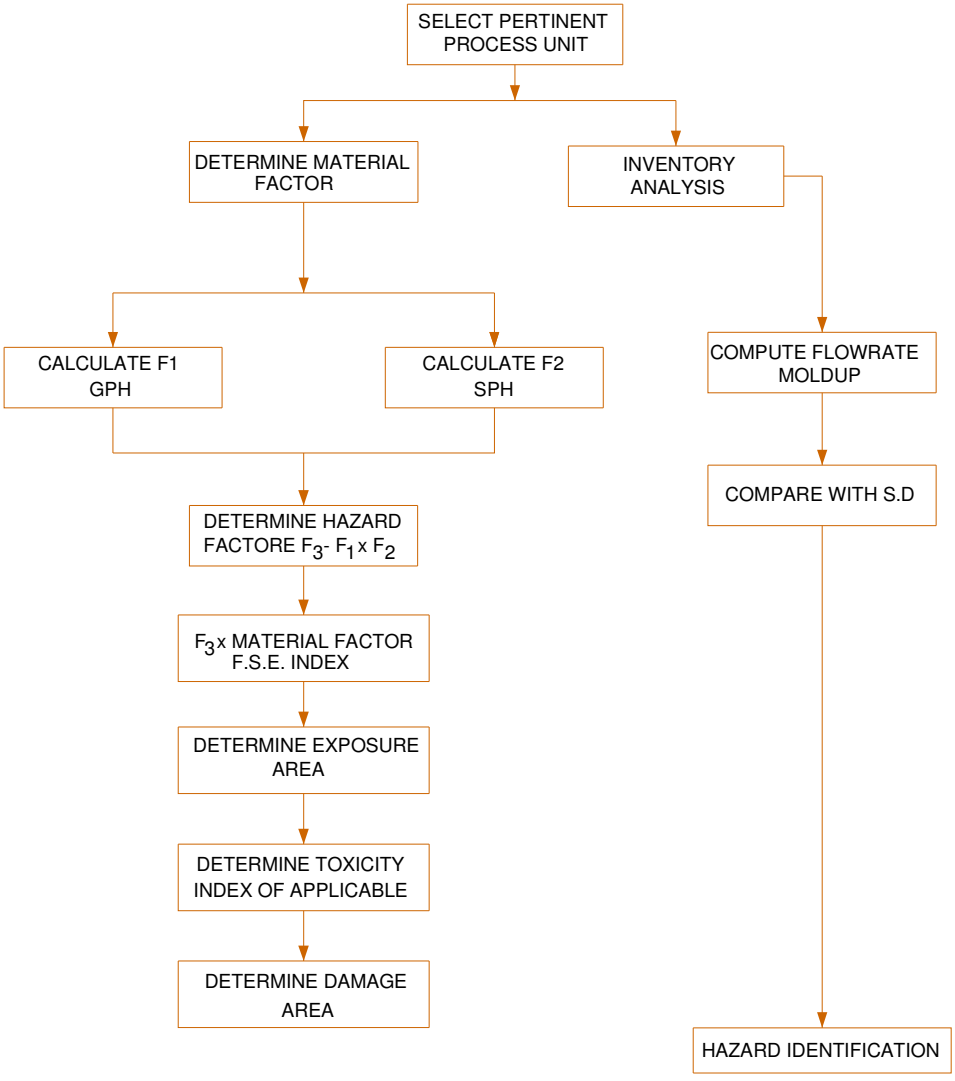


FIGURE- 7.3
STEPS IN HAZARD IDENTIFICATION

TABLE-7.8
DAMAGE DUE TO INCIDENT RADIATION INTENSITIES

Sr. No.	Incident Radiation (kW/m^2)	Type of Damage Intensity
1	62.0	Spontaneous ignition of wood
2	**37.5**	**Sufficient to cause damage to process equipment**
3	32.0	Maximum thermal radiation intensity allowed on thermally protected adjoining equipment
4	25.0	Minimum energy required to ignite wood at infinitely long exposure (non-piloted)
5	12.5	Minimum energy required for piloted ignition of wood, melting of plastic
6	8.0	Maximum thermal radiation intensity allowed on thermally unprotected adjoining equipment
7	**4.5**	**Sufficient to cause pain to personnel if unable to reach cover within 50 seconds, however blistering of skin (1st degree burns)**
8	1.6	Causes no discomfort on long exposures
9	0.7	Equivalent to solar radiation

The effect of incident radiation intensity and exposure time on lethality is given in **Table-7.9.**

TABLE-7.9
RADIATION EXPOSURE AND LETHALITY

Radiation Intensity (kW/m^2)	Exposure Time (seconds)	Lethality (%)	Degree of burns
4.5	20	0	1st
4.5	50	0	1st
8.0	20	0	1st
8.0	50	<1	3rd
8.0	60	<1	3rd
12.0	20	<1	2nd
12.0	50	8	3rd

7.5.6 Scenarios Considered for MCA Analysis

HSD and LSHS stored in tanks and MIBC and lubricating oil stored in drums at the plant area. In case of tank/stored drums or material released in the dyke/storage area catching fire, a steady state fire will ensue. Failures in pipeline may occur due to corrosion, mechanical defect and external interference (such as digging of the area by outsiders unknowingly).

The gas or vapour released either instantaneously or continuously will be spread in the surrounding area under the influence of the atmospheric turbulence. In the case of gas dispersion, a distinction must be made between neutral gas dispersion and heavy gas dispersion.

The concentrations of the gas released in the surrounding area can be calculated by means of these dispersion models. These concentrations are important for determining whether, for example, an explosive gas cloud can form or whether injuries will occur in the case of toxic gases. The following failure scenarios are derived for MCA analysis.

- BLEVE fireball due to rupture of MIBC stored drums;
- Pool fire of HSD tanks due to rupture; and
- Pool fire of LSHS and lubricating oil storage area due to rupture.

7.5.6.1Model Used for MCAA Analysis

Radiation program **RADN** has been used to estimate the steady state radiation effect from HSD / LSHS tanks at different distances. The model has been developed by VIMTA based on the equations compiled from various literature by Prof. J. P. Gupta, Department of Chemical Engineering, IIT Kanpur.

7.5.6.2Model Computations

Although our interest of this study is to find out the distance from a burning tank/drum storage area to a radiation intensity level of 4.5 Kw/m^2, calculations were done of the levels of radiation intensity as indicated above in Section-6.6.3.1. The distances of occurrence of various radiation intensities are presented in **Table-7.10** for different scenarios and depicted in **Figure-7.4** and **Figure-7.5.**

TABLE-7.10
DISTANCE OF OCCURRENCE OF VARIOUS THERMAL RADIATION INTENSITIES

Radiation Intensity (Kw/m^2)	Lethality	Radiation Distances (m)					
		HSD Storage			LSHS	Lub. Oil	MIBC
		Main Gate	Mine Gate	Near DG set	Near DG set		
37.5	100% Lethality	3.4	5.8	5.2	76.9	6.1	47.3
32.0	75% Lethality	3.8	6.3	5.7	84.2	6.7	51.2
25.0	50% Lethality	4.3	7.3	6.6	96.9	7.7	58.0
12.5	1.0% Lethality	6.5	10.8	9.8	143.9	11.4	82.0
4.5	First Degree Burns	11.6	19.3	17.5	257.6	20.4	136.7
1.6	No Discomfort	20.8	34.9	31.5	464.5	36.7	229.2

7.5.6.3Results of MCA Analysis

The results of MCA analysis are tabulated indicating the distances for various damages identified by the damage criteria, as explained earlier in Section-7.6.3.1. The hazard distance for pool fire of HSD tanks, LSHS, lubricating oil and MIBC are tabulated in **Table-7.10.**

- **Pool Fire of HSD**

In the event of a tank spilling its content through a small leakage or due to rupture of the pipeline connecting the tank and on ignition fire. As the HSD tanks are constructed near main gate, mine gate and DG set.

It should be noted that the occurrence of bund fire is rather rare but such data/discussions are useful for emergency planning. There will be adequate time to evoke emergency planning and evacuate people by the time a small fire in HSD tank area can grow into a full fledged bund fire.

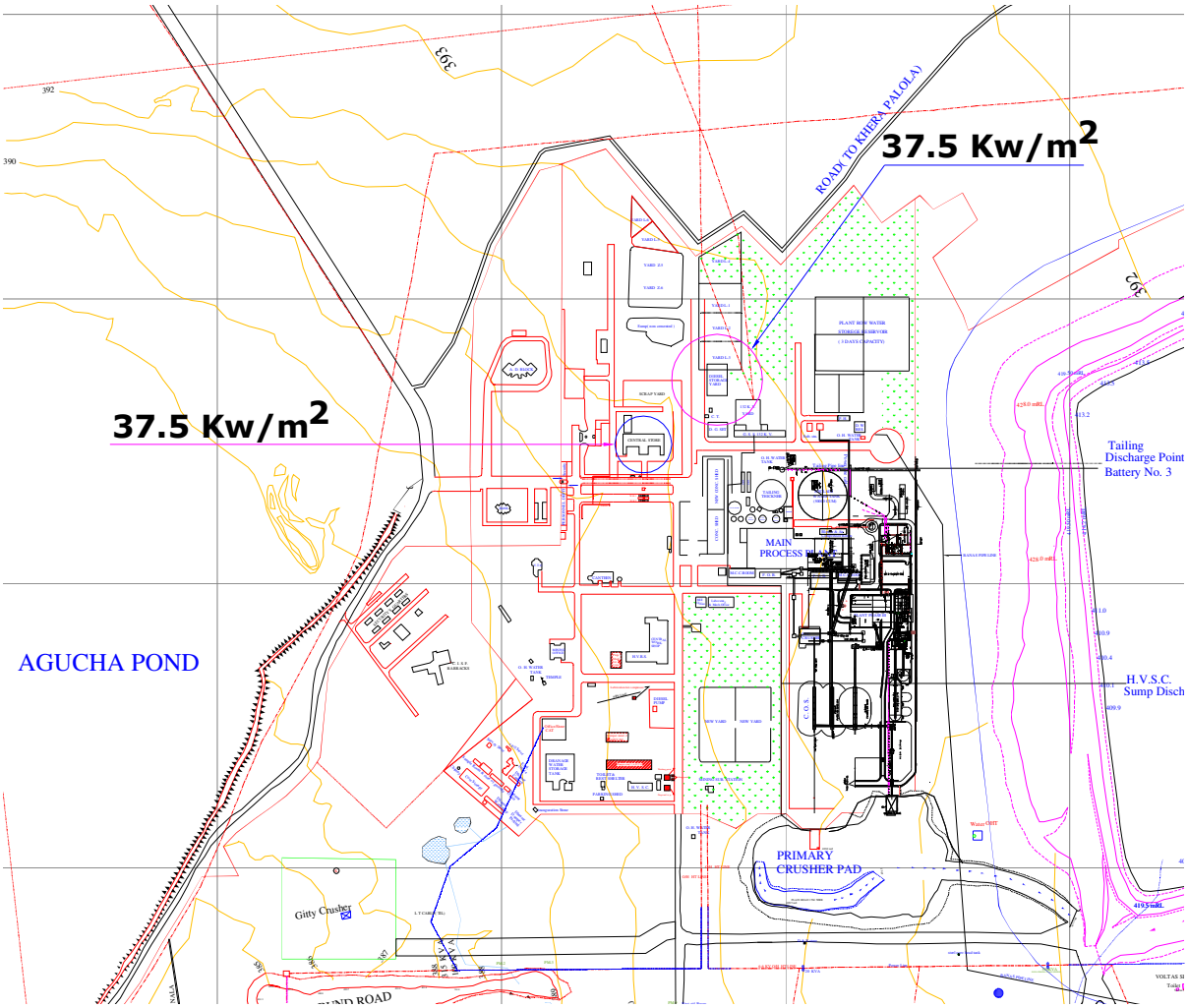


FIGURE-7.4
FAILURE OF STORAGE TANKS- 37.5 kw/m2 CONTOUR

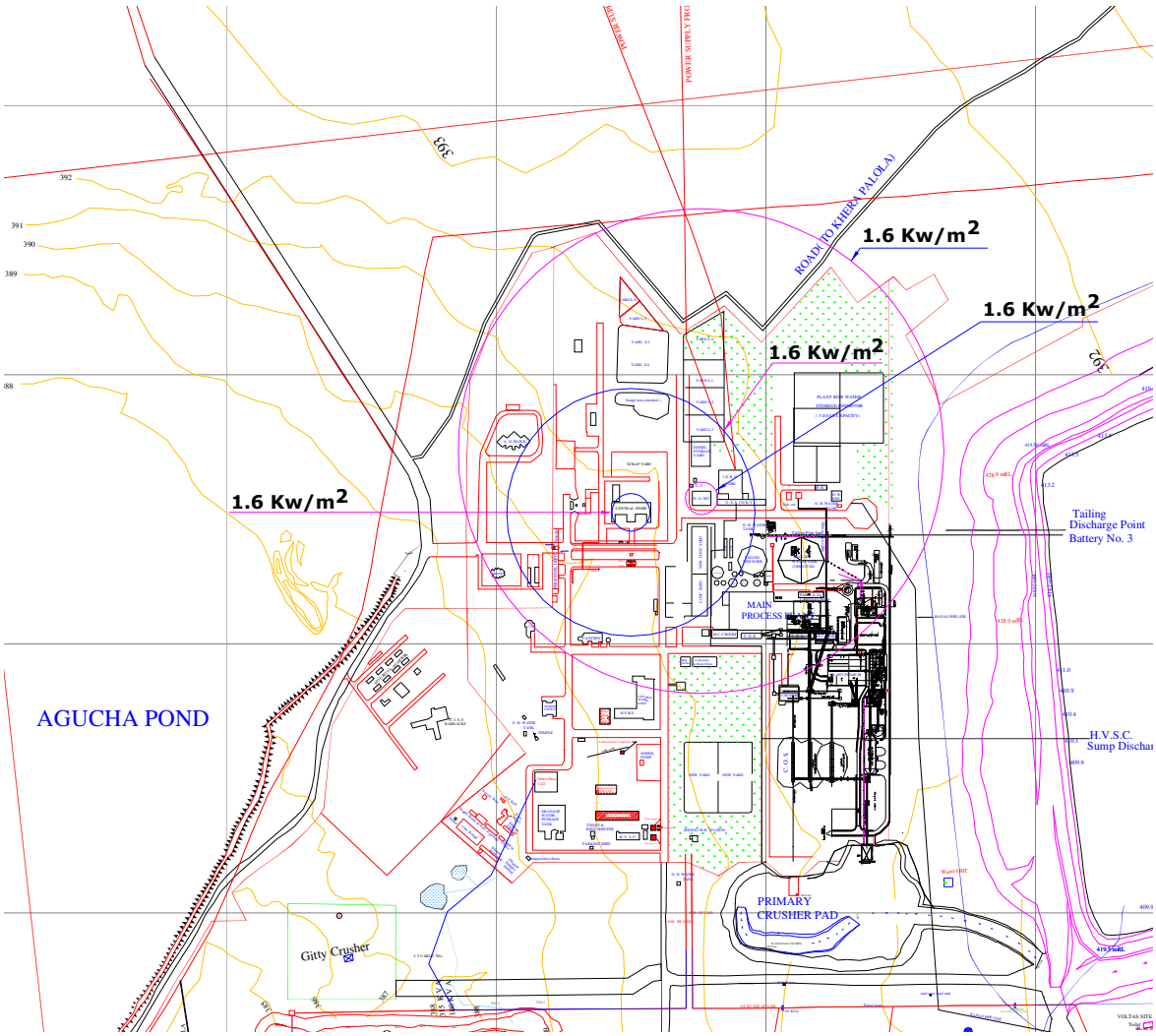


FIGURE-7.5
FAILURE OF STORAGE TANKS- 1.6 kw/m2 Contour

Threshold limited for the safe distance for other installations corresponds to radiation level of 37.5 kW/m^2. A perusal of **Table-7.10** shows that the vulnerable zone in which the thermal fluxes above the threshold limit for safe distance from other installations (37.5 kW/m^2) is restricted to 3.4 m, 5.8 m and 5.2 m in case of HSD tank on fire from the pool edge for the tank near main gate, tank near mine gate and near DG set respectively.

Similarly, the threshold limit for first degree burns is 4.5 kW/m^2. From the results, it may be conclude that the vulnerable zone in which the thermal fluxes above the threshold limit for first degree (4.5 kW/m^2) is restricted to 11.6 m, 19.3 m and 17.5 m in case of HSD tank from the pool edge for the tank near main gate, tank near mine gate and near DG set respectively.

The 1.6 kW/m^2 radiation zone, which is considered to be safe, of the HSD tank near main gate will cover only tank area. The HSD tank near mine gate will cover the heavy vehicle service center. The HSD tank near DG set, covers part of DG set room.

- **Pool Fire of LSHS**

The hazard distance for pool fire of LSHS storage is tabulated in **Table-7.10** The maximum quantity of storage of LSHS in the drums will be 500 KL. The storage drums will be made of mild steel. As the worst case, it is assumed that the entire contents leak out into the storage area forming a pool, which may catch fire on finding a source of ignition. As a result of pool fire, the surrounding installations and personnel will be subjected to thermal radiation.

Threshold limited for the safe distance for other installations corresponds to radiation level of 37.5 kW/m^2. A perusal of **Table-7.10**, shows that the vulnerable zone in which the thermal fluxes above the threshold limit for safe distance from other installations (37.5 kW/m^2) is restricted to 76.9 m from the pool edge of the storage area.

Similarly, the threshold limit for first degree burns is 4.5 kW/m^2. From the results, it may be conclude that the vulnerable zone in which the thermal fluxes above the threshold limit for first degree (4.5 kW/m^2) is restricted to 257.6 m from the pool edge of storage area.

The 37.5 kW/m^2 radiation zone of LSHS covers storage area only.

The 4.5 kW/m^2 radiation zone of LSHS tank near DG set covers CRAP yard, tailing thickener, main process plant zinc & lead yard, HSD storage near main gate and HSD tank near DG set etc.

- **Pool Fire of Lubricating Oil**

The hazard distance for pool fire of lubricating oil storage is tabulated in **Table-7.10** The maximum quantity of storage of lubricating oil in the drums will be 80 KL. The storage drums will be made of mild steel. As the worst case, it is assumed that the entire contents leak out into the storage area forming a pool, which may catch

fire on finding a source of ignition. As a result of pool fire, the surrounding installations and personnel will be subjected to thermal radiation.

Threshold limited for the safe distance for other installations corresponds to radiation level of 37.5 kW/m^2. A perusal of **Table-7.10**, shows that the vulnerable zone in which the thermal fluxes above the threshold limit for safe distance from other installations (37.5 kW/m^2) is restricted to 6.1 m from the pool edge of the storage area.

Similarly, the threshold limit for first degree burns is 4.5 kW/m^2. From the results, it may be conclude that the vulnerable zone in which the thermal fluxes above the threshold limit for first degree (4.5 kW/m^2) is restricted to 20.46 m from the pool edge of storage area.

- **BLEVE Fireball of MIBC**

The hazard distance for pool fire of MIBC stored drums is tabulated in **Table-7.10**. The maximum quantity of storage of MIBC in the drums will be 25 tonnes. The storage drums will be made of mild steel. As the worst case, it is assumed that the entire contents leak out into the storage area forming a pool, which may catch fire on finding a source of ignition. As a result of pool fire, the surrounding installations and personnel will be subjected to thermal radiation.

Threshold limited for the safe distance for other installations corresponds to radiation level of 37.5 kW/m^2. A perusal of **Table-7.10** shows that the vulnerable zone in which the thermal fluxes above the threshold limit for safe distance from other installations (37.5 kW/m^2) is restricted to 47.3 m from the pool edge of MIBC storage area.

Similarly, the threshold limit for first degree burns is 4.5 kW/m^2. From the results, it may be conclude that the vulnerable zone in which the thermal fluxes above the threshold limit for first degree (4.5 kW/m^2) is restricted to 136.7 m from the pool edge of MIBC storage area. The 4.5 KW/m^2 intensity radiation circle covers the complete plant area. The 37.5 KW/m^2 radiation circle covers the entire Chemical storage area.

7.5.6.4Conclusions On MCA Analysis

Based on the MCA analysis given above the following observations are drawn on the existing and proposed layout plan of the plant.

It can be observed that the 4.5 KW/m^2 radiation zone in case of HSD, LSHS, lubricating oil and MIBC storage, which will cause pain to personnel will cover process equipment and installations where continuous presence of workers is expected. Whereas, in case of MIBC storage the 4.5 KW/m^2 intensity radiation intensity covers the complete chemical storage area, where continuous presence of workers is not anticipated. However, the radiation intensity is not likely to cross the boundary of the plant.

Agucha village is the nearest populated area approximately at a distance of 3.0 km from the plant site. From MCA analysis it can be seen that the maximum damage distance corresponding to a heat radiation of 1.6 kw/m^2 for top event is < 0.5 km. Therefore, it can be concluded none of the villages surrounding the plant site will be effected due to any failure of tanks at the plant site.

7.5.6.5 Cascade/Domino Potential of the Radiation

Many past accidents, like the famous LPG accident at Mexico (1984) and West Germany have resulted in a cascade of events. The single catastrophic events can therefore greatly multiply disaster potential if proper protection is not given to installations/units occupying adjacent sites. These secondary or tertiary events, often called C*ascade or Domino effects*, include Pool fires, BLEVES, explosions and toxic gas releases.

In order to evaluate the overall risk due to consequences of various MCA scenarios, damage potential must be analyzed at both the levels, i.e. accident at equipment level and accident at plant level. Consequence analysis of an accident at equipment level would mean evaluation of harmful impacts due to identified MCA scenarios for equipment, i.e. HSD or LSHS or MIBC tank.

For site level consequence analysis all the units are clubbed together, as due to domino or secondary effects there are substantial chances of propagation of fire or explosion in near by equipment, covering the whole plant.

As discussed earlier the existing storages for HSD, LSHS, Lubricant oil and MIBC will be utilized. The storages are spread as per the following distances given in **Table-7.11.**

TABLE-7.11
DISTANCE BETWEEN STORAGES

Sr. No.	Unit		Distance (m)
	From	To	
1	HSD (near DG set)	LSHS	100
2	HSD (near DG set)	MIBC	110
3	HSD (near DG set)	HSD (near Main Gate)	300
4	HSD (near DG set)	HSD (near Mine Gate)	500
5	HSD (near DG set)	Lub oil	160
6	LSHS	MIBC	220
7	LSHS	Lub oil	227
8	LSHS	HSD (Main Gate)	300
9	LSHS	HSD (Mine Gate)	620
10	HSD (Mine Gate)	MIBC	470
11	HSD (Mine Gate)	Lub oil	470
12	HSD (Main Gate)	MIBC	160
13	HSD (Main Gate)	Lub oil	110

Engulfment of storage area with fires and explosions resulting in cascade events is examined as possible scenarios. Thermal radiation of HSD, LSHS, Lubricant oil and MIBC tanks have been examined as possible fire initiators. The following criteria are internationally accepted for identifying the secondary and subsequent impacts.

Radiation Intensity (kW/m^2)	Observed Effect
37.5	Sufficient to cause damage to process equipment
25	Minimum energy required to ignite wood at indefinitely long exposures without a flame
12.5	Minimum energy required for piloted ignition of wood, melting of plastic tubing etc.

Based on the above, for Cascade/Domino effect calculations, a radiation of 37.5 kw/m^2 is considered as the threshold value for identifying the secondary effects. The 100% lethality distances resulting from failure of HSD (Main Gate), HSD (Mine Gate), HSD (DG set), LSHS, Lubricant oil and MIBC tanks are 3.4 m, 5.8 m, 5.2 m, 76.9 m, 6.1 m and 47.3 m respectively. No tanks falls within 37.5 kw/m2 contour of each other except Lubricant oil tank. Lubricant oil tank falls within the threshold limit contour of MIBC. The fuel storages fall within the zone of 100% lethality. Hence, this may lead to Cascade or Domino effect. However, the storage quantity of Lubricant oil is very less.

7.6 Disaster Management Plan

7.6.1 Disasters

A disaster is a catastrophic situation in which suddenly, people are plunged into helplessness and suffering and, as a result, need protection, clothing, shelter, medical and social care and other necessities of life.

Disasters can be divided into two main groups. In the first, are disasters resulting from natural phenomena like earthquakes, volcanic eruptions, storm surges, cyclones, tropical storms, floods, avalanches, landslides, forest fires. The second group includes disastrous events occasioned by man, or by man's impact upon the environment. Examples are armed conflict, industrial accidents, radiation accidents, factory fires, explosions and escape of toxic gases or chemical substances, river pollution, mining or other structural collapses, air, sea, rail and road transport accidents and can reach catastrophic dimensions in terms of human loss.

There can be no set of criteria for assessing the gravity of a disaster in the abstract since this depends to a large extent on the physical, economic and social environment in which it occurs. What would be consider a major disaster in a developing country, ill equipped to cope with the problems involved, may not mean more than a temporary emergency elsewhere. However, all disasters bring in their wake similar consequences that call for immediate action, whether at the local, national or international level, for the rescue and relief of the victims. This includes the search for the dead and injured, medical and social care, removal of the debris, the provision of temporary shelter for the homeless food, clothing and medical supplies, and the rapid re-establishment of essential services.

7.6.2 Objectives of Disaster Management Plan [DMP]

The Disaster Management Plan is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operations in this same order of priorities. For effective implementation of the

Disaster Management Plan, it should be widely circulated and personnel training through rehearsals/drills.

The Disaster Management Plan should reflect the probable consequential severities of the undesired event due to deteriorating conditions or through 'Knock on' effects. Further the management should be able to demonstrate that their assessment of the consequences uses good supporting evidence and is based on currently available and reliable information, incident data from internal and external sources and if necessary the reports of out side agencies.

To tackle the consequences of a major emergency inside the factory or immediate vicinity of the factory, a Disaster Management Plan has to be formulated and this planned emergency document is called "Disaster Management Plan". The objective of the Industrial Disaster Management Plan is to make use of the combined resources of the plant and the outside services to achieve the following:

1. Effect the rescue and medical treatment of causalities;
2. Safeguard other people;
3. Minimize damage to property and the environment;
4. Initially contain and ultimately bring the incident under control;
5. Identify any dead;
6. Provide for the needs of relatives;
7. Provide authoritative information to the news media;
8. Secure the safe rehabilitation of affected area;
9. Preserve relevant records and equipment for the subsequent enquiry into the cause and circumstances of the Emergency.

In effect, it is to optimize operational efficiency to rescue, rehabilitation and render medical help and to restore normalcy.

7.7 Emergencies

7.7.1 General, Industrial, Emergencies

The emergencies that could be envisaged in the plant and tank/drum storage are as follows:

1. A situation of fire at the HSD/LSHS/Lubricating oil storage areas involving fuel storage;
2. A situation of fire/explosion at the MIBC storage;
3 Fire/explosion at Chemical Storage Room, Mixing Room;
4. Fast spreading fires;
5. Structural failures;
6. Breach in Tailing Dam
7. Contamination of food/water; and
8. Sabotage/Social disorder.

7.7.2 Specific Emergencies Anticipated in the Beneficiation Plant

7.7.2.1Fire and Explosion

Fire consequences can be disastrous, since they involve huge quantities of fuel either stored or in dynamic inventory in pipelines or in nearby areas. Toxic releases can affect persons working around. Preliminary hazard Analysis has provided a basis for consequence estimation. Estimation can be made by using various pool fire, tank fire consequence calculations. During the study of Risk Assessment, the nature of damages is worked out and probability of occurrence of such hazards is also drawn up. Therefore, the risk assessment report is to be essentially studied in conjunction with disaster management plan.

7.7.3 Environmental Disasters in Mining Operations

Mining and allied activities are associated with several potential hazards to both the employees and the public at large. A worker in a mine should be able to work under conditions which are adequately safe and healthy. At the same time the environmental conditions should be such as not to impair his working efficiency. This is possible only when there is one of the most essential aspects of any working mine. Indeed safety of the mine and the employees is taken care of by the Mines Act 1952.

7.7.3.1Identification of Hazards

The various hazards associated with mining operations are:

a) Blasting
b) Overburden
c) Heavy Machinery

The mining activity has several disaster prone areas.

● Blasting

Most of the accidents from blasting occur due to the projectiles, as they may some times go even beyond the danger zone, mainly due to overcharging of the shot-holes as a result of certain special features of the local ground. Fly rocks are encountered during initial and final blasting operations. Vibrations also lead to displacement of adjoining areas. Dust and noise problems are commonly encountered during blasting operations.

7.8 Identification of Hazards in Open Cast Mines

● Overburden

The high overburden dumps may cause land slides. High overburden dumps created at the quarry edge may cause sliding of the overburden dump or may cause failure of the pit slope due to excessive loading, thereby causing loss of life

and property. Siltation of surface water may also cause run-off from overburden dumps.

- **Heavy Machinery**

Most of the accidents during transport of dumpers, trucks and other heavy vehicles are often attributable to mechanical failures, in which the factor of human errors cannot be ruled out.

7.8.1 Disaster Management in Open-Cast Mines

7.8.1.1Measures to Avoid Accidents Due to Blasting

- Shots should not be fired except during the hours of day light or until adequate provision is made of artificial light then the holes charged on any particular day shall be fired on the same day.

- Shots, if fired after hours of day light should be muffled so that the flying fragments from the blasting material do not project beyond a distance of 10 meters from the place of blasting.

- Adequate shelters or other protection should be provided at all times.
- The shot fired should give sufficient warning by effective signals over the entire area falling within a radius of 500 meters.

- Where any permanent building or structure of permanent nature not belonging to the owner lies within the danger zone, the aggregate maximum charge in all the holes fired at any particular time shall not exceed 2 kg. But then if blasting is done with at least half second delay of the detonator, even a maximum charge of 2 kg can be used in each hole.

- If a single shot exploder is used or if blasting is done with ordinary detonator, the shot-firer should not fire more than fifty shots in one shift, but if multishot exploder is used the number can be eighty.

- During the approach and progress of electrical storm, adequate precaution shall be taken.

- No shot hole should be drilled in the overburden above the underground galleries.

7.8.1.2Measures to Prevent the failure of Overburden

- A sturdy stone wall should be built around the toe of each active dump at a distance of about 50 m from the toe.

- To prevent the failure of overburden slopes, especially during rainy season, following precautions need to be taken against this hazard :

- Proper terracing of the dump slopes, with maximum bench height of 40 meters.

- In flat areas where the dumping operations have come to an end, the slope angle should be flattened by about 5^0 lower than the angle of repose, which varies from site to site but it is generally expected to be around 27^0.

- Planting vegetation as early as possible over the overburden dump slopes;

- The drainage channels along the overburden dump toe provide additional protection;

- While doing this, a distance of over 15 m should be left between the overburden dump and the bench; and

- If the mine is abandoned, the bench and overburden dump should be separated from each other by digging a trench of 6 to 10 m width.

7.8.1.3Measures to Prevent Accidents Due to Trucks and Dumpers

- All transportation within the main working should be carried out directly under the supervision and control of the management.

- The vehicles must be maintained in good repairs and checked thoroughly at least once a week by the competent person authorized for the purpose by the Management.

- Broad signs should be provided at each and every turning point specially for the guidance of the drivers at night.

- To avoid danger while reversing the trackless vehicles, especially at the embarkment and tripping points, all areas for reversing of lorries should as far as possible be made man free.

- A statutory provision of the fence, constant education, training etc. will go a long way in reducing the incidents of such accidents.

7.9 Emergency Organization

It is recommended to setup an Emergency Organization. A senior executive who has control over the affairs of the plant would be heading the Emergency Organization. In the present case *General Manager* is designated as Site Controller. As per the General Organization chart, *Dy General Manager (Mines)* would be designated as the Incident Controller. In the case of stores, utilities, open areas, which are not under the control of the Production Heads, Senior Executive responsible for maintenance of utilities would be designated as Incident Controller. All the Incident Controllers would be reporting to the Site Controller.

Each Incident Controller, for himself, organizes a team responsible for controlling the incidence with the personnel under his control. Shift In-charge would be the

reporting officer, who would bring the incidence to the notice of the Incidence Controller and Site Controller.

Emergency Co-ordinators would be appointed who would undertake the responsibilities like fire fighting, rescue, rehabilitation, transport and provide essential and support services. For this purposes, Security In-charge, Personnel Department, Essential services personnel would be engaged. All these personnel would be designated as Key personnel.

In each shift, electrical supervisor, electrical fitters, pump house in-charge, and other maintenance staff would be drafted for emergency operations. In the event of power or communication system failure, some of staff members in the office/plant offices would be drafted and their services would be utilized as messengers for quick passing of communications. All these personnel would be declared as essential personnel. The Organisation chart of the existing unit of HZL is shown in **Figure-7.6**. The On-site emergency plan for combating the emergencies is shown in **Figure-7.7**.

7.9.1 Emergency Communication

Whoever notices an emergency situation such as fire, growth of fire, leakage etc. would inform his immediate superior and Emergency Control Center. The person on duty in the Emergency Control Center, would appraise the Site Controller. Site Controller verifies the situation from the Incident Controller of that area or the Shift In-charge and takes a decision about an impending On Site Emergency. This would be communicated to all the Incident Controllers, Emergency Co-ordinators. Simultaneously, the emergency warning system would be activated on the instructions of the Site Controller.

7.10 Emergency Responsibilities

The responsibilities of the key personnel are appended below:

7.10.1 Duties of Main Gate in-charge

i) He shall forthwith inform mine control tower for fire tender giving details of location of fire.
ii) He shall operate the emergency siren for 2 minutes with gaps (5 seconds) to indicate emergency and for indication of all clear continuous 3 minutes siren.
iii) He shall inform Manager (Security & Intelligence) telephonically.

7.10.2 Duties of Shift Engineer (Mine)

In case of fire in plant or storage of fuel and chemicals –

i) On getting information from main gate he shall immediately depute HEMM operator and others to take fire tender to the site of fire.
ii) He shall inform the Mine Manager regarding fire.
iii) He shall remain at mine control tower.

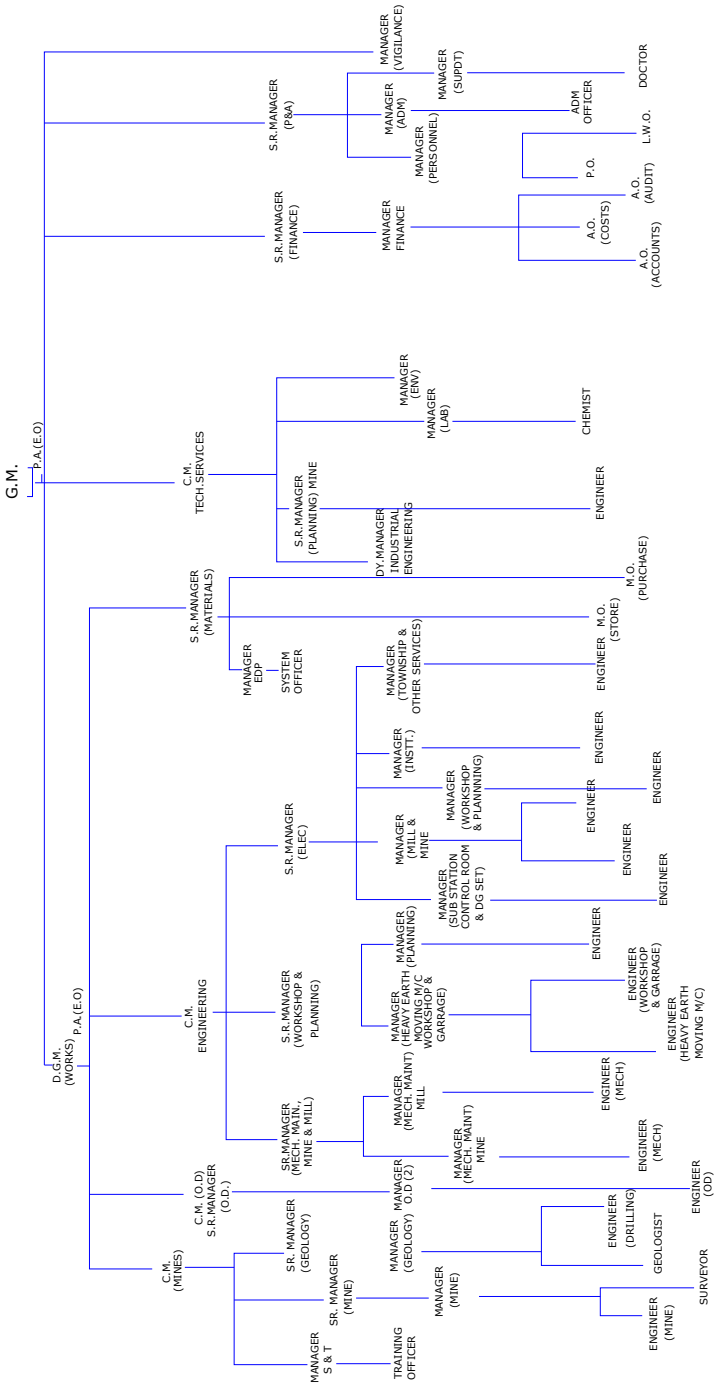


FIGURE- 7.6
ORGANISATION CHART OF HZL

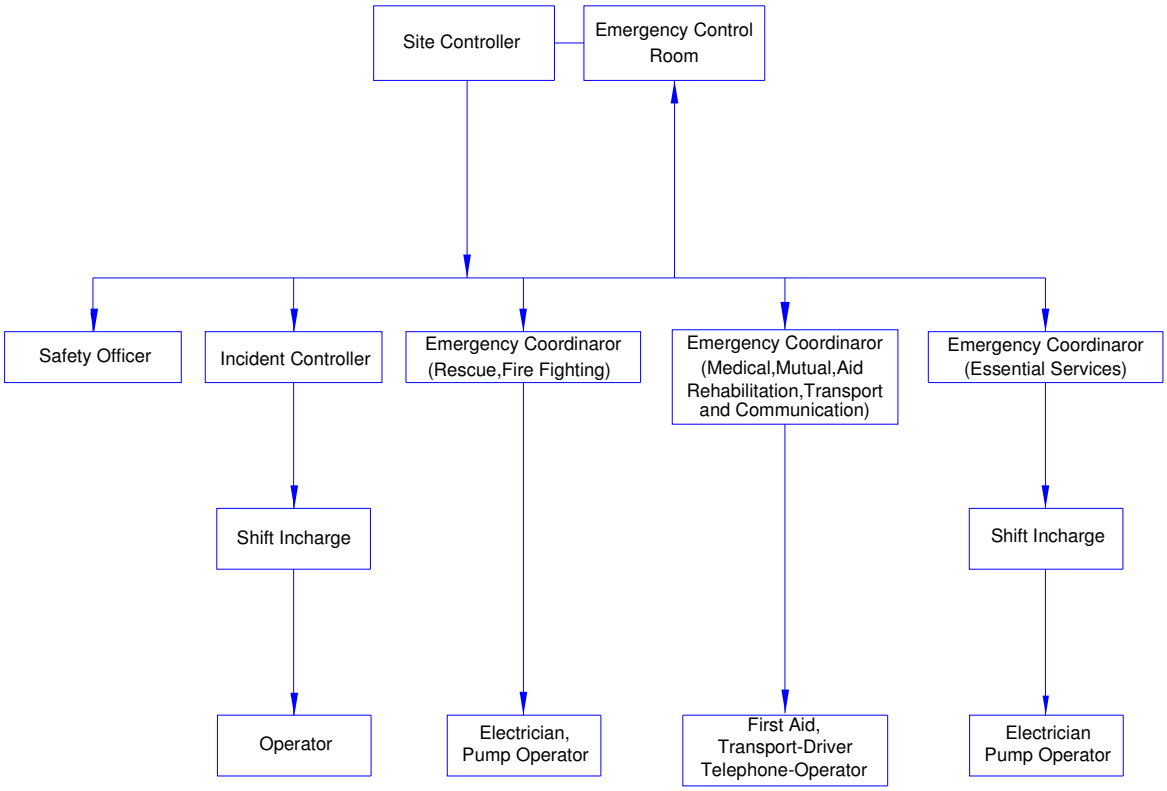


FIGURE-7.7
ON-SITE EMERGENCY PLAN FOR HZL

7.10.3 Duties of Shift Engineer (Mill)

i) On getting information of fire, he shall assess the danger to employees working in the plant and if required, shall withdraw all employees to a safe assembly point.
ii) He shall ensure that the machineries are not left in a condition, which may cause damage or accident.
iii) If required, portable fire extinguishers placed in the plant area shall be made available.
iv) In case of noticing fire in plant area, he shall try to extinguish it with the resources available nearby him. And in case, the fire seems to be extensive, he shall inform the main gate and seek assistance from other departments.
v) He shall immediately notify CM (OD).
vi) In case of extensive fire in plant area, he shall withdraw all employees whose presence is not required for fire fighting to a safe assembly site depending upon location of fire and prevailing wind direction.

7.10.4 Duties of Sr. Manager (Safety & Training)

i) He shall, on receiving information regarding fire, shall provide all fire extinguishers, fire suits and breathing apparatus available in VTC.
ii) He shall guide the fire fighting team.

7.10.5 Duties of Mine Manager (Mine)

i) On getting information of an extensive fire, he shall inform Dy General Manager and immediately proceed to Control Room.
ii) He shall remain in control room and will direct fire-fighting operations, recovery and rehabilitation work with the help of the committee.

7.10.6 Duties of General Manager (RAM)

i) On receiving information about a fire in the plant, he shall proceed to take charge of Communication Center.
ii) He shall inform the head office about the fire and action being taken.
iii) He shall inform the local and district authorities about the fire and seek help, if needed.
iv) He shall maintain liaison with different authorities.

7.10.7 Duties of members of control room committee

i) As soon as they get information regarding a fire, they shall proceed to control room and shall remain there to assist the work of fire fighting, recovery and rehabilitation works
ii) They will assist the controller in carrying out different works needed.

7.10.8 Duties of Manager (Personnel & administration)

i) On being informed of a fire, he shall immediately proceed to his office.
ii) He shall depute an official to man information center.

iii) He shall ascertain that all employees from the affected area have been withdrawn and are assembled at assembly site.
iv) He shall open up communication with fire stations located nearby for timely assistance, if required.
v) He shall arrange for canteen facilities to be made available for persons engaged in different emergency operations.
vi) He shall remain in communication center and assist Dy General Manager in liaison with district administration.

7.10.9 Duties of Sr. Manager (Electrical)

i) He shall all arrangements for continuous supply of power to pump house from state electricity board or captive power plant (DG set).
ii) He shall arrange for Diesel operated pump operation in case of failure of power supply.
iii) He shall ascertain that power supply to affected area is cut off and shall take all possible actions so that it remains discontinued till completion of work.

7.10.10 Duties of Sr. Manager (Civil)

i) On getting information of a fire, he shall make arrangements for continuous supply of water for fire fighting operations.
ii) He shall see that hydrant pump is immediately operated and continue to do so till end of fire fighting. In case of power failure, diesel pump to be operated.

7.10.11 Duties of Manager (Instrumentation)

He shall maintain liaison with telecommunication authorities to keep the lines of communication available.

7.10.12 Duties of Chief Medical Officer

i) He shall, on getting information about a fire in plant, alert staff in the hospital.
ii) He shall organize a medical team and send to the plant.
iii) He shall alert the nearby hospitals for emergency and will maintain liaison with them.

7.10.13 Duties of Manager (DG set)

He shall ensure continuous operation of DG set unless fire is located at fuel storage of DG set.

7.10.14 Duties of Sr. Manager (Materials)

i) He shall keep the stores open and make available any material needed in emergency.
ii) He shall keep in contact with local suppliers for quick delivery of emergent items, if needed.

7.10.15 Duties of senior most office bearer of Union

i) He shall help to control the situation.
ii) He shall encourage employees to take up fire fighting and quench the fire.

7.10.16 In case of fire in HEMM

1. Shift engineer shall inform the Chief Manager (Mine).
2. Shift engineer shall organise fire fighting with the help of portable fire extinguishers available on HEMM and kept near Mine control tower.
3. Shift Engineer shall depute operators to take fire tender near HEMM and sprinkle water to quench fire.
4. Sr. Manager (Mine) and Chief Manager (Mine) shall, on getting information of fire shall proceed to Mine control tower and shall organise fire fighting.

7.10.17 Emergency due to breach of Tailing Dam

The existing tailing dam is having surface area of 130 ha. and height 24 m with 3 m filter bed i.e. total height is 27 m from ground level (392.5 M.R.L. to 419.5 M.R.L). The tailing dam was made of waste rocks with soil lining and rip – rap of stone. There is provision of raising the side walls for future capacity enhancement. While designing the dam many parameters were taken into account like rainfall in the area, earthquake history etc. The present dam is very stable with adequate capacity.

7.10.17.1 Likely Causes for the Failure of Tailing Dam

- **Due to Heavy Flooding**

The existing tailing dam is above ground level. Since out side surface runoff will not enter the tailing dam due to its height, only accumulation of rain water in the tailing dam is possible. The peak rainfall intensity recorded in meteorological monograph of Indian Meteorological Department is 180 mm per day. This amounts to approximately 14 days of slurry volume being pumped to tailing dam. The amounts itself is designed to accommodate slurry up to 2011. Hence failure of the tailing dam due to flooding is ruled out.

- **Due to Earth Quake**

There is no history of earthquake in Rampura – Agucha area. Therefore failure of tailing dam due to earthquake is also ruled out.

- **Due to Structural Failure**

The third possibility is the failure of the tailing dam due to structural failure. HZL has taken adequate care during the engineering design of the tailing dam. In year 2000 a study conducted by National Institute of Rock Mechanics KGF Karnataka for evaluating stability of tailing dam by using "ground Penetrating Radar and

seismic Exploration Methods ''. The results indicate no threat to the stability of the tailing dam after raising the height of the dam to 30 m.
Not withstanding above, should there be a failure of the tailing dam, the impact of is likely to be on agricultural fields, ground water quality near the tailing dam and on the population who are down gradient.

In case of sliding of wall on dry portion of tailing dam, the accumulated tailings will fall out of the which may effect only on adjacent area.

Kheda palola will be likely to affect which is located on down stream of tailing dam.

7.10.18 On- site Emergency Management Plan

1. The discharge of slurry would be stopped immediately to tailing dam.
2. Operation of the plant would be suspended with immediate effect.
3. The breach of the dam would be identified and flow of the water and tailings blocked with sand bags. The activity has to be taken up on war footing.
4. The people from affected area would be shifted to safer place. They will be provided with food and medical facility.
5. People in the affected area would be advised not to use water from dugwells and bore wells for drinking purpose. Alternate arrangements for drinking water will be provided.
6. Water quality of all wells and surface water bodies from the area would be monitored the suitability of wells for drinking water purpose will be certified.
7. The topsoil of the effected agricultural land would be scrapped to remove the deposited tailings.
8. The effected area would be surveyed and damages be estimated accordingly necessary compensation should be worked out in consultation with district authorities
9. Constitution of emergency organization for on site measures.

7.10.19 Emergency Organization Under On – Site Measures

A senior executive who has control over the affairs of the plant would be heading the Emergency organization.

- The unit head will be the site controller.
- Chief Manager (ore dressing) will be incident controller.
- AGM (Maint) would be designated as Incident controller.
- All incident controllers will be reported to the site controller
- Each incident controller for himself organize a team responsible for controlling the incidence with the personnel under his control.
- Shift In charge will be the reporting officer
- Emergency coordinators would be appointed who would under take the responsibilities like rescue, rehabilitation, transport and provide essential and support services for this purpose.
- Pump house operator and other maintenance staff members would be drafted and their services would be utilized.

7.11 Emergency Facilities

7.11.1 Emergency Control Center (ECC)

For the time being Administrative Office Block is identified as Emergency Control Center. It would have external Telephone, Fax, Moblies and Walki-Talki facility. All the Site Controller/Incident Controller Officers, Senior Personnel would be located here. Also, it would be an elevated place. Various other material that are to be maintained in the Emergency Control Center are :
The following information and equipment are to be provided at the Emergency Control Center (ECC).

- Intercom, telephone
- P and T telephone
- Safe contained breathing apparatus
- Fire suit/gas tight goggles/gloves/helmets
- Hand tools, wind direction/velocities indications
- Public address megaphone, hand bell, telephone directories (internal, P and T) factory layout, site plan
- Emergency lamp/torch light/batteries
- Plan indicating locations of hazard inventories, plant control room, sources of safety equipment, work road plan, assembly points, rescue location vulnerable zones, escape routes.
- Hazard chart
- Emergency shut-down procedures
- Nominal roll of employees
- List of key personnel, list of essential employees, list of Emergency Co-ordinators
- Duties of key personnel
- Address with telephone numbers and key personnel, emergency coordinator, essential employees.
- Important address and telephone numbers including Government agencies, neighboring industries and sources of help, out side experts, chemical fact sheets population details around the factory.

7.11.2 Assembly Point

Number of assembly depending upon the plant location would be identified wherein employees who are not directly connected with the disaster management would be assembled for safety and rescue. Emergency breathing apparatus, minimum facilities like water etc. would be organized.

In view of the size of plant, different locations are ear marked as assembly points. Depending upon the location of hazard, the assembly points are to be used.

Employees withdrawn from work place will assemble one of the under mentioned places well away from fire and upward side of prevailing wind direction –

i) Control tower
ii) Concentrate yard near mill

iii) Concentrate yard near Weigh bridge
iv) Lawn outside Administrative building.

7.11.3 Emergency Power Supply

Plant facilities would be connected to Diesel Generator and would be placed in auto mode. Thus water pumps, plants lighting and emergency control center. Administrative building and other auxiliary services are connected to emergency power supply. In all the blocks flame proof type emergency lamps would be provided.

7.11.4 Fire Fighting Facilities

First Aid, Fire Fighting equipment suitable for emergency are maintained in each and at Bulk Storage of HSD, LSHS, Lubricating oil and MIBC. Fire hydrant line covering major areas would be laid. It would be maintained as 6 kg/sq.cm pressure. Fire alarms would be located in the bulk storage areas. Adequate fire fighting equipment are installed at different areas in the plant. The fire hydrants points in the existing and proposed enhancement plant are given in **Table-7.12.**

TABLE-7.12
FIRE HYDRANT POINTS IN THE EXISTING PLANT

Sr. No.	Location of Fire Hydrant Points	Number
1	Administrative Building	04
2	Central Cement Godown	01
3	Central Store	03
4	DG Set (GSS)	08
5	Central Workshop	03
6	Primary Crusher and Fine Ore Bin	03
7	Tailing thickener	02
8	Concentrate Yard	01
9	Proposed Expansion	06

7.11.5 Location Of Wind Sock

On the top of the Administration block, top of each production blocks, wind socks would be installed to indicate direction of wind for emergency escape.

7.11.6 Emergency Medical Facilities

Stretchers, gas masks and general first aid materials for dealing with chemical burns, fire burns etc. are maintained in the medical center in the plant. The plant hospital located in the township will be approached for emergency help. Breathing apparatus and other emergency medical equipment are provided and maintained.

Apart from plant first aid facilities, external hospital facilities in the township will be approached in case of emergencies. Necessary specific medicines for emergency treatment of Burns Patients, and for those affected by toxicity are maintained. The plant hospital located in the township is furnished with 12 beds supported by clinical, pathological lab, X-ray, physiotherphy lab and MOT. Round the clock

service is provided for employees. Three qualified Doctors with supporting staff are employed at the hospital.

7.11.7 Ambulance

An ambulance with driver is available in all the shifts and in the hospital. The vehicle is maintained to transport injured or affected persons to the hospital. Number of persons are trained in first aid so that, in every shift first aid personnel are available.

7.12 Emergency Actions

7.12.1 Emergency Warning

Communication of emergency is made familiar to the personnel inside the plant and people outside. An emergency warning system is established.

7.12.2 Emergency Shutdown

There are number of facilities which can be provided to help deal with hazardous conditions, when a tank is in fire. The suggested arrangements are:

1. Stop feed;
2. Dilute contents;
3. Remove heat;
4. Deluge with water; and
5. Transfer contents.

Whether a given method is appropriate depends on the particular case. Cessation of agitation may be the best action in some instances but not in others. Stopping of the feed may require the provision of by pass arrangements.

Methods of removing additional heat include removal through the normal cooling arrangements or use of an emergency cooling system. Cooling facilities, which use vapouring liquid may be particularly effective, since a large increase in vaporization can be obtained by dropping pressure.

7.12.3 Evacuation of Personnel

There could be more number of persons in the storage area and other areas in the vicinity. The area would have adequate number of exits, stair cases. In the event of an emergency, unconnected personnel have to escape to assembly point. Operators have to take emergency shutdown procedure and escape. Time Office maintains a copy of deployment of employees in each shift, at ECC. If necessary, persons can be evacuated by rescue teams.

7.12.4 All Clear Signal

Also, at the end of an emergency, after discussing with Incident Controllers and Emergency Co-ordinators, the Site Controller orders an all clear signal. When it becomes essential, the Site Controller communicates to the District Emergency

Authority, Police, Fire Service personnel regarding help required or development of the situation into an Off-Site Emergency.

7.13 General

7.13.1 Employee Information

During an emergency, employees would be warned by raising siren in specific pattern. Employees would be given training of escape routes, taking shelter, protecting from toxic effects. Employees would be provided with information related to fire hazards, antidotes and first aid measures. Those who would designated as key personnel and essential employees should be given training to emergency response.

7.13.2 Public Information And Warning

The industrial disaster effects related to this plant may mostly be confined to the plant area. The detailed risk analysis has indicated that the pool fire effects would not be felt outside. However, as an abundant precaution, the information related to chemicals in use would be furnished to District Emergency Authority for necessary dissemination to general public and for any use during an off site emergency. Factories of this size and nature are in existence in our state since long time. There was no reported instance of an off site emergency in such gas based power plants.

7.13.3 Co-ordination With Local Authorities

Keeping in view of the nature of emergency, two levels of coordination are proposed. In the case of an On Site Emergency, resources within the organization would be mobilized and in the event extreme emergency local authorities help should be sought.

In the event of an emergency developing into an off site emergency, local authority and District emergency Authority (normally the Collector) would be appraised and under his supervision, the Off Site Disaster Management Plant would be exercised. For this purpose, the facilities that are available locally, i.e. medical, transport, personnel, rescue accommodation, voluntary organizations etc. would be mustered. Necessary rehearsals and training in the form of mock drills should be organized.

7.13.4 Mutual Aid

Mutual aid in the form of technical personnel, runners, helpers, special protective equipment, transport vehicles, communication facility etc. should be sought from the neighboring industrial managements.

7.13.5 Mock Drills

Emergency preparedness is an important on that of planning in Industrial Disaster Management. Personnel would be trained suitably and prepared mentally and physically in emergency response through carefully planned, simulated procedures. Similarly, the key personnel and essential personnel should be trained in the operations.

7.13.6 Important Information

Important information such names and addresses of key personnel, essential employees, medical personnel, out side the plant, transporters address, address of those connected with Off Site Emergency such as Police, Local Authorities, Fire Services, District Emergency Authority should be prepared and maintained.

7.14 Off-Site Emergency Preparedness Plan

The task of preparing the Off-Site Emergency Plan lies with the District collector, however the off-site plan will be prepared with the help of the local district authorities. The proposed plan will be based on the following guidelines.

7.14.1 Introduction

Off-site emergency plan follows the on-site emergency plan. When the consequences of an emergency situation go beyond the plant boundaries, it becomes a off-site emergency. Off-site emergency is essentially the responsibility of the public administration. However, the factory management will provide the public administration with the technical information relating to the nature, quantum and probable consequences on the neighboring population.

The off-site plan in detail will be based on those events which are most likely to occur, but other less likely events which have severe consequence will also be considered. Incidents which have very severe consequences yet have a small probability of occurrence should also be considered during the preparation of the plan. However, the key feature of a good off-site emergency plan is flexibility in its application to emergencies other than those specifically included in the formation of the plan.

The roles of the various parties who will be involved in the implementation of an off-site plan are described below. Depending on local arrangements, the responsibility for the off-site plan should be either rest with the works management or, with the local authority. Either way, the plan should identify an emergency co-ordinating officer, who would take the overall command of the off-site activities. As with the on-site plan, an emergency control center should be setup within which the emergency co-ordinating officer can operate.

An early decision will be required in many cases on the advice to be given to people living "within range" of the accident - in particular whether they should be evacuated or told to go indoors. In the latter case, the decision can regularly be reviewed in the event of an escalation of the incident. Consideration of evacuation may include the following factors:

a. In the case of a major fire but without explosion risk (e.g. an oil storage tank), only houses close to the fire are likely to need evacuation, although a severe smoke hazard may require this to be reviewed periodically;

b. If a fire is escalating and in turn threatening a store of hazardous material, it might be necessary to evacuate people nearby, but only if there is time; if

insufficient time exists, people should be advised to stay indoors and shield themselves from the fire. This latter case particularly applies if the installation at risk could produce a fireball with vary severe thermal radiation effects (e.g.LPG storage);

c. For release or potential release of toxic materials, limited evacuation may be appropriate down wind if there is time. The decision would depend partly on the type of housing "at risk". Conventional housing of solid construction with windows closed offers substantial protection from the effects of a toxic cloud, while shanty house, which can exist close to factories, offer little or no protection.

The major difference between releases of toxic and flammable materials is that toxic clouds are generally hazardous down to much lower concentrations and therefore hazardous over greater distances. Also, a toxic cloud drifting at, say 300 m per minute covers a large area of land very quickly. Any consideration of evacuation should take this into account.

Although the plan will have sufficient flexibility built in to cover the consequences of the range of accidents identified for the on-site plan, it will cover in some detail the handling of the emergency to a particular distance from each major hazard works.

7.14.2 Aspects Proposed to be Considered in the Off-Site Emergency Plan

The main aspects, which should be included in the emergency plan are:

Organization

Details of command structure, warning systems, implementation procedures, emergency control centers.

Names and appointments of incident controller, site main controller, their deputies and other key personnel.

Communications

Identification of personnel involved, communication center, call signs, network, lists of telephone numbers.

Specialized knowledge

Details of specialist bodies, firms and people upon whom it may be necessary to call e.g. those with specialized chemical knowledge, laboratories.

Voluntary organizations

Details of organizers, telephone numbers, resources etc.

Chemical information

Details of the hazardous substances stored or procedure on each site and a summary of the risk associated with them.

Meteorological information

Arrangements for obtaining details of whether conditions prevailing at the time and whether forecasts.

Humanitarian arrangements

Transport, evacuation centers, emergency feeding treatment of injured, first aid, ambulances, temporary mortuaries.

Public information

Arrangements for a] dealing with the media press office; b] informing relatives, etc.

Assessment

Arrangements for : (a) collecting information on the causes of the emergency; (b) reviewing the efficiency and effectiveness of all aspects of the emergency plan.

7.14.3 Role of the Emergency Co-ordinating Officer

The various emergency services should be co-ordinated by an emergency co-ordinating officer (ECO), who will be designated by the district collector. The ECO should liaise closely with the site main controller. Again depending on local arrangements, for very severe incidents with major or prolonged off-site consequences, the external control should be passed to a senior local authority administrator or even an administrator appointed by the central or state government.

7.14.4 Role of the Local Authority

The duty to prepare the off-site plan lies with the local authorities. The emergency planning officer (EPO) appointed should carry out his duty in preparing for a whole range of different emergencies within the local authority area. The EPO should liaise with the works, to obtain the information to provide the basis for the plan. This liaison should ensure that the plan is continually kept upto date.

It will be the responsibility of the EPO to ensure that all those organizations, which will be involved off site in handling the emergency, know of their role and are able to accept it by having for example, sufficient staff and appropriate equipment to cover their particular responsibilities. Rehearsals for off-site plans should be organized by the EPO.

7.14.5 Role of Police

Formal duties of the police during an emergency include protecting life and property and controlling traffic movements.

Their functions should include controlling bystanders evacuating the public, identifying the dead and dealing with casualties, and informing relatives of death or injury.

7.14.6 Role of Fire Authorities

The control of a fire should be normally the responsibility of the senior fire brigade officer who would take over the handling of the fire from the site incident controller on arrival at the site. The senior fire brigade officer should also have a similar responsibility for other events, such as explosions and toxic release. Fire authorities in the region should be apprised about the location of all stores of flammable materials, water and foam supply points, and fire-fighting equipment. They should be involved in on-site emergency rehearsals both as participants and, on occasion, as observers of exercises involving only site personnel. The flow chart for off-site emergency plan is given in **Figure-7.8.**

7.14.7 Role of Health Authorities

Health authorities, including doctors, surgeons, hospitals, ambulances, and so on, should have a vital part to play following a major accident, and they should form an integral part of the emergency plan.

For major fires, injuries should be the result of the effects of thermal radiation to a varying degree, and the knowledge and experience to handle this in all but extreme cases may be generally available in most hospitals. For major toxic releases, the effects vary according to the chemical in question, and the health authorities should be apprised about the likely toxic releases from the plant which will unable then in dealing with the aftermath of a toxic release with treatment appropriate to such casualties.

Major off-site incidents are likely to require medical equipment and facilities additional to those available locally, and a medical " mutual aid " scheme should exist to enable the assistance of neighboring authorities to be obtained in the event of an emergency.

7.14.8 Role of Government Safety Authority

This will be the factory inspectorate available in the region. Inspectors are likely to want to satisfy themselves that the organization responsible for producing the off-site plan has made adequate arrangements for handling emergencies of all types including major emergencies. They may wish to see well documented procedures and evidence of exercise undertaken to test the plan.

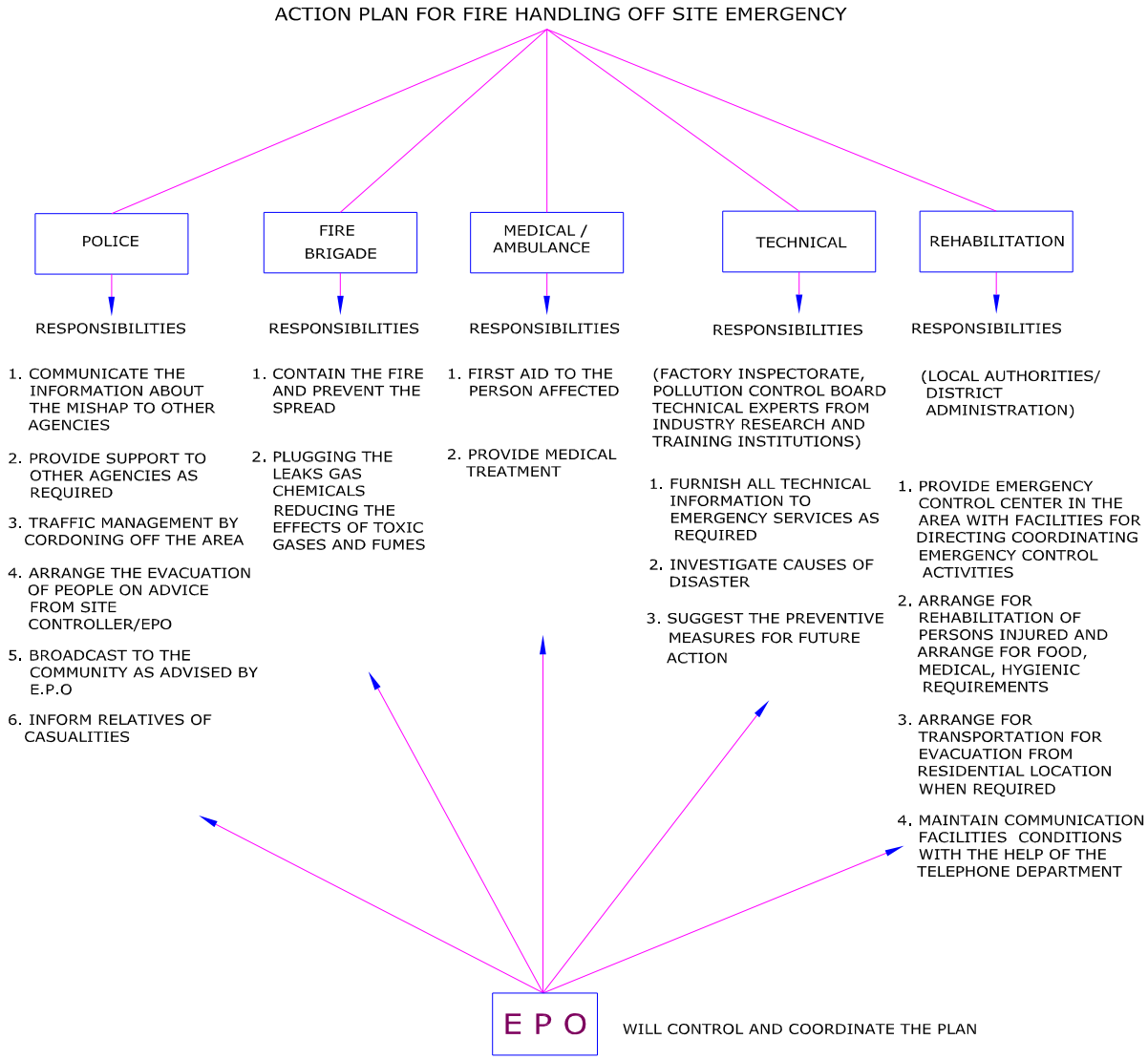


FIGURE-7.8
OFF-SITE EMERGENCY PLAN

In the event of an accident, local arrangements regarding the role of the factory inspector will apply. These may vary from keeping a watching brief to a close involvement in advising on operations in case involvement in advising on operations. In cases where toxic gases may have been released, the factory inspectorate may be the only external agency with equipment and resources to carry out tests.

7.15 Occupational Health and Safety

Large industries, in general, where multifarious activities are involved during construction, erection, testing, commissioning, operation and maintenance, the men, materials and machines are the basic inputs. Along with the boons, the industrialization generally bring several problems like occupational health and safety.

The industrial planner, therefore, has to properly plan and take the steps to minimize the impacts of industrialization and to ensure appropriate occupational health, safety including fire plans. All these activities again may be classified under construction and erection, and operation and maintenance. The existing and proposed safety plan is given below:

7.15.1 Occupational Health

Occupational health needs attention during operation and maintenance of mine and mill. However, the problem varies both in magnitude and variety in the above phases.

The problem of occupational health, in the operation and maintenance phase is due to noise hearing losses. Suitable personnel protective equipments are given to employees. The working personnel are 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
- Safety belt/line man's safety belt
- Leather hand gloves
- Asbestos hand gloves
- Acid/Alkali proof rubberized hand gloves
- Electrically tested electrical resistance hand gloves
- Industrial safety shoes with steel toe and gum boots

Full fledged hospital facilities are available round the clock for attending emergency arising out of accidents, if any. All working personnel are 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.

7.15.2 Safety Plan

Safety of both men and materials during construction and operation phases is of concern. The preparedness of an industry for the occurrence of possible disasters is known as emergency plan. The disaster in the plant is possible due to leakage of chemicals like MIBC, Sodium Cyanide, Copper Sulphate, collapse of structures and fire/explosion etc.

Safety is required during construction, operation and maintenance phases. HZL has formulated safety policy with the following regulations keeping in view of directives given by Controller of Explosives:

- 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 design, construction, operation and maintenance of plants, machinery and equipment.
- To ensure that adequate safety instructions are given to all employees.
- To provide wherever necessary protective equipment, safety appliances and clothing, and to ensure their proper use.
- To inform employees about materials, equipments 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 personal injury or injury to health with a view to taking corrective, remedial and preventive action.
- To promote through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees.

- To publish/ notify regulations, instructions and notices in the common language of employees.

- To prepare separate safety rules for each types of occupation/processes involved in a project.

- To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipments, work places and operations.

In operation, the safety guidelines are framed in consultation with CEGB and are tested under their guidance.

7.15.3 Safety Circle

In order to fully develop the capabilities of the employees in identification of hazardous processes and improving safety and health, safety circles are constituted in each area of work. The circle consist of 5-6 employees from that area. The circle normally meets for about an hour every week.

7.15.4 Safety Training

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

- Compartmentation of cable galleries, use of proper sealing techniques of cable passages and services in all directions would help in localizing and identifying the area of occurrence of fire as well as ensure effective automatic and manual fire fighting operations;

- Spread of fire in horizontal direction would be checked by providing fire stops for cable shafts;

- Reliable and dependable type of fire detection system with proper zoning and interlocks for alarms are effective protection methods for conveyor galleries.

- 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.

7.15.5 Health And Safety Monitoring Plan

All the potential occupational hazardous work places such as chemical storage area, acid and alkali storage areas are monitored regularly. The health of employees working in these areas are monitored once in five year for early detection of any ailment due to exposure to hazardous chemicals.

8.0 CONCEPTUAL FINAL MINE CLOSURE PLAN

8.1 Introduction

Rampura Agucha deposit is amenable for open pit mining up to a depth of 372 m from surface. Reserves beyond the open pit limits, mainly remains in the upper levels of northern side and below the ultimate pit limit are amenable to underground operations. With the proposed ore production target of 5.0 MTPA, open pit mine life of about 10 years has been envisaged.

Further exploration is currently in progress, resultant exploration information shall be utilised to generate geometrical, quantitative and qualitative parameters of ore body so as to develop future scheme of mining including the mining method.

The underground mining entries will be from Footwall side of the existing pit and pit will continue to be in use. The beneficiation plant and tailing dam will also continue to function to cater to underground mining.

The final mine closure plan (FMCP) will have main elements, viz. Mine pit and Underground mine, Waste dump, Tailing dam and Surface infrastructure (mine decommissioning) including beneficiation plant.

The ore body at Agucha mine has a limited strike length (1580 m) and steep dip angle (50-80º), which is open in depth. Underground mining will be commenced beyond the open pit mine to extract deeper level resources.

Final closure of the mine will be influenced by method of mining to be adopted, entries to the underground mine and rate of ore production.

Draft underground conceptual study envisaged the Sub Level Open Stopping (Where ore body width is > 15 meter) and Benching mining (Where ore body width is < 15 meter) mining methods with filling of mined stopes.

8.2 Conceptual Final Closure

Based on the present information, conceptual final closure of the mine (Open pit and Underground) may be considered as combination of following options:

The ore body at Agucha mine has a limited strike length (1580 m) and steep dip angle (50-80º). The entire mine pit will remain active throughout, the mine life thereby rendering back filling non-feasible, which does not allow to back fill the waste material. **On account of this progressive closure of the pit is not possible.**

However, at the end of open pit life, some quantity of waste generated from underground operations will be accommodated at bottom bench.

However, based on the present information, conceptual final closure of the mine has been considered.

Plantation and Fencing

The acquired land area of 869.5 hectares of the mining lease is already covered with a stone masonry boundary wall of 16 Km length and 1.5 meter height to provide separation of mining activities from the surrounding area.

Additionally, to ensure the safety of the human being and animals, stone masonry wall (size 1.5 m high x 0.5 m wide) will be constructed around the perimeter of ultimate pit limit. Total linear length of stone masonry wall will be approx. 4 Km.

To further increase the aesthetic beauty of the closed mine, to the outer side of the stone masonry wall, a green belt of 20-meter width will be developed, with specific species of Neem, Shisham and Desi Babool so that animals are not attracted towards the pit. Approximately 10,000 trees will be planted.

To keep the run off water away from the open pit, garland drain will be constructed (1.5m x 1.2m) around the periphery of pit. It will carry the run off water and discharge it in to the existing nallah (drain).

Inert building rubble arising from the demolition of surface infrastructure will be filled into the shaft and a mass concrete cap of 1000-mm thickness will be constructed at the mouth of the shaft.

For Final Closure of the mine and for safety consideration, sealing of all underground mine entries including adits, declines, shafts will be done. This will be conducted in a systematic manner so as to obviate the potential safety risks.

Waste Dump

Progressive rehabilitation of waste dumps through plantation has been planned. During the remaining life (as on 1.04.2006) of open pit mine, 157.63 Mt of waste rock will be generated and dumped separately in designated places (1,2,3 and 4) in 4 m x 10 m lifts. Each waste dump will be rehabilited progressively by planting of tree over the slopes and over the top surface. Plantation will act as protective measure against siltation, erosion and dust generation. The existing garland drain around the waste dump will continue to collect the run off from the dump slopes and through a settling pond shall be taken to the existing natural drainage. Detailed year wise plantation schedule over the dumps is given in **Table-8.1**.

TABLE- 8.1
PROPOSED PLANTATION SCHEDULE

Year	Area (ha)	No. of Trees
Plantation on Overburden Dump		
Year 1 (2008 – 2009)	0	0
Year 2 (2009 – 2010)	0	0
Year 3 (2010 – 2011)	4.8	3900
Year 4 (2011 – 2012)	4.7	3800
Year 5 (2012 – 2013)	7.9	6300
Total	**17.4**	**14000**

Tailing Dam

The existing tailing dam will continue to serve till the end of mine life. Side of the tailing pond is constructed by dumping the fine to average size of waste material over the edges of it. Height of the dam would be raised up to a height of 41 meter. Further, being active throughout its life, progressive closure is not possible.

The tailing at the end of mine life will have a surface area of 125 hectare at a height of 41 meter from ground surface. The final closure envisages retaining a fifth of total surface area (25 hectare) as water pond in the center. The surrounding surface shall be brought under vegetative cover. The tailing being acidic in nature shall require neutralization with suitable amenders such as hydrated lime, gypsum, clay, phosphate tailing (alkaline), soil, farm yard manure, agro waste and vermi compost etc. The quantity, proportion and dose shall be determined on a scientific basis. The choice of species of plants, plantation techniques, watering schedule and after care shall be determined based on bio-technological solutions. The field trials shall precede actual application.

Mine Decommissioning

During the Final Closure of the mine, all the equipment's shall be removed and disposed off. All infrastructure building, foundations, conveyors and other ancillary structures shall also be demolished to natural ground level.

Chemical / fuel / concentrate / ore storage areas shall be Decontaminated. The demolished area shall be leveled and developed for plantation. Care shall be taken to avoid fuel wood species in vegetating these areas to avoid theft and destruction.

INFRASTRUCTURE: All necessary infrastructures like metal road, power, water transportation, colony, school & telecommunication are available & will be kept in place during the period of mining plan as management does not envisage closure during this period.

For final mine closure, No definitive plan for the use of infrastructure has been proposed. It shall be prepared when mine will undergo for closure. However, conceptually, the most likely use of the infrastructure may be considered as under.

Some of the buildings like the administrative block & other office building can be offered to the state Govt. to further utilize them and all other plant infrastructure buildings & foundations shall be demolished to natural ground level. All the equipments shall be removed and disposed off. The demolished area shall be leveled and plantation will be developed over it.

DISPOSAL OF MINING MACHINERY: Mining machineries after their useful life are being disposed by use at company's other site by inter unit transfer or auction etc. The same procedure will continue in future also.

SAFETY & SECURITY: Mining is being carried out as per permission of safety regulating authority DGMS (Directorate General of Mine Safety). For the security of mine premises lessee has deployed one competent agency to manage the security needs of the mine.

Economic Repercussion of Closure of Mine and Manpower Retrenchment:

No. of local residents employed in the mine, Status of the continuation of family occupation and scope of joining the occupation back: This is a progressive mine closure plan & management does not envisage closure in the plan period. However there are 214 local residents employed in mine as permanent employees besides few engaged as contract labour. The status of continuation of family occupation & scope of joining the occupation back is not an issue with majority as out of 214 only 138 are the land looser whose livelihood was agriculture. However as per practices & policies of the company, HZL provides opportunity of alternate employment in other works of the company or provide legitimate compensation in such cases of closure & retrenchment.

Compensation given or to be given to the employees connecting with sustenance of himself & their family members: This is a progressive mine closure plan & management does not envisage closure in the plan period. Till date no body has been retrenched & in future all legitimate dues at that time will be given to employees if situation arises as mentioned above.

Satellite occupation connected to the mining industry – no. of persons engaged therein – continuance of such business after mine closes : This is a progressive mine closure plan & management does not envisage closure in the proposed plan period & as such no satellite occupation connected to Rampura Agucha Mine is there in the vicinity of the mine. Hence there is no issue of continuance of such business after mine closes.

Continued engagement of employees in the rehabilitated status of mining lease area & any other remnant activities: This is a progressive mine closure plan & management does not envisage closure in the plan period. However continued engagement of employees in alternate employment at other works of company or legitimate compensation is a policy & past history of HZL.

Envisaged repercussions on the expectation of society around due to closure of mine: This is a progressive mine closure plan & management does not envisage closure in the period of current mining scheme.

TIME SCHEDULE FOR ABANDONMENT: This is a progressive mine closure plan & management does not envisage closure in the plan period. Rampura Agucha deposit is amenable for open pit mining up to a depth of 372-m from surface. Reserves beyond the open pit limits, mainly remains in the upper levels of northern side and below the ultimate pit limit are amenable to underground operations.

The ore body at Agucha mine has a limited strike length (1550 m) and steep dip angle (50-80º), which is open in depth. Underground mining will be done beyond the open pit mine to extract deeper level resources. Some of the structures for underground mining will be located within the pit. On account of these reasons,

concurrent / progressive closure of the pit will not be possible and hence open pit and underground mine together will be closed at the end of mine life.

However, in case of Final mine closure, , the FMCP of the mine will have main elements, viz mine pit, waste dump, tailing dam sealing of all underground mine entries including declines, shafts and Mine decommissioning.

Steeply dipping ore body at Rampura Agucha Mine does not allow the concurrent filling of the pit and hence other suitable alternatives like fencing of the pit is envisaged. To ensure the safety of the human beings and animals, stone masonry wall will be constructed around the perimeter of the ultimate pit limit. The total length of the masonry wall will be approx. 4-Km.

On waste dump, progressive rehabilitation has been planned. Each waste dump will be re-habilitated progressively by planting of the trees over the slopes and top surface.

The existing tailing dam will continue to serve till the end of the mine life. At the end of the mine life, tailing pond will generate an area of around 125-Ha. The final closure envisages to bring the surface under vegetation.

During the final closure of the mine, all the equipments shall be removed and disposed off. All the infrastructure buildings, foundations, conveyors and other ancillary structures shall also be demolished to natural ground level. Inert building rubble arising from the demolition of surface infrastructure will be filled into the shaft and a mass concrete cap of 1000-mm thickness will be constructed at the mouth of the shaft, all other mine entries including adits, declines, shafts will be sealed.

Tentative closure schedule will be as given in **Table-8.2**.

TABLE-8.2
TENTATIVE CLOSURE SCHEDULE

Sr. No.	Activity	Year 1	Year 2	Year 3	Year 4	Year 5
1	Open pit closure					
2	Waste dump closure					
3	Tailing dam closure					
4	Mine decommissioning					
5	UG openings closure					

ABANDONMENT COST: This is a progressive mine closure plan & management does not envisage closure in the period of current mining scheme. However mine will comply applicable statute in case of abandonment as per The Mineral Conservation & Development Rules, The Metalliferrous Mines Regulations & The Mineral Concession Rule wherein fencing is required along with necessary updating of plans & sections with information to the regulatory authorities & compliance of provisions of closure as per final mine closure plan which will be submitted at due time i.e. one year prior to intended closure. Presently all

acquired land is fenced by boundary wall, a structure of permanent character sufficient to effectively prevent persons falling into or entering the same.

In case of final mine closure tentative cost for rehabilitation will be as given in **Table-8.3**.

TABLE-8.3
FINAL MINE CLOSURE TENTAIVE COST

Sr. No.	Activity	Work involvement	Cost (Rs. Crores)
1	Open pit closure	Preparation of masonry wall etc.	0.55
2	Waste dump closure	Plantation	1.13
3	Tailing dam closure	Plantation	2.4
4	Mine decommissioning	Decommissioning-decontaminating and plantation	2.9
5	UG openings closure	Filling and sealing of all openings with inert material	0.5
Total			**7.48**

Post Closure monitoring

- To ensure the stability of the benches, post closure monitoring of the slopes at appropriate interval will be done by installation of three permanent pillars at F/W and H/W respectively; and
- Water monitoring.

The existing monitoring of ground water and surface water will be continued after closure:

- Bore well water monitoring all around the tailing dam, waste dump and mine pit;
- Well water monitoring in buffer zone;
- Surface water monitoring for Agucha dam, Paprikhera pond and Kothian pond in pre and post monsoon seasons. (see enclosed map for locations) . Analysis for al the parameters will be carried out as per IS method; and
- Monitoring will be done for two seasons summer and winter for 3-5 years. The monitored data will be evaluated and reviewed intermittently to elicit trend in the post closure period, so that appropriate action such as re-location of sampling station, change in periodicity, other alternatives, inclusive of termination of monitoring, may be initiated whenever necessary.

Conceptual Mine Closure Plan is given **Figure-8.1** and the details are given in **Table-8.4**.

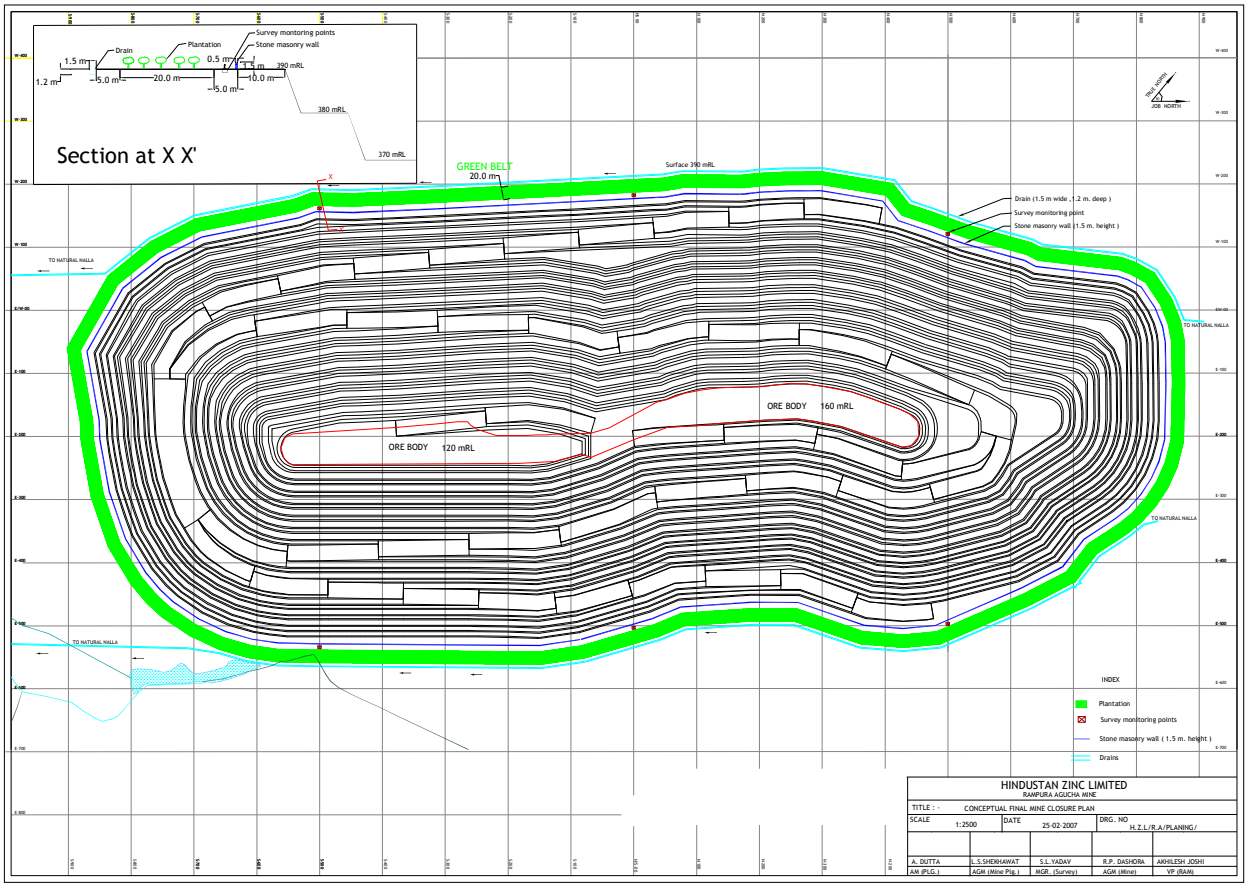


FIGURE-8.1
CONCEPTUAL MINE CLOSURE PLAN

TABLE-8.4
CONCEPTUAL MINE CLOSURE PLAN

Break up of Land Use	**Beginning of Plan Period**		**End of Plan Period**		**End of mine life**	
	Area put in use for Mining and allied activities	Area fully Reclaimed /Rehabilita-ted	Area put in use for Mining and allied activities	Area fully Reclaimed /Rehabilita-ted	Area put in use for Mining and allied activities	Area fully Reclaimed /Rehabilitated
Pit & Waste Dump	348.52		447.08	9.5	596.84	**Conceptual mine closure plan** No definitive plan for the post mine land use has been proposed. It will be prepared when mine will undergo for closure. However ,conceptually, in case of final mine closure the most likely use of the land will be as under: Steeply dipping ore body at Rampura Agucha Mine does not allow the concurrent filling of the pit and hence other suitable alternatives like fencing of the pit is envisaged. To ensure the safety of the human beings and animals, stone masonry wall will be constructed around the perimeter of the ultimate pit limit. Waste dump will be rehabilitated progressively by planting of the trees over the slopes and top surface Tailing Dam will be reclaimed and rehabilitated with Plantation. Some of the buildings like the administrative block & other office building can be offered to the state Govt. to further utilize them and all other plant infrastructure buildings & foundations shall be demolished to natural ground level
Concentrator	39		45		45	
Tailing dam	163.51		189.69		189.69	
Infrastructure	47.64		47.64		47.64	
Land put in use for mining & allied activities	**598.67**		**729.41**	**9.5**	**879.17**	
Green belt development	255.04		158.07		145.33	
Rest (Future green belt & other works)	15.79		2.02		0	
Total	**869.5**	**0**	**889.5**	**9.5**	**1024.5**	

9.0 Additional Studies

Additional studies like, geotechnical studies, effects of blasting and blast vibration, rain water harvesting designing, study for further raising of tailing dam, and socio-economic studies are being carried out by different agencies.

9.1 Geotechnical Studies for Stability of Surface Crown Pillar Underground Stope Modeling

Subsidence prediction study and shaft & Raise Pillar Design at RA Mine by CIMFR (Central Institute of Mining and Fuel Research) Dhanbad.

Scope of Work:

1. Review of previously available reports.

2. Determination of stable thickness of surface crown pillar Interfacing open pit and underground workings, stability and size (dimensions) of rib pillars in underground stopes, stability study of any openings and junctions in underground workings at RAM through numerical modeling.

i) Determination of stability of crown pillar, rib pillars and openings / junctions Simulation of mining scenario using Numerical modeling on suitable software like FLAC-3D, etc
ii) Suggest optimum dimensions of crown pillar, rib pillars for stability.
iii) Suggest optimum size of openings / Junctions and support system at different depths.
iv) Suggest any other remedial measures and instrumentation required for monitoring stability.

3. Evaluations of any possibility of subsidence considering RAM open pit and underground workings through numerical modeling and suggestion of its monitoring scheme and remedial measures.

i) Evaluations of any possibility of subsidence considering RAM open pit and Underground workings through numerical modeling.
ii) Suggestion of its monitoring scheme and remedial measures. iii) Location of survey pillars if required for monitoring.
iii) Suggestion on instrumentation if required.
iv) Any effect of the existing tailing dam on underground workings

4.Determination of location of the shaft and main ventilation raise, dimension of shaft and raise pillar, study of stability of both the pillars.

i) Determination of stability of shaft and ventilation raise pillar
ii) Suggest optimum dimensions of shaft and ventilation raise pillar.
iii) Suggest location of bore holes for determining insitu stress, lithology and geotechnical parameters.
iv) Analysis of core samples & determination of geotechnical parameters of drilled bore holes as per suggestions in above point.
v) Suggest any other remedial measures and instrumentation required for

monitoring stability.

5 Presenting and defending the outcome of the study before DGMS and MoEF, etc, if required.

9.2 Geotechnical Study Analysis of Waste Dump

Geotechnical Study Analysis of Waste Dump and Deriving the optimum waste dump height along with other dump design parameters at Rampura Agucha Mine by CIMFR (Central Institute of Mining and Fuel Research) Dhanbad.

Scope of work:-

- Review previous available report
- General geotechnical information in the field and soil & Rock Mechanics laboratory of CIMFR
- General data for physico- mechanical properties in the laboratory after testing the samples collected from the field
- Estimate ground water / rain water condition based on the information provided by HZL
- Comprehensive stability analysis with the help of GALENA software considering seismic and high impacts
- Optimum slope design including height of waste dump, other relevant design parameters recommendation after analysis. Aiming to determine the most critical parameter in the slope by sensitivity analysis.
- Suggestion for suitable and practical remedial / stabilization measures for any critical slope based on the above sensitivity analysis for the protective management of the waste dump.

9.3 Effects of Blasting & Blast Vibrations

Study the effects of blasting & blast vibrations produced by open pit operations on underground workings vice versa, also the suggestions of remedial measures to minimize it at Rampura Agucha Mine by CIMFR (Central Institute of Mining and Fuel Research) Dhanbad.

Scope of Work:

- Review of previously available reports
- Examine the impact of blasting & blast vibration produced by open pit operations on underground workings and, vice versa.
- Suggestions and remedial measures in case of any adversity
- Suggestions of blast vibration monitoring and analysis including firing sequence and maximum charge per delay
- Formation of predictor equations on PPV(Peak Partical Velocity)
- Suggestion of any soft ware / blast simulation id required
- Presenting and defending the out come of the study before DGMS and MoEF

9.4 Rain Water Harvesting

Designing Rain Water Harvesting Programme by Hydro- Geosurvey Consultant Pvt Ltd.

Scope of work:-

Designing Rain Water Harvesting(RWH) Programme based on study of satellite imagery and topo sheets of the buffer zone, first and second order streams will be marked along with estimation of its catchments areas, catchment yields, depth and width of streams, downstream wells likely to be benefited by recharge structures. All proposed locations amy be photographed along with estimations of water storage,recharge potentials etc and general designs of anicuts. The ground water recharge by each recharge structute may be estimated which may be used in modeling studies.

9.5 Raising of Tailing Dam Height

A study is being carried out by engaging IISc, Bangalore for further raising of Tailing dam height at Rampura Agucha Mine.

Scope of the study:

- Review of existing dyke system with mine waste and total pond system along with history of failure / seepage through dyke system
- Review of existing geotechnical data for further raising scheme
- Make rock slope stability assessment based on scientific study forth field conditions i.e rock type, pit configuration, surcharge load due to tailing dam etc. (detailed slope stability analysis with and without seismic loading of pit)
- Study and suggest various design / construction methodologies to optimize tailing dam height to generate maximum possible storage capacity mine pit location and its stability.
- Prepare detailed construction drawing for the height from RL 493 to 499m and suggestions to take up height raising work in phases of 6 meter each(including detailed analysis & drawing for every stage)
- Carry out tailing pond dyke stability analysis under seismic and non seismic (Blasting) conditions as per the provisions of latest IS codes.
- Suggest suitable lining arrangement on upstream face of the dam to prevent seepage etc
- Recommendation for materials of construction to be used in different proposed dykes
- Preparation of technical specifications for the proposed raising scheme and construction
- Provide technical specifications of various lining materials & references to applicable codes IISC.

9.6 Socio- economic study of the village Bherukhera (I)

Various Socio- economic studies of the village Bherukhera (I) at Rampura Agucha Mine by Institute of Rehabilitation and Development Studies, Udaipur.

Scope of work:

To carry out various socio- economic study of the village Bherukhera (I) covering Social organization, demographic structure, social stratification economic activities and available facilities in the village also to study the proposed modes of displacement and rehabilitation and to propose a plan for rehabilitation and resettlement of the outs tees at Bherukhera village (I) in Agucha Panchayat, Tehsil Hurda, Distt Bhilwara.

Home Oustees	216 Families
Land Loosers	NIL
Displaced Families	216 Families
Popupation to be displaced	600 Approx
Total Land to be Acquired	74.04 Bigah
Total Land to be Acquired for resettlement	89.11Bigah

10.0 DISCLOSURE OF CONSULTANTS

10.1 Introduction

Vimta Labs Limited is a leading multi-disciplinary testing and research laboratory in India. VIMTA provides contract research and testing services in the areas of clinical research, pre-clinical (animal) studies, clinical reference lab services, environmental impact assessments and analytical testing of a wide variety of products.

VIMTA-Environment Division has been in the forefront of its vision to provide better environment through guiding and assisting the industry for sustainable development. A stalwart in the mission to protect and preserve the natural resources on earth for future generations, Vimta offers extensive research and consultancy services in the field of Environment. With its rich experience, multi-disciplinary expertise and with the support of its state-of the-art analytical equipment, the services offered by Vimta are wide ranging and encompasses entire gamut of Environment Management and Monitoring Services. With its emphasis on quality services, Vimta, over the years, has evolved itself into a single reference point in India for Comprehensive Environmental Services.

10.2 The Quality Policy

- VIMTA is committed to good professional practices and quality of operations in its testing, validation and research services.
- VIMTA shall ensure customer satisfaction by maintaining independence, impartiality and integrity in its operations.
- VIMTA shall provide the services in accordance with national and international norms.
- VIMTA shall implement quality system as per ISO/IEC 17025 and applicable GLPs & GCPs, to generate technically valid results/data.
- VIMTA shall ensure that all its personnel familiarize with the policies and procedures of the quality system and implement the same in their work.

10.3 Milestones and Accreditations

- 1984 - Registered with an initial investment of Rs.2 Lakhs.
- 1985 - Recognized by ISI (now known as Bureau of Indian Standards).
- 1987 - Qualified by the criteria of Ministry of Environment and Forests was notified as one of the 14 standard Environmental Laboratories published in the Gazettee of India.
- 1988 - Licensed for carrying out tests on Drugs and Pharmaceuticals.
- 1990 - Cherlapally land purchased with plans of larger, more comprehensive facility.
- 1991 - Accredited by NCTCF, DST, Government of India (the forerunner of NABL).
- 1992 - Laboratories shifted to new facility at Cherlapally.
- 1993 - State-of-the-art equipment worth Rs.60 million procured.

- 1995 - Accredited by NABL under its revised scheme, certified by Standards Australia, Quality Assurance Services as per ISO/IEC Guide 25 and ISO 9002.
- 1996 - GLP Compliance.
- 1997 - Restructuring of Vimta from 165 to 100 associates with same performance.
- 1998 - Accreditation by GOSSTANDART and joint venture for certification of Food Exports with ROSTEST, Russia.
- 2001 - World Bank Recognition.
- 2002 - ANVISA Brazil certification.
- 2003 - USFDA accepts Vimta Bioequivalence study report. Showcased Vimta at AAPS (USA) and ICSE-CPHI (Germany).
- 2003 - Vimta VHS Research Center inaugurated at Chennai, Launched district laboratories at Visakhapatnam and Vijayawada, Patient service centers launched at 160 locations across the country.
- 2003 – Vimta Labs Recognized by Saudi Arabian Standards Organization.
- 2004 - Vimta increases people strength from 225 in 2003 to 400 in 2004. Vimta achieves export turnover of $ 2.5 million.
- 2004 - Vimta releases its first fortnightly medical newsletter "Vaidyalekha", Vimta enters Gulf market - bags a contract for Environmental Consultancy in Kuwait.
- 2004 - Vimta acquires 10.7 acres of land in S.P.Biotech Park – Genome Valley, Hyderabad, to create a world class Research Laboratory of 150000 sq.ft by July 2005.
- 2004 – Vimta starts a new state of the art speciality services in Molecular Diagnostics at TICEL Bio-Tech Park" at Chennai.
- 2006 – Vimta expands its overseas activities. Undertakes environmental assignments in Saudi Arabia and Tanzania.
- 2008-09 – Undertaking CEIA assignments in Cameroon, Africa.

10.4 Services Offered

Spread over the 70,000 Sq.ft lush green garden premises at Cherlapally, Hyderabad (India), the scientifically designed and meticulously groomed infrastructural facility of the Central Laboratory of **VIMTA** has the most sophisticated instruments backed by an excellent team of professionals. The 40,000 Sq.ft, three-storied, 120 roomed, centrally air conditioned state-of-the-art Laboratory equipped with Rs.100 million worth analytical instruments and computerized data management systems, all under one roof is perhaps the only one of its kind in South Asia in the contract testing and research sector.

Vimta offers various services under the following divisions:

- Environment
- Analytical
- Clinical Reference Lab
- Clinical Research

The environment division of VIMTA Labs Limited (VLL) has its presence all over India including a strong association with international consultants like Japan Bank for International Cooperation (JBIC), Kennametal Inc. - USA, BBL - UK, Rudal Blanchard – UK, E&E Solutions – Japan, NEPESCO & KNPC – Kuwait, Marafiq – Saudi Arabia and others. Vimta Laboratory has the following credentials:

- Recognitions by BIS;
- Recognitions by Ministry of Environment and Forests, Govt. of India;
- Recognitions by State Pollution Control Boards (wherever applicable) ;
- Recognitions by Department of Science & Technology, Govt. of India (NABL) ;
- Recognitions by Ministry of Defense, Govt. of India;
- Recognitions by APEDA, Ministry of Commerce, Govt. of India;
- Recognitions by Saudi Arabia Standard Organization (SASO), Saudi Arabia;
- Recognitions from NEMC, Tanzania;
- Accreditations by NCTCF;
- Certification from Standard Australia;
- Recognition from ANVISA Brazil;
- Quality Assurance Services as per ISO/IEC 17025; and
- Quality Assurance Services as per ICH Guidelines

10.5 Services

Environment essentially being a multi-disciplinary science, the range of services offered by the Division are also comprehensive and caters to the needs of industry, pollution control agencies, regulatory authorities and in a larger pursuit of a green globe. The services under Environmental Assessments include:

- Site Selection and Liability Studies;
- Environmental Impact Assessments;
- Environment Management Plans;
- Carrying Capacity based Regional Studies;
- Environmental Audits;
- Solid and Hazardous Waste Management;
- Risk Assessment (MCA,HAZON,HAZOP) & DMP;
- Occupational Health and Safety, Industrial Hygiene;
- Environmental Monitoring for Air, Meteorology, Water, Soil, Noise, Ecology and Socio-Economic;
- Industrial Emission Source Monitoring;
- Offshore Sampling and Analysis of Marine Water and Sediments;
- Marine Ecological Studies;
- Marine Impact Assessment;
- Rehabilitation and Resettlement Studies;
- Forestry and Ecological Studies;
- Geological and Hydro-geological Studies;
- Land Use /Land Cover Studies based on Remote Sensing;
- Socio-Economic Studies;
- Due Diligence Studies;
- Epidemiological Studies;
- Wasteland Management Studies; and
- Study on Bio-indicators.

The services under Environmental Chemistry include:

- Analysis of Water, Wastewater, Soil, Solid Waste, Hazardous waste as per Indian and International Codes;
- Source Emissions and Work Zone Air/Noise quality monitoring;
- Analysis of SVOCs, VOCs, PAH, BTEX, AOX, PCB's, TCLP metals, TOC etc.;
- Categorization of Hazardous Waste; and
- Pesticide Residue Analysis.

10.6 Facilities

Vimta-Environment Division is located in scientifically designed Central Laboratory with the state-of the-art modern facilities to offer vide range of services in indoor and outdoor monitoring and analytical characterization in the field of Environment. Further, it is ably supported by highly skilled and experienced team of professionals in the fields of Science, Engineering, Ecology, Meteorology, Social Planning, Geo & Hydro-geology, and Environmental Planning.

Besides the regular monitoring equipment such as Respirable Dust Samplers, Automatic Weather Monitoring Stations, Stack Monitoring Kits, Personal Samplers, Noise Meters, Portable Water Kits etc, the other major specialized equipment include:

- Monostatic Sodar–Designed by National Physical Laboratory, GOI;
- Integrated Noise Level Meter–Quest, U.S.A;
- Flue Gas Analyzers–Testo, Germany;
- 113-A Gravimetric Dust Sampler-Casella, London;
- ICP AES– Varian, USA;
- Gas Liquid Chromatographs with FID, ECD & pFPD–Varian, USA;
- Gas Chromatograph with Mass Detector–Varian, USA;
- Atomic Absorption Spectrometer [AAS]–Varian, USA;
- PAS-AFC-123 instrument;
- High Performance Liquid Chromatograph;
- Laser Particle Size Analyzer;
- Bomb Calorimeter;
- Polarographs;
- X-ray Fluorescent Spectrometer;
- Flame Photometer;
- Carbon Sulphur Analyzer;
- Computerized Fatigue Testing Machine;
- Electronic Universal Testing Machine;
- Fourier Transmission Infrared Spectroscope; and
- Water Flow Current Meter – make Lawrence & Mayo.

10.7 Quality Systems

The fact that Environment division and its supporting Site Laboratories are accredited by NABL (IS0-17025) and Ministry of Environment and Forests and by other international bodies such as Asian Development Bank (ADB) and World Bank stands testimony to its emphasis on Quality Systems.

10.8 Achievements

Being the first laboratory to be recognized under Environment Protection (EP) Act by GOI in 1986, Environment Division with its best mind power and industrial knowledge competency that allows it to compare with the best in the business.

- The Environment Division till date has executed about 450 Environmental Impact Assessment (EIA) and Environment Management Studies with Risk Assessment and Disaster Management Plans and obtained statutory approvals.
- Supported by the strong modern laboratory support and experienced hands, Environment division is well equipped in conducting Due Diligence, Phase-I and Phase-II studies.
- Undertaken specialized studies such as Regional Environmental Impact Assessment on Carrying Capacity Principle; Upper Air Meteorological studies using SODAR for major Industrial Complexes.
- Associated with prestigious studies such as Environmental Pollution monitoring around Taj Trapezium, Pre and Post Satellite launch studies for SHAR, ISRO and monitoring for offshore Oil & Gas exploration for deep-sea water and sediment sampling.
- The services offered include vide spectrum of industries covering Power, Chemical, Cement, Mining, Steel & Alloys, Metallurgical, Dye & Intermediates, Bulk Drugs, Pesticides, Agro-Chemicals, Petro-Chemicals, Refineries, Pulp & Paper, Oil & Gas Exploration & Production, Asbestos, Infrastructure, River valley, Foundries etc.
- The Environment division has also offered its services to major infrastructure projects such as Ports, Oil & Gas Pipelines, Green field Air Ports, Roads and Highways.
- The Environment division has undertaken the performance evaluation and capacity expansion of Sewage Treatment Plant and Industrial Wastewater Treatment Plant for Marafiq, Saudi Arabia.
- The Environment division has also undertaken Environmental Impact Assessment studies for Paper Plant expansion of Mufindi Paper Mills, Tanzania, Africa.
- The Environment Division is also undertaking Comprehensive Environmental Impact Assessment studies for Mining of Two Bauxite Deposits in Cameroon, Africa.

The details of the persons involved in the preparation of the present EIA/EMP report is given below:

DETAILS OF PERSONNEL INVOLVED IN CURRENT EIA/EMP STUDY

Sr. No.	Name	Qualification	Position	Contribution	Experience
1	Mr. M.Janardhan	M.Tech (Env. Engg)	Vice President (Environment)	Co-ordination	About 17 years of experience in the field of environmental management and environmental engineering
2	Mr. E. Shyam Sundar	M.Sc., M.Phil (Chem) PGDES	Assoc. Vice President (Env.Projects)	Co-ordination	About 16 years of experience in the field of environmental chemistry and monitoring
3	Dr. MVRN Acharyulu	M.Sc., Ph.D (Ecology)	Group Leader	Expert	About 16 years of experience in the field of Terrestrial, Aquatic and Marine Ecology
4	Mr. K.V. Kishore Babu	M.Tech (Env)	Group Leader	Expert	About 8 years of experience in the field of Air Pollution and wastewater management
5	Dr. C. Mary Sukanya	M.Sc. (Tech), Ph.D	Env. Scientist	Project Coordinator	About 6 years of experience in the field of environmental chemistry and Management
6	Ms. P. Bhavna	M.Tech (Env)	Env. Engineer	Expert	About 5 years of experience in the field of environmental engineering
7	Mr. V. Rangasamy	M.Tech.,(Env)	Env. Engineer	Expert	About 6 years of experience in the field of environmental studies and impact assessment
8	Mr. S. Karunakar	M.Tech (Env)	Env. Engineer	Expert	About 2 years of experience in the field of environmental studies and management
9	Mr. P. Niranjan Babu	B.Com	Asst Manager	Secretarial Support	About 18 years of experience in the field of environmental monitoring
10	Mr. P. Krishna	I.T.I (Civil)	Sr. Draftsman	Cartography	About 9 years experience in the field of environmental management and civil drawings
11	Mr. J. Rama Krishna	I.T.I (Civil)	Draftsman	Cartography	About 7 years experience in the field of environmental management and civil drawings
12	Ms. V. Sireesha	B.Sc.	Lab Assistant	Secretarial	About 2 years of experience in Secretarial Assistance
13	Mr. R. Pathak	Intermediate	Field Assistant	Field Expert	About 12 years of experience in the field monitoring and secondary data collection

HINDUSTAN ZINC LIMITED

EXECUTIVE SUMMARY

FOR

PROPOSED EXPANSION
OF
RAMPURA AGUCHA MINE

Expansion of Mine From 5.00 Mtpa To 6.15 Mtpa
By Opencast and Underground Mining
and
Beneficiation Plant
From 5.00 Mtpa to 6.50 Mtpa

RAMPURA AGUCHA MINE
P.O.: AGUCHA 311029
DIST. BHILWARA (RAJ)

April -2009

1.0 INTRODUCTION

Rampura-Agucha Mine was commissioned in the year of 1991 and it is located in Bhilwara district at 225-km North of Udaipur (Rajasthan). This open cast mine is having a world class deposit with good mineralogy leading to higher recovery and resultant low cost of production. The present capacity of the mine is 5.0 Mtpa ore production and beneficiation plant to produce zinc and lead concentrates of 53-54% and 60-65% respectively.

HZL is proposing to increase the mine production and ore treatment to a level of 6.15 Mtpa with corresponding increase in beneficiation capacity production from 5.0 Mtpa to 6.5 Mtpa. Expansion of ore beneficiation is planned to process the increased output. The total process capacity is planned for 6.5 Mtpa as against ore production of 6.15 mtpa from Rampura Agucha mine and additional ore of 0.35 Mtpa from Kayar underground Lead-Zinc mine project located in Ajmer district 95-km from Rampura Agucha mine.

Rampura-Agucha Mine is an **ISO - 9001, ISO - 14001 & OHSAS - 18001 and SA-8000 certified unit**. The mine has also got 5-S Certified (TPM) and has obtained four star rating by British Safety Council. Presently mining at Rampura Agucha Mine is being carried out as per approved modified mining plan, vide letter no. 584(6) (3) (268)/2006-AJM, dated 02.11.2006 (under Rule 10 of MCDR 1988).

The Proposed expansion is planned in the existing and acquired in the existing premises and acquired mining lease only. Additional land of 155 Ha will be required in the proposed expansion project.

1.1 Project Philosophy

1.1.1 Opencast Operations

The estimated ore reserves as on 01.04.2009 is 118.76 million Tonnes, out of which 43.03 million Tonnes are amenable to opencast mining upto a depth of below 372-m.

The present proposal is to accelerate the rate of exploitation by enhancing capacity from 5.0 Mtpa to 6.15 Mtpa to reach the ultimate economic pit depth and for expansion of beneficiation capacity from 5.0 to 6.5 Mtpa. The Environmental Clearance is for the opencast mining phase which is likely to continue up to 2018-19 and for commencement of production from underground mine from 2011-12.

1.1.2 Underground Operations

The mineralized resource below the open pit at Rampura Agucha mine has very good potential for underground operation. R.A.Mine has carried out conceptual underground study from M/s SRK, UK and AMC Australia independently. The deposit has potential of producing 2.0-2.4 Mtpa as well as it is possible to carry out concurrent mining in open pit as well as underground. Accordingly the

infrastructures will be developed. The mining will be "Stoping with backfilling" and will be a Trackless mining system.

Environmental Impact Assessment (EIA) studies have been conducted for proposed capacity expansion of the mine and mill to 6.15 and 6.5 Mtpa respectively.

1.2 Environmental Setting of the Project Area

The study area of 10-km radius from the periphery of the mine lease boundary is considered as buffer zone.

For the study of reserve forest, wildlife sanctuary, biodiversity etc and archaeological monuments, study area of 25-km radial distance from the mine lease boundary is considered. There are no industries within 10-km radius of the mine lease boundary.

The environmental setting of the site is given in the **Table-1.**

TABLE-1
ENVIRONMENTAL SETTING OF THE SITE

Sr. No.	Particulars	Details
1	Location	Rampura Agucha Mine
	Village	Agucha
	Tehsil	Hurda, Shahpura
	District	Bhilwara
	State	Rajasthan
2	Latitude	N 25° 50' 00"
3	Longitude	E 74° 44' 15"
4	Geographical Location in Toposheet	45 K/9 & 45 K/13
5	Elevation above Mean Sea Level	390 m
6	Climatic Conditions as per IMD	Tropical, semi-arid and hot, experiences bitter cold in winter and intensely warm in summer.
	Temperature	Max. 46.80C Min. 2.80C
	Relative Humidity	35.30 % (Average)
	Atmospheric Pressure	950.8 (Average) Range – 943.6 -958.8 Pa.
	Wind Speed range	2.3 to 4.6 Kmph
	Total Annual rainfall	450 mm average
7	Distance from the sea coast	Approx. 800 km
8	Nearest Highway	NH 79 (Approx. at 15 km distance)
9	Nearest railhead	Rupaheli
10	Nearest railway line	Ajmer - Chittorgarh (Broad Gauge) 11 km)
11	Nearest airport	Jaipur 200 km.
12	Other Historical / Religious places	No
13	Defense installations	Nasirabad Cantonment at 60 kms.
14	Ecologically sensitive areas (National Parks / Wild life sanctuaries / bio-sphere reserves)	No National Park / Wild life sanctuaries / bio-sphere reserves exist within 25km radius.
15	Reserved / Protected Forest	No reserved / protected forests
16	Nearest village	Agucha
17	Villages within 1 km radius	Agucha, Bherukhera, Rampura
18	Nearest town	Gulabpura

Sr. No.	Particulars	Details
19	Nearest city	Gulabpura
20	Nearest major city with 2,00,000 population	Bhilwara – 70 kms Ajmer – 85 kms
21	Nearest Tourist place	Ajmer 85 kms
22	Hills / valleys	Delhi fold
23	List of Industries	Mayur Mill, Raj. Coop. Mill (13 km)
24	Seismicity	Sesmic Zone II
25	Nearest IMD Station	Ajmer
26	Nearest river	Mansi (Seasonal)
27	Nearest lake / ponds	Agucha Pond – 1km
28	Nearest port	Kandla Port (800 Kms)
29	Soil type	Sandy loam
30	Depth of water table	15-25 m (Approximately)
31	Major crops	Wheat, Maize, Jowar, Mustard and Gram
32	Rehabilitation & Resettlement	R&R plan for resettlement of one village will be prepared.
33	Population Core Area Buffer Zone	 900 1.04 Lac as per 2001 census (from Bhilwara & Ajmer districts)

1.3 Salient Features of the Project

1.3.1 Project Details

The salient features of the proposed capacity expansion of the mine and beneficiation plant are given in **Table-2**.

TABLE-2
SALIENT FEATURES OF PROJECT

Sr. No.	Parameter	Description
I	**Mining Project**	
1	Total Ore Reserves	118.76 Million Tonnes (as on 1/4/2009)
2	Mineable through opencast mining	43.03 Million Tonnes (as on 1/4/2009)
3	Zinc in ore	13.90 %
4	Lead in ore	2.0 %
5	Total Mine Lease Area	1200 ha
6	Additional ML	Nil
7	Lease Period	20 years
8	Date of Expiry of Lease	13-03-2020
9	Present Capacity of Mine	5.0 Million Tonnes/Annum ore production
10	Capacity after proposed expansion of Mine	6.15 Million Tonnes/Annum
11	Overall Stripping Ratio	1:10.8
12	Method of Mining	Opencast and underground method
II	**Beneficiation Plant**	
1	Existing Capacity	5.0 Mtpa
2	Proposed Capacity	6.5 Mtpa
3	Power Requirement of the Beneficiation plant and Mine (together)	30 MW (at Present) 50 MW (after proposed expansion)
4	Water Requirement (For Mines and Beneficiation plant together)	Present water requirement is 8500-m^3/day and additional fresh water required after expansion is 3200-m^3/day Total - 11700-m^3/day
5	Water Source	Radial wells in the bed of Banas river (60-km)

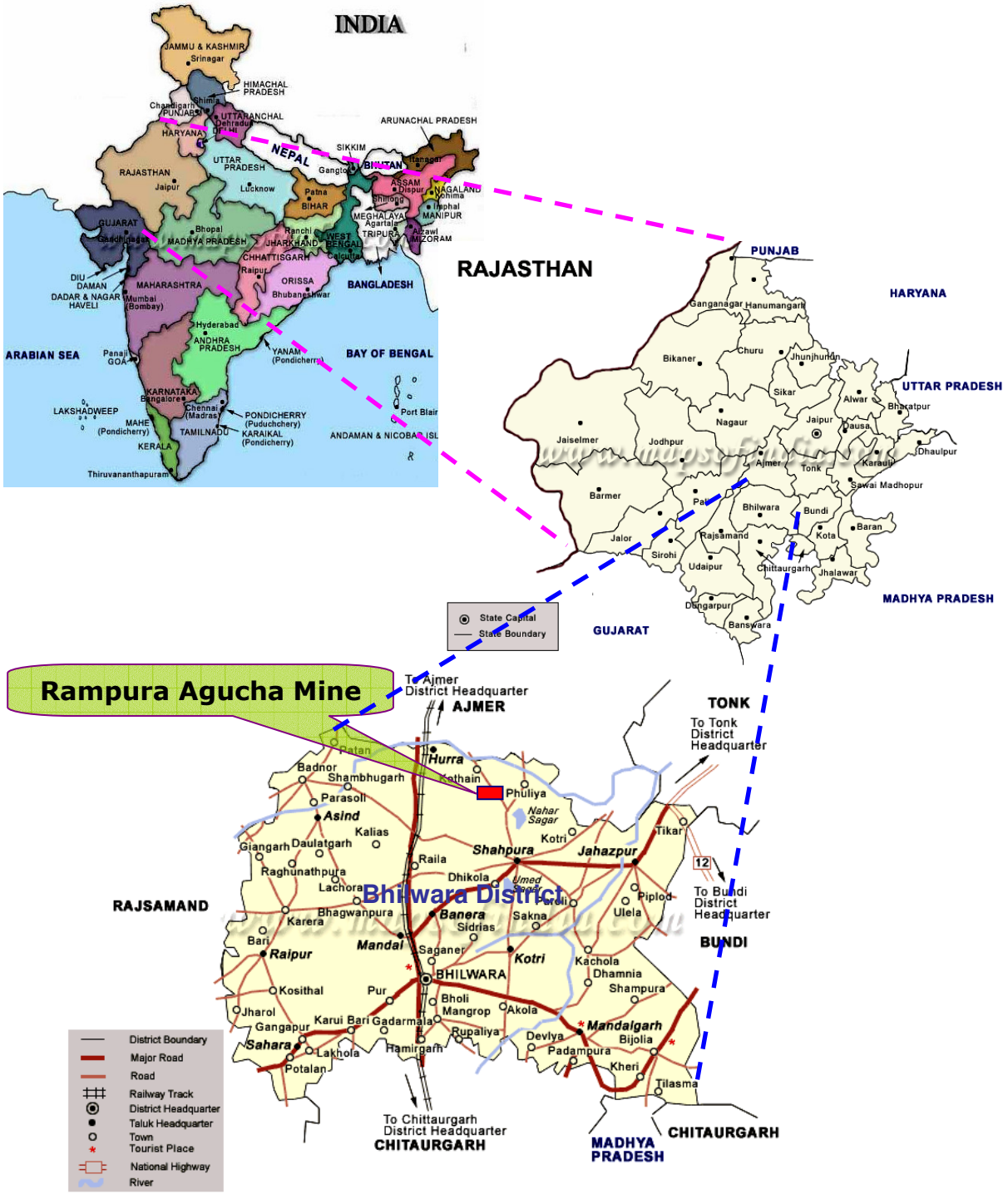
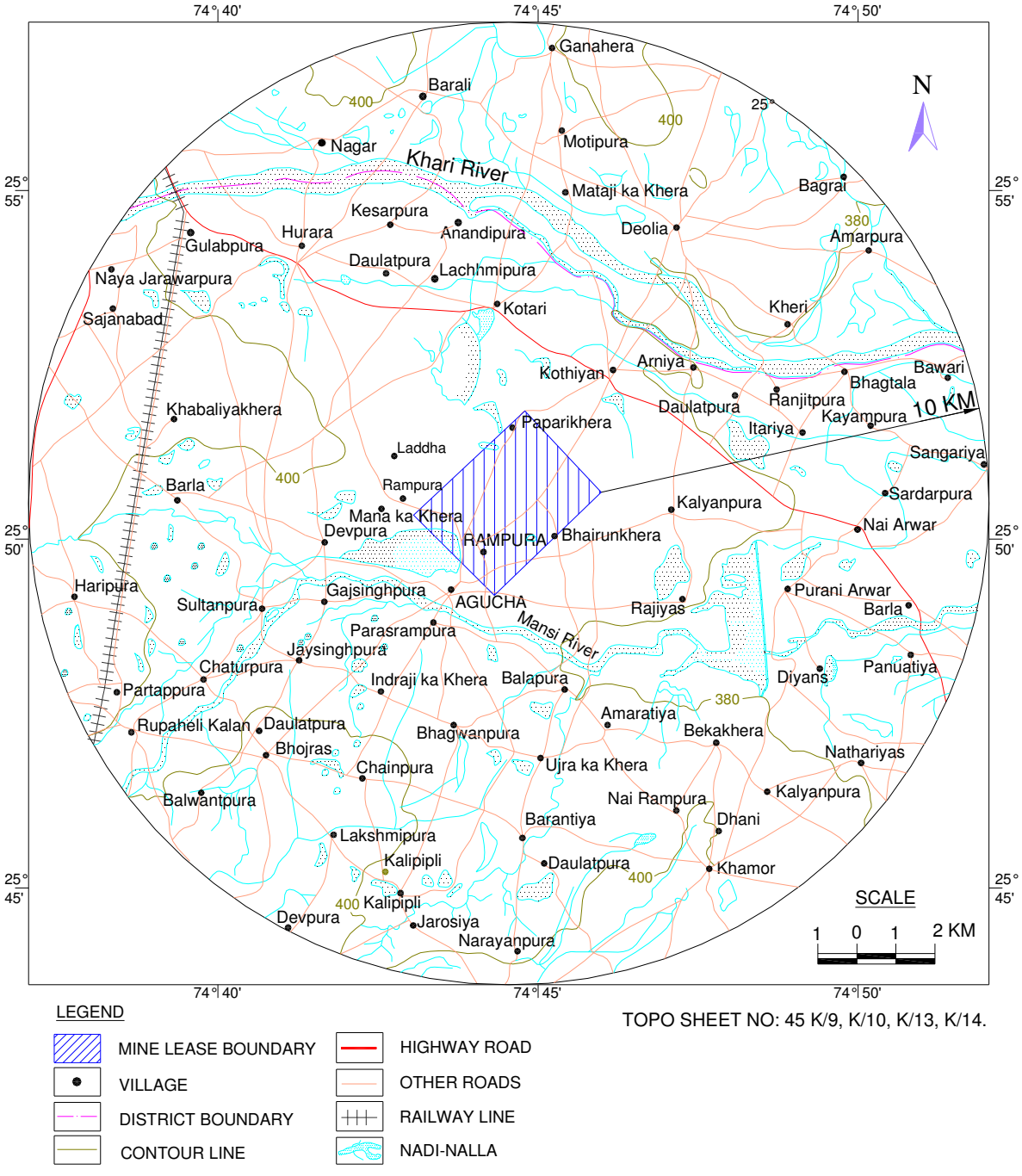


FIGURE-1
INDEX MAP



TOPO SHEET NO: 45 K/9, K/10, K/13, K/14.

FIGURE-2
STUDY AREA MAP OF THE PROJECT SITE -10KM

1.4 Brief Description of Mining and Beneficiation Plant

Open pit mining method with an overall stripping ratio of 1:10.8 is being used at Rampura-Agucha Mine. Drilling and blasting followed by loading, transportation and unloading of ore/waste rock are involved in the process of mining. These operations are fully mechanized.

Mined ore is crushed in three stages followed by two-stage grinding in close circuit with hydro-cyclones for classification. The classified slurry is subjected to differential froth flotation for separation and concentration of lead and zinc mineral in their respective concentrates. The concentrates are dewatered and filtered before dispatching to smelters for metal extraction.

In the current year of mining i.e., 2008-09 (till the end of March, 2009), ore production of 4.915 Million Tonnes and total excavation of 40.97 Million Tonnes has been achieved, with a strip ratio of 1:7.3.

For the proposed expansion, some of the existing equipment and facilities will be used after modification and up-gradation and then the balance required equipment would be installed. Best available technologies would also be adopted for achieving the optimum metallurgical performance and the lowest operating cost. This covers details of the existing plant transformation to achieve the capacity expansion.

1.5 Mining

In the proposed expanded ore production scenario, life of the mine(including underground) will be approx. 30 years, which may get extended depending upon addition of ore reserves at depth and level of ore production from underground mine, beyond the economic depth of open pit. The combined open pit and underground ore production schedule for the next three years is as given in **Table-3**.

TABLE-3
THREE YEAR ORE PRODUCTION SCHEDULE
(OPENPIT AND UNDERGROUND)

Particulars	2009-10	2010-11	2011-12
Open pit (Million Tonnes)	5	6.15	6.05
Underground (Million Tonnes)	0	0	0.1
Total (Million Tonnes)	5	6.15	6.15

- The environment clearance is for expansion of mine production capacity by open cast method from 5.0 mtpa to 6.15 mtpa.
- Underground mine development will go simultaneously with proposed expansion of open cast mines capacity and mine production will commence in the year 2011-12 to achieve full mine capacity of 6.15 mtpa

- Expansion in beneficiation capacity from 5.00 Mtpa to 6.5 mtpa which will contain 6.15 mtpa from Rampura Agucha Mines and 0.35 mtpa from Kayar underground mines at Ajmer making it 6.5 mtpa.

Conceptual mine parameters are as given in **Table-4.**

TABLE-4
CONCEPTUAL MINE PARAMETERS

Sr. No.	Details	Plan
1	Mining width at working bench level	50 m
2	Ultimate pit wall slopes H/W F/W	 42 ° 35 °
3	Berm width and bench angle	Berm Width of 7.6 & 9.6 meter with individual bench angle of 60° on F/W side and berm width of 6 & 7.5 m with 60° & 70° on H/W side.
4	Ramps	Two ramps, one each in H/W & F/W of 30 m width and gradient of 1 in 12
5	Ultimate depth of pit	Full strike of ore body will be mined up to 155 mRL and southern portion of ore body will be mined further up to 120 mRL. The depth may increase in case it is feasible to adopt steeper slope parameters in future
6	Ultimate/overall stripping ratio (As on 01.04.2008)	10.8:1 (Overburden/Ore)
7	Waste Management	Waste generated by mining will be dumped at pre decided sites in ultimate dump configuration of 4 X 10 m lifts. In the proposed expansion, the ultimate height is proposed to be raised upto 100m with individual benches of 20m and overall slope angle of 27 degrees.

Rampura Agucha deposit lying at comparatively shallow depth with an average width of 58-m over a strike length of 1550 m which is ideally suited for open pit mining with conventional mining equipment up to a depth of 372-m from surface (Up to 18 mRL).The ore reserves beyond the ultimate pit are economical to mine by under ground mining method.

- **Open Cast Mining**

a) Mechanized open pit operation: In the proposed expansion, mining will continue with shovel dumpers combination, utilizing the capacity of existing equipment and addition of required numbers of equipment (Excavators in 30-34-m3 capacity with 177 to 218 metric tonne capacity dumpers)

   Looking to the higher capacity mining equipments and supported by geo-technical investigations, bench height of 12-m has been proposed. Both access ramps are designed with gradient of 1 in 10 and 30-m width.

b) It is envisaged that bench height in overburden and ore shall be 12 m with individual bench angles of 60^0 in FW and 60^0 & 70^0 in HW

c) Geotechnical studies were conducted in the area by various experts in the field like, SNC (1982), GCCE (1993), CMRS (1994), NIRM (2002), SRK (2007-

08) and CMRI (2003 and 2008) for open pit slope design and stability of rocks. Based on study of CMRI, Dhanbad and SRK, UK and subject to working permission granted by DGMS, proposed open pit mining parameters at Rampura Agucha Mine will be incorporated in workings. These geotechnical studies further recommended for conceptualizing and opening of the under ground mine concurrently with open pit mine.

d) Mine is having a full fledged work shop equipped with lathe machine, drill machine, shipping, milling, grinding, hydraulic press, plate and pipe bending machine and overhead crane etc. for repair and maintenance of heavy earth moving machinery and beneficiation plant. The mine is having heavy vehicle service centre and repaired shop equipped with required facilities

TABLE-5
OPEN PIT MINING EQUIPMENT (EXISTING AND PROPOSED)

Equipment	Capacity	Existing (Nos.)	Addition (Nos.)	Total (Nos.)
Excavator	6-m^3	1	0	1
	9-m^3	2	0	2
	15-m^3	2	1	3
	30-34-m^3	0	3	3
Dumper	95 Tonnes	23	2	25
	177-218 Tonnes	0	24	24
Drill	165-mm	7	0	7
	165-200 mm	-	7	7
	115-mm	2	2	4
Water Sprinkler	28/40 KL	4	1	5
Track Dozer	510 HP	5	3	8
Motor Grader	280 HP	2	2	4
RT Dozer	318 HP	1	2	3

- **Under Ground Mining**

After Conceptual study it is proposed to mine the deposit by Open Stoping with back filling. Based on the geotechnical parameters, ore body physicals, available technology; equipments etc, two concepts of Open stoping are proposed.

a) Sub Level Open Stoping (SLOS) in area having ore body thickness >12-15m.
b) Benching/ AVOCA stoping in extremities having ore body thickness <12-15m

SLOS will be used to mine about 80-85% of the underground resources. The Stoping would advance from the bottom upwards and center outwards to the ends of the first mining block. The front of stoping would be an inverted "V". The method would be without interim pillars i.e. "continuous advance".

Sublevel Open Stoping (SLOS)

Transverse stopes are formed. Competent hanging wall will allow the stope to remain open for a 25-30m length during mining and prior to back filling. The method is successfully used in Cannigton, Mount Isa Copper, Rosebery, etc.

It has two drill drives. Blast holes are done parallel to HW to minimize blast damage to HW. The rings are blasted against slot raise. The sublevels are at 25-30m level interval. The blasted ore is mucked using remote operated load haul and dump (LHD) machine and loaded into Trucks/ ore pass. Once the block gets extracted, it is backfilled up to hanging wall.

A footwall drive at 60 – 100-m level interval is located at safe distance (25 – 30-m) away from ore body and all along the strike length for drawing ore, access drill drives and ventilation,

Bench Stoping

It is also a variant of AVOCA stoping method. It is proposed for mining narrow and down dip resources mostly towards the ends of ore body. A centrally located drill drive or two parallel drill drive are developed to drill the entire width of ore body. The drill levels are located at 15m vertical interval. The stoping advances from center strike-length toward the ends. At the levels of SLOS and interim rib pillar would be retained until the stoping at those SL has completed. The ore is mucked using LHD's (remote mucking). As the extraction proceeds, backfill is commenced from the center.

AVOCA method

In general the Avoca method consists of developing three 20-25m levels starting at the lower level and progressing upwards. The lower level lies upon a sill pillar. Mining of the three levels using the Avoca method is continued at depth leaving the sill pillars in place. A slot to act as free face is developed above the level to be mined. Slot development and ring drilling has the flexibility to be carried out from the lower or upper drive of the stope depending on the equipment.

- **Under ground**

It is proposed to mechanize the operations to all possible extent. Accordingly Trackless mining is proposed and take the advantage of decline connecting all sublevels. The trackless equipments (drill jumbo, drilling, mucking, transport, wall support, etc.) will be deployed as given in **Table-6**

TABLE-6
PROPOSED UNDERGROUND MINING EQUIPMENT

Sr. No.	Equipment	No.
	Development	
1.	Drill Jumbo	2
2.	Loaders (LHD-8 m^3)	2
3.	Trucks (LPDT-45-50T)	2
	Production	
4.	Long hole drills (57-165-mm)	3
5.	Loaders (LHD-3.5-8 m^3)	6
6.	Mining type Trucks (LPDT-50/60 T)	5
	Service Equipment	
7.	Winder	1
8.	Ventilation Fan	2
9.	Crusher & feeder	1
10.	Pumps	6
11.	Personal carrier	2
12.	Backfill Activities	
	Electric Loader (8 m^3)	2
	Ejector Truck 45T	4

1.6 Handling of Waste/Sub-Grade Material

1.6.1 Proposal for Expanded Capacity

- **Waste Dumping**

The following areas are presently available for accommodating waste:

- Current Dump Area;
- Tailing Dam Bund (Height to be raised up to 51-m in lifts);
- Bund / wall around pit of 5 to 10-m height & 30-40-m wide at top; and
- Main dump area (north of the pit)

To accommodate the balance waste quantity (and pit expansion) over the life of the mine, additional land of approx. 155 ha is required, which will be acquired from the land falling within lease boundary.

Year wise dumping plan for the plan period is given in **Table-7.** These sites are sufficient to take care of waste disposal during the plan period. Due care is taken in all respect for its confinement like the provision of dump stabilization by vegetation on ultimate non-moving ends.

TABLE-7
YEAR WISE SCHEDULE OF OVER BURDEN DUMPING

All figures are in Million Tonnes

Plan Period	Particular	Waste Dump	Tailing Dam	Bund Preparation	Total
	Area to be occupied (Ha.)	250.40	189.60	-	440.00
	Total Capacity	443.08	73.43	7.14	523.65
	Capacity until (31.03.09)	112.79	49.38	5.12	167.29
	Capacity anticipated as on	330.29	24.05	2.02	356.36

Plan Period	Particular	Waste Dump	Tailing Dam	Bund Preparation	Total
	01.04.09				
Year 1	Year 2009-10	73.01	9.79	-	82.80
Year 2	Year 2010-11	87.14	14.26	-	101.40
Year 3	Year 2011-12	85.32	-	2.02	87.34
	Grand Total	**245.47**	**24.05**	**2.02**	**271.54**

- **Underground**

Very small quantity of waste rock will be generated from underground as compared to open pit mining. All the initial developmental waste rock generated in initial years upto 2011-12 (about 1 Million Tonnes) for developing the Decline, shaft, footwall drives, ventilation shafts etc, will be accommodated in the existing waste dump at surface. Subsequent developmental waste rock will be disposed off in stoped out areas in underground itself.

1.7 Land Requirement

Mining lease area is 1200-Ha of which the land acquired for mining and industrial use is 869.5-Ha.

An additional land of 155 Ha will be acquired for disposal of waste dump including shifting of Bherukhera-I village. The acquisition status and additional acquisition proposed of the mine lease area is given in **Table-8.**

TABLE-8
ACQUISITION STATUS AND ADDITIONAL ACQUISITION PROPOSED DETAILS OF LAND OF MINING LEASE

	Village	Govt. Land (Ha)	Pvt. Land (Ha)	Total (Ha)
Land Acquired	Agucha	138.30	325.00	463.30
	Kothiyan	51.67	354.53	406.20
	Sub total	**189.97**	**679.53**	**869.50**
Additional Acquisition Proposed	Agucha*	8.86	62.59	71.45
	Kothiyan	0.97	82.58	83.55
	Sub total	**9.83**	**145.17**	**155.00**
	Grand Total	**199.80**	**824.70**	**1024.50**
Land Acquired outside ML area for township	Hurda (7 km from Mines)	74.00	-	74.00

1.8 Existing and Proposed Mitigation Measures

1.8.1 Air Emissions Control

- ***Existing Mitigation Measures***

Various mitigation measures are adopted in the existing mining and beneficiation plant to control the air pollution.

- Track mounted DTH drills with wet drilling system are being used for drilling;
- The production of blast fumes containing noxious gases are reduced by the following methods;
  - Proper mixing of Site Mixed Slurry (SMS) to ensure complete detonation.
  - Use of adequate booster/primer.
  - Proper stemming of the blast holes.
  - Use of electrical/non-electrical initiation system.
- A well-equipped workshop is set up for the regular maintenance of vehicles and machineries in order to control emissions. Air Conditioned Cabins are provided to shovel and dumpers to protect the operator from the direct exposure to dust and gaseous emissions;
- Water spray nozzles are provided at crusher, and the locations where enclosure and fugitive dust collection is difficult;
- The primary, secondary and tertiary crushers are provided with wet venturi scrubber to collect the dust while crushing the ore. The scrubbed slurry is pumped to grinding for disposal within the process. Sampling ports are provided for source emission monitoring purpose.
- The dust on the haul road is suppressed by automatic water sprinklers system installed at permanent haul roads and by three water sprinklers of 28-m^3 and two 40 KL capacity each. The haul road is maintained by two motor graders. In addition, an automatic water sprinkling system has been installed on permanent haul roads. The frequency has been increased and will be extended as per the mine development;
- The exhaust of all the earth moving machinery is directed upwards to prevent dust entrapment;
- Truck tyre washing system is installed near the weigh bridge to wash out the concentrates attached to wheels of the truck;
- Cleaning of Industrial roads by Mechanical Road Sweeper;
- The conveyor belts are covered to prevent dust losses into atmosphere;
- The moisture content of 7 % to 8% in the concentrates is maintained to prevent dust generation during loading and transportation. The concentrate carrying trucks are covered with tarpaulins from top and sides;
- Ambient Air quality monitoring is regularly conducted at three locations within the mine area and three locations in nearby villages. Stack emissions are also regularly monitored;

- The Eco-Plan was prepared in the year 1988-89 for the Greenbelt development and the same is meticulously implemented covering 260 ha of land out of 869.5 ha. Till date more than 2,70,000 saplings have been planted in the existing mine and colony with survival rate of more than 80%;

- Truck/ tyre washing system will be installed near the concentrate stock yards for washing of concentrate sticking on truck tyres;

- In order to control dust generation during blasting, drill cuttings have been removed before the blasting operation;

- The over burden is dumped by giving less aerial lift and grading is done by gradual dozing. This helps in reduction of dust generation on the waste dumps while dumping the waste;

- Water sprays are sprayed on coarse ore stock piles for reducing dust generated during fall of ore from the tripper conveyors;

➢ ***Proposed Mitigation Measures***

The mitigation measures adopted in the existing mine to control air pollution will be continued in the proposed expansion project also. The plantation in the mine area shall be improved by planting more trees in vacant areas. The following additional measures are proposed:

- Increasing the frequency of the water sprinkling on haul roads ;

- Additional plantation on waste dumps and near tailing dam shall be carried out and year wise schedule for plantation has been prepared for plantation on overburden dump and in mine area. It is envisaged to plant about 14000 plants in 17.4 ha on overburden dumps and about 19000 plants in 23-ha of land as peripheral plantation in the mine area from 2008-09 to 2012-2013; and

- Additional truck / tyre washing system will be installed near the concentrate stockyards for control of dust pollution.

1.8.2 Water Pollution Control Measures

➢ ***Existing Mitigation Measures***

- Plant tailings are discharged in tailing dam, tailing water is collected and pumped back to beneficiation plant for reuse in process;

- Mine water is pumped to reclaim water reservoir and gets recycled;

- All spillages, overflows and other wash streams from the industrial area are collected and pumped to reclaim water reservoir for recycling;

- Run-off water from waste dump area is collected during monsoon and pumped to reclaim water reservoir;
- Oil and grease trap is used for collecting oil & grease from Heavy Vehicle Service Center (HVSC) effluents;
- Sewage Treatment Plant having capacity of 425 KL/day is being installed in HZL township and 300 KL/day at mine to treat domestic wastewater; and
- A reservoir of 50000 m^3 was constructed near beneficiation plant to collect and recycle water from tailing dam, mine and other areas for reduction of evaporation losses in tailing dam.
- Improved dumper cleaning system at Heavy Vehicle Service Center (HVSC) including oil trap;
- Sewage Treatment Plants in the industrial area with provision for recycling of treated effluent to increase the water recovery and reduce the fresh water consumption;
- High rate thickeners to improve the water recovery from tailing and concentrates; and
- Flocculants in the thickeners to improve water recovery.

As a result of these measures, an effective zero discharge is maintained from the mine premises. As a part of the improvement measures, recently, a system for tailing dewatering through hydro-cyclones has been commissioned to increase the water recovery from tailings before disposal to tailing dam.

Water quality is being monitored at various locations within and outside the mine area and is observed to be unaffected by mining activities.

➢ ***Proposed Mitigation Measures***

The existing measures adopted in the mine will be continued in the proposed capacity expansion project. The additional measures recommended are;

- Improvements in dumper cleaning system at HVSC including oil trap;
- A reservoir of 20,000 m^3 was constructed near beneficiation plant to collect and recycle water from tailing dam and other areas for reduction of evaporation losses in tailing dam;
- High rate thickeners will be installed to improve the water recovery from tailing and concentrates; and
- Use of flocculants in the tailing thickeners to improve water recovery.
- Use of wetting chemical for dust suppression at mine haul roads

- Use of evaporation retardant chemicals at tailing dam and water reservoirs tank

1.8.3 Mitigation Measures for Noise

➢ ***Existing Mitigation Measures***

Adopted mitigation measures for noise and ground vibrations are of following types:

- Well equipped workshop is set up for the regular maintenance of vehicles and machineries in order to reduce noise generation;
- Steel liners in Ball mill are replaced by Rubber liners;
- Dumpers & excavators are provided with A. C. enclosures;
- Boundary walls (Baffle walls), waste banks and dense belt of trees are erected as acoustic barriers;
- Noise is abated at source by suitable mounting of equipment and ventilation systems and by providing noise enclosures or padding wherever necessary;
- Blasting is performed strictly as per the DGMS guidelines such as blasting during day hours between 2 PM to 3 PM when temperature inversions are unlikely and blasting is avoided during high wind conditions;
- Over charging is avoided;
- Excavators & dumpers supplier has to demonstrate the noise level below 85 dB (A) inside the cabin and they have to maintain the equipment in good health for 5 years;
- Air over pressure is controlled effectively in each and every round of blast by using non-electrical / electrical initial system;
- The charge per delay and total charge is minimized and preferably more number of delays are used per blast; and
- Greenbelt is developed in and around the mine area to intercept noise transmission. A 30-40 m wide belt of trees of different heights are useful to act as noise attenuator in the mining areas.

➢ ***Proposed Mitigation Measures***

In addition to the existing mitigation measures, following additional measures are proposed:

- Avoiding secondary blasting by using rock breaker;

- Equipments to be procured will have the noise emission optimal for their design/operation. Proper maintenance/working will be done to keep the equipment in good health;

- Further upgraded technology of the blasting will be undertaken to further reduce the blast-induced noise and vibrations; and

- Further improving the existing greenbelt by planting more trees in the vacant area and increasing the vegetation density to attenuate the noise level.

1.8.4 Solid Waste Management

The solid waste is systematically stacked at waste dump having 4 x 10 m lifts with ultimate height of 40-m and with an overall slope of 27^{o}.

➢ **Existing Mitigation Measures**

- Overall slope of 27^{o} and maximum height of 40-m is maintained to give proper stability to the dump;

- Waste is stacked systematically in layers and leveled by dozer;

- After reaching the benches to their ultimate location, plantation is being done;
- Construction of garland drains around the dump so that surface run off from the dump is collected in a sump and pumped to tailing dam;

- Regular maintenance of the garland drains constructed around the solid waste dump to collect the surface run off;

- Stabilization of the dump by soil cover and vegetative plantation is under progress; and

- Efficacy of the protection measures is monitored by means of monitoring wells downstream of the dump.

➢ **Proposed Mitigation Measures**

In the proposed capacity expansion project, the overburden generated will be continued to be systematically stacked in the existing waste dumps sites and proposed to dump in 20 m lifts upto 100 m height. Existing measures will be continued and in addition, the plantation will be done as and when area is available on the dump. Additional garland drains will be constructed for the effective collection of the run-off water.

1.8.5 Green Belt

- About 2,70,000 number of trees have been planted in the mine area and about 35,000 trees have been planted in the colony area;

- The survival rate has been observed to range from 80-90%;

- Area covered under green belt is 260 ha (246.22 ha in industrial area + 33.5 ha in the colony area) till 2008-09; and

- During the proposed expansion programme, additional total greenbelt of 33,000 plants will be planted in phased manner on overburden dumps and mining area.

1.9 Project monitoring

A comprehensive monitoring program keeping in line with the existing monitoring strategy is being conducted by HZL. The existing monitoring programme shall be upgraded to meet the requirements of expansion programme.

TABLE-9
ENVIRONMENTAL ATTRIBUTES AND FREQUENCY OF MONITORING PROPOSED TO BE ADOPTED

Sr. No.	Attribute	Parameters	Frequency of Monitoring
1	Ambient air quality	TSPM, RPM, SO2, NOx, CO, Lead, Zinc and Cadmium	24 hours monitoring at minimum 6 fixed and 5 mobile locations at a frequency of twice a week . CO samples collection on 8 hourly basis.
2	Dustfall	Quantity of dustfall	Monthly in a season at six locations
3	Meteorology	Wind Speed and Direction, Temperature, Relative Humidity, Rainfall and other non instrumental observations like visibility, hail, thunder storms, dust storms, fog and smog.	a] Continuous for a seasons with hourly recording through setting up of a site meteorological station; b] Collection & Review of Data from secondary sources like IMD - Ajmer.
4	Water quality	Physical, Chemical and Bacteriological Parameters.	Once in a season at thirteen (3 SW and 10 GW) locations.
5	Ecology	Terrestrial and aquatic ecology.	Through field visits (once during study period).
6	Noise levels	Noise levels in dB (A).	Twice during study period at Ten locations (along with traffic study).
7	Traffic Survey		Twice during study period at Two locations.
8	Soil characteristics	Soil profile, characteristics, soil type and texture, heavy metal, NKP value etc.	Twice during study period at six locations.
9	Land use	Land use for different categories.	Collection & Review of data published in district census handbooks (subject to availability of the latest data). Remote sensing study for landuse / landcover.
10	Socio-economic aspects	Socio-economic characteristics, labor force characteristics, boom town effects, R&R measures proposed.	Collection & Review of data published in district census handbooks (subject to availability of the latest data), and primary sample household survey. Feed back through public hearing.
11	Hydrology (Surface and Ground)	Drainage area and pattern, nature of streams, aquifer characteristics, recharge and	Collection & Review of data from secondary sources.

Sr. No.	Attribute	Parameters	Frequency of Monitoring
		discharge areas.	
12	Risk assessment, Disaster Management Plan and Occupational Health and Safety	Identification of areas where disaster can and occupational hazards take place	Based on assessment.

1.10 Project Benefits

HZL has built one hospital in the township under the existing mining project. The facilities of this health care center are extended to the people residing in the vicinity in case of emergency. This hospital will be adequate even after the proposed expansion project also. Hence, new health center is not proposed in the expansion of the project.

One school in the township is already built for the employees' children. The school facilities are also extended to the children of near by villagers. This may be continued in future also after the proposed expansion.

In proposed capacity expansion project, local skilled people shall be given preference during recruitment of the additional man power.

HZL has carried out various community development projects in the surrounding villages benefiting the population .The funding for community development projects shall be continued in the future also under proposed capacity expansion project.

1.11 Conclusion

The proposed integrated project complex has certain level of marginal impacts on the local environment. R & R activities are involved in the project. R & R will be applicable as per R & R policy of the government. The employment would be provided to the local population to the extent possible, based on the need of the project and the eligibility.

Thus, it can be concluded that with the judicious and proper implementation of the pollution control and mitigation measures, the proposed project will be beneficial to the society and will help reduce the demand – supply gap of zinc-lead and will contribute to the economic development of the region in particular and country in general.

हिन्दुस्तान जिंक लिमिटेड

रामपुरा आगुचा खान के प्रस्तावित विस्तार हेतु

कार्यकारी संक्षेप

(5.00 से 6.15 मिलियन टन प्रतिवर्ष ओपन कास्ट व भूमिगत खनन प्रणाली से एंव 5.00 से 6.50 मिलियन टन अयस्क सज्जीकरण प्रतिवर्ष)

रामपुरा आगुचा खान
आगुचा 311029
जिला : भीलवाडा (राज)

अप्रेल 2009

1.0 परिचय

रामपुरा आगुचा खान व अयस्क सज्जीकरण संयंत्र मार्च 1991 लगा तथा यह राजस्थान में उदयपुर के उत्तर मे 225 किमी. दूरी पर भीलवाडा जिले मे स्थित है। इस खुली खदान में अच्छी खनिज संपदा के साथ विश्व स्तरीय निक्षेप है जिसमें से अत्यधिक उत्पादन की संभावना है और जिसमें उत्पादन की लागत कम होगी। खान की वर्तमान क्षमता 5.0 मिलियन टन प्रतिवर्ष अयस्क उत्पादन करने की है और बेनिफिकेशन प्लांट में जिंक ओर लेड का क्रमश: 53-54% एवं 60-65% की सांद्रताएं उत्पादन करने की क्षमता है।

हिन्दुस्तान जिकं लिमिटेड का खान उत्पादन और अयस्क उपचार को 6.15 मिलियन टन प्रतिवर्ष के स्तर तक और उसके अनुरूप बेनिफिकेशन क्षमता उत्पादन को 5.0 मिलियन टन प्रतिवर्ष से 6.5 मिलियन टन प्रतिवर्ष तक वृद्धि करने का प्रस्ताव है। अयस्क बेनिफिकेशन के विस्तार की योजना, बढ़ते उत्पादन के लिए की जा रही है। रामपुरा आगुचा खान से 6.15 मिलियन टन प्रतिवर्ष के अयस्क उत्पादन और रामपुरा आगुचा खान से 95 कि.मी. की दूरी पर अजमेर जिला में स्थित कायड भूमिगत लेड-जिंक खान परियोजना से 0.35 मिलियन टन प्रतिवर्ष के अतिरिक्त अयस्क के उत्पादन के प्रति कुल संसाधन क्षमता 6.5 मिलियन टन प्रतिवर्ष की योजना है।

रामपुरा-अगुचा खान एक आईएसओ-9001,आईएसओ-14001 एवं ओएचएसएएस-18001 और एसए-8000 प्रमाणीकृत इकाई है। इस खान को 5-एस प्रमाणपत्र(टीपीएम) भी प्राप्त है और इसे ब्रिटिश सुरक्षा परिषद द्वारा फोर स्टार रेटिंग भी प्रदान किया गया है। वर्तमान में रामपुरा-अगुचा खान में खनन, पत्रांक : 584(6)(3)(268)/2008-एजेएम, दिनांक 02.11.2006 (एमसीडीआर, 1988 के नियम 10 के अंतर्गत) के जरिए अनुमोदित संशोधित खान योजना के अनुसार किया जा रहा है।

प्रस्तावित विस्तार के लिए वर्तमान में अधिग्रहीत खान पट्टा के अंतर्गत ही योजना है। प्रस्तावित विस्तार परियोजना के लिए 155 हेक्टर की अतिरिक्त भूमि की आवश्यकता होगी।

1.1 परियोजना की पृष्ठभूमि

1.1.1 ओपन कॉस्ट खदान प्रचालन

01.04.2009 को यथास्थित आकलित अयस्क निक्षेप 118.76 मिलियन टन है, जिसमें से 372-मी नीचे की गहराई तक खुली खदान के लिए 43.03 मिलियन टन की साध्यता है।

वर्तमान मे खनन की क्षमता मे वृद्धि 5.0 मिलियन टन प्रतिवर्ष से 6.15 मिलियन टन प्रतिवर्ष तक विस्तार करने के लिए आधुनिकतम तकनिक का उपयोग करते हुए गहराई तक पहुँचने हेतु क्षमताओं को बढ़ाते हुए दोहन की क्षमता में वृद्धि करने का वर्तमान प्रस्ताव है एवं अयस्क सज्जीकरण सयन्त्रा की क्षमता को 5.0 मिलियन टन प्रतिवर्ष से 6.5 मिलियन टन प्रतिवर्ष करने का प्रस्ताव है। पर्यावरणीय स्वीकृति हेतू , ओपन कॉस्ट चरण, जो 2018-19 तक जारी रहने की संभावना है और 2011-12 से भूमिगत खान से उत्पादन प्रारंभ करने के लिए है।

1.1.2 भूमिगत खनन प्रणाली

रामपुरा आगूचा खान मे अयस्क की उपलब्धता ओपन पिट में गहराई मे होने के कारण भूमिगत खनन प्रणाली की उपयुक्तता के लिये M/s SRK,UK और AMC Australia से अध्ययन करवाया ।

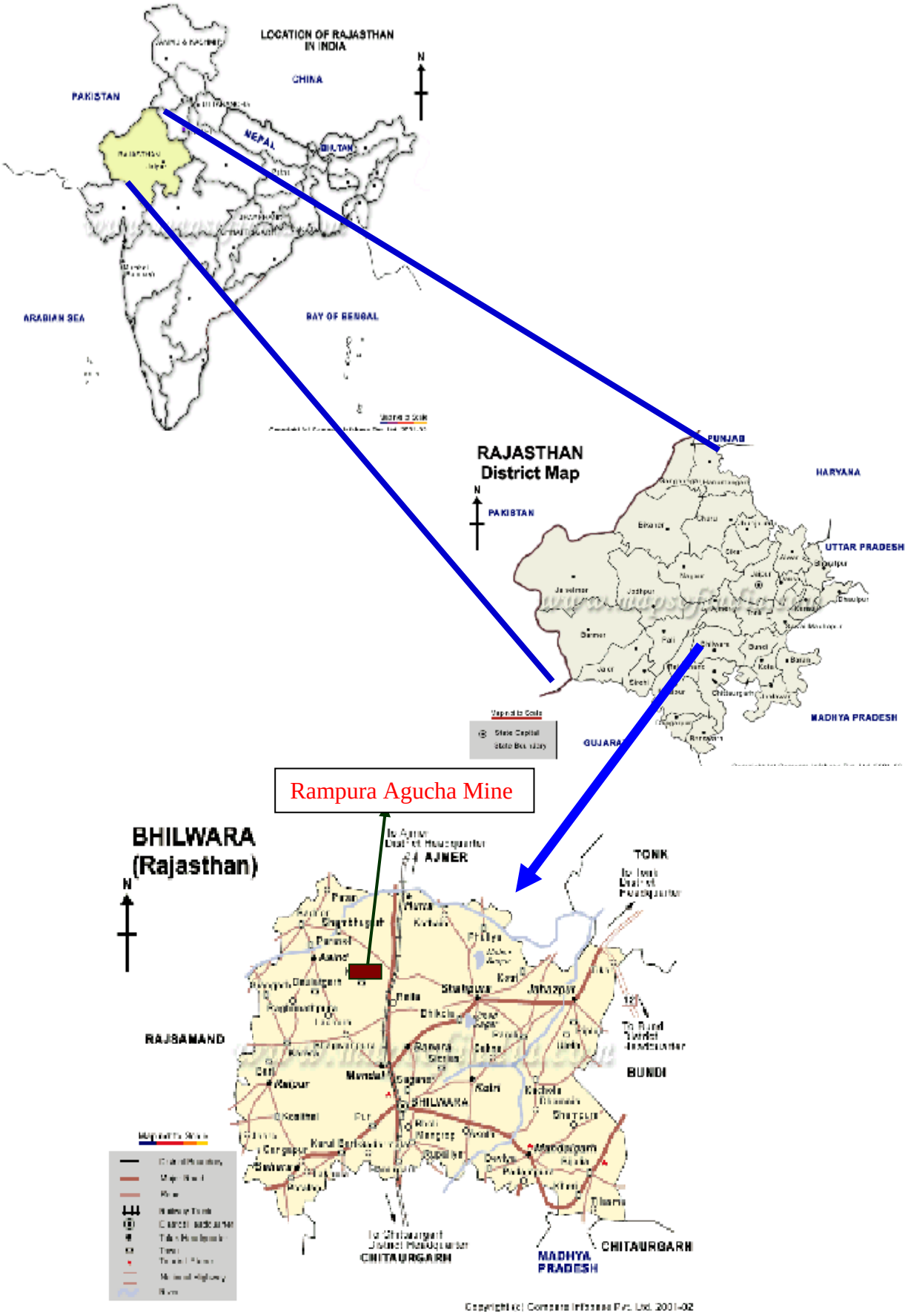
गहराई मे अयस्क की उपलब्धता को देखते हुए 2.0-2.4 मिलियन टन प्रतिवर्ष अतिरिक्त उत्पादन भूमिगत खनन प्रणाली से करने की संभावना हैं। इन्ही संभावनाओ को देखते हुए ओपन कॉस्ट व भूमिगत खनन को साथ साथ उत्पादन करने हेतू सुविधाएं उपलब्ध कराई जाएगीं । भूमिगत खनन " Stoping with backfilling" प्रणाली से की जाएगी ।

परियोजना की वर्तमान क्षमता 5.00 मिलियन टन प्रतिवर्ष से 6.15 मिलियन टन खनन एंव 6.50 मिलियन टन अयस्क सज्जीकरण से उत्पन्न पर्यावरणीय प्रभाव का अध्ययन (EIA) करवाया गया ।

1.2 परियोजना क्षैत्र की पर्यावरणीय स्थिति

खनन पट्टे की बाउन्ड्री से 10 किमी क्षैत्र को बफर जॉन मान कर अध्ययन किया गया। अध्ययन में वन, वन्यप्राणी अभ्यारण्यए जैव-विविधता आदि और पुरातत्वीय स्मारकों के अध्ययन के लिए खनन पटटे् की सीमा से 25 किमी की दूरी को माना गया है। खनन पट्टे की बाउन्ड्री से 10 किमी क्षैत्र मे कोई उघोग नहीं हैं ।

Fig. 1


LOCATION OF RAJASTHAN IN INDIA
CHINA
PAKISTAN
NEPAL
BHUTAN
ARABIAN SEA
BAY OF BENGAL
RAJASTHAN
District Map
PUNJAB
HARYANA
UTTAR PRADESH
MADHYA PRADESH
Rampura Agucha Mine
BHILWARA
(Rajasthan)
AJMER
TONK
RAJSAMAND
BUNDI
CHITAURGARH
MADHYA PRADESH
CHITAURGARH

पर्यावरणीय स्थिति को **सारणी–1.1** में दर्शाया गया है और खान / सयंत्र स्थान का अध्यन क्षैत्र चित्र1.1 पर्यावरणीय स्थिति मे दिखाया गया है।

सारणी–1.1
स्थल की पर्यावरणीय व्यवस्था

क्र.सं	विवरण	ब्यौरा
1	स्थान	रामपुरा–आगुचा खान
	गांव	आगुचा
	तहसील	हुरडा , शाहपुरा
	जिला	भीलवाड़ा
	राज्य	राजस्थान
2	अक्षांक्ष	उत्तर $25^0 50' 00''$
3	रेखांश	पूर्व $74^0 44' 15''$
4	टोपोशीट नम्बर	45 K/9 एवं 45 K /13
5	समुन्द्र तल से ऊँचाई	390 मीटर
6	मौसमीय स्थितियां	उष्णकटिबंधी,(ट्रापिकल), अर्ध–सूखा, एवं ग्रीष्म, शीत ऋतु में कडी ठंडी और गरमी के मौसम में गहन सूखापन
	तापमान	अधिकतम 46.80^0C न्यूनतम 2.80^0 C
	सापेक्षिक आर्द्धता	35.30% (औसत)
	वायुमंडलीय दबाव	950.8(औसत) रेंज – 943.6–958.8 Pa
	वायु की गति	2.3 से 4.6 Kmph
	वार्षिक वर्षा	450मि.मी. औसत
7	समुद्र तट से दूरी	लगभग 800 कि.मी.
8	निकटतम राजमार्ग	NH–79(15कि.मी. की दूरी)
9	निकटतम रेल्वे स्टेशन	रूपाहेली
10	निकटतम रेलमार्ग	अजमेर–चितौडगढ़(ब्रॉडगेज) 11 कि.मी.
11	निकटतम इवाई अड्डा	जयपुर 200 कि.मी.
12	अन्य ऐतिहासिक/धार्मिक स्थल	कोई नहीं
13	रक्षा संस्थापन	नासीराबाद कंटोन्मेंट –– 60 कि.मी.
14	पारिस्थितिकी रूप से संवेदनशील क्षेत्र(राष्ट्रीय उद्यान/ वन्य प्राणी अभयारण्य/ जैव–मंडल रिजर्वस)	25 कि.मी. क्षैत्र में कोई राष्ट्रीय उद्यान / वन्य प्राणी अभयारण्य/ जैव–मंडल रिजर्वस मौजूद नहीं है
15	आरक्षित/संरक्षित वन	कोई आरक्षित/संरक्षित वन नहीं है
16	निकटतम गांव	आगुचा

क्र.सं	विवरण	ब्यौरा
1	स्थान	रामपुरा–आगुचा खान
	गांव	आगुचा
	तहसील	हुरडा , शाहपुरा
	जिला	भीलवाड़ा
	राज्य	राजस्थान
17	1 कि.मी. की दूरी में गांव	आगुचा, भेरुखेडा, रामपुरा

क्र.सं	विवरण	ब्यौरा
18	निकटतम शहर	गुलाबपुरा
19	निकटतम नगर	गुलाबपुरा
20	निकटतम प्रमुख नगर जहां की आबादी 2,00,000 से अधिक है	भीलवाडा – 70 कि.मी. अजमेर – 86 कि.मी.
21	निकटतम दर्शनीय स्थल	अजमेर – 85 कि.मी.
22	पर्वत/घाटियां	दिल्ली फोल्ड
23	उद्योगों की सूची	मयूर मिल, राज.को–आप. मिल (13कि.मी.)
24	भूकंपन	भूकंप जोन–प्प
25	निकटतम आईएमडी केन्द्र	अजमेर
26	निकटतम नदी	मानसी
27	निकटतम झील/तालाब	आगुचा तालाब – 1 कि.मी.
28	निकटतम बन्दरगाह	कांडला पोर्ट(800 कि.मी.)
29	मृदा प्रकार	सेंडी लूम ;ंदकल सववउद्ध
30	भूजल की गहराई	15–25 मी.(लगभग)
31	प्रमुख फसल	गेहूं, मक्का, जवार, सरसों और चना
32	पुनर्वास एवं पुनर्स्थापना	एक गांव की पुनर्स्थापना के लिए आर एंड आर योजना तैयार की जाएगी
33	जनसंख्या कोर जोन बफर जोन	 900 1.4 लाख– 2001 जनगणना के अनुसार (भीलवाडा एवं अजमेर जिले के क्षैत्र)

1.3 <u>परियोजना के मुख्य बिन्दू</u>

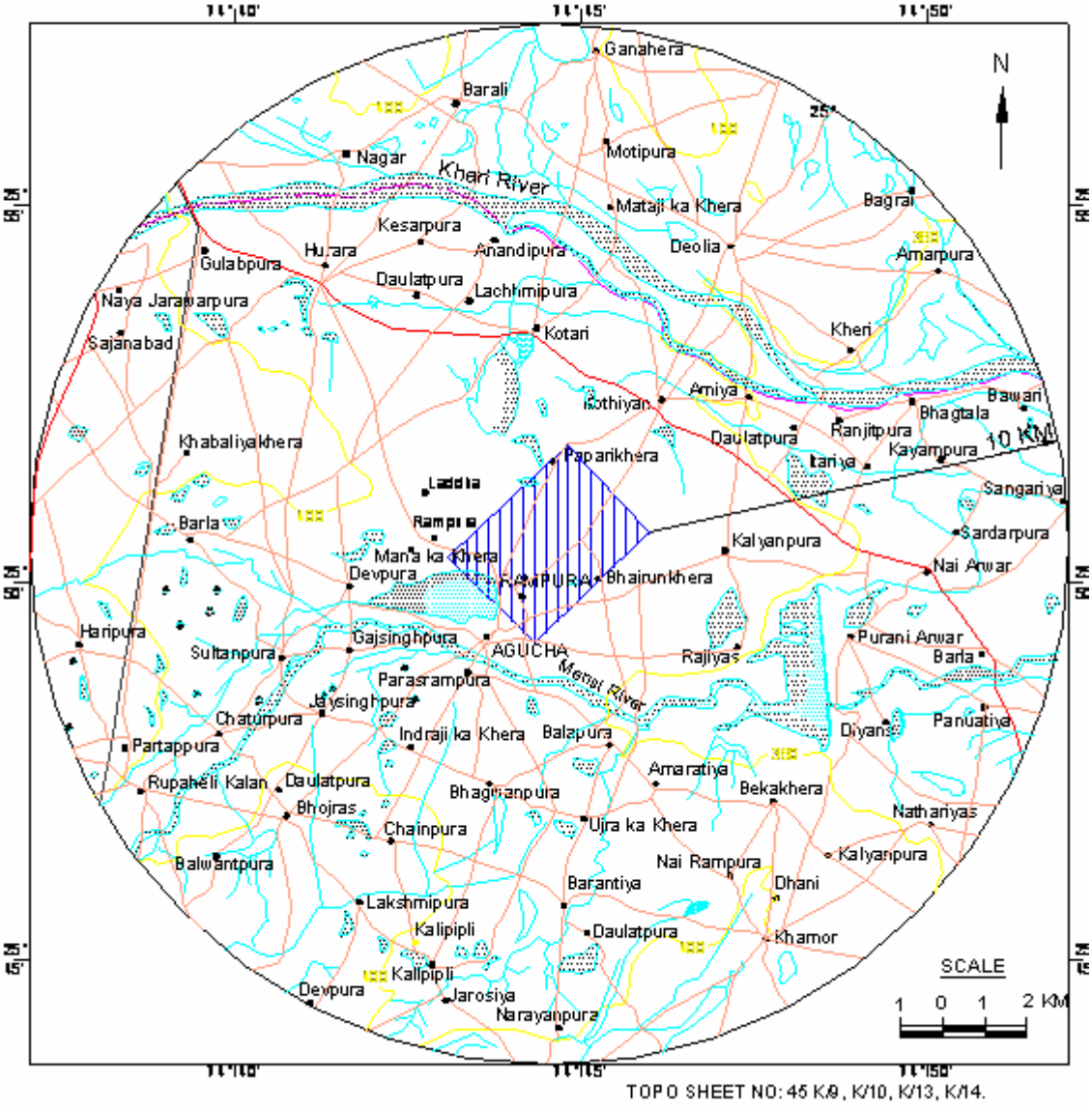
1.3.1 <u>परियोजना का विवरण</u> खान व अयस्क सज्जीकरण के प्रस्तावित विस्तारीकरण के मुख्य बिन्दूओं को **सारणी–1.2** में दर्शाया गया है।

सारणी–1.2

<u>परियोजना की महत्वपूर्ण बातें</u>

क्र.सं	प्राचल	विवरण
I	खनन परियोजना	
1	कुल अयस्क निक्षेप	118.76 मिलियन टन(1.4.2009 को यथास्थित)
2	खुली खदान पद्धति द्वारा खनन योग्य अयस्क	43.03मिलियन टन(1.4.2009 को यथास्थित)
3	अयस्क में जस्ता (जिंक)	13.90%
4	अयस्क में सीसा(लेड)	2.0 %
5	कुल खनन पट्टा क्षेत्र	1200 हेक्टर
6	अतिरिक्त खनन पट्टा	शून्य
7	पट्टे की अवधि	20 वर्ष
8	पट्टी की समाप्ति की तारीख	13-03-2020
9	खान की वर्तमान क्षमता	5.0 मिलियन टन/प्रति वर्ष अयस्क उत्पादन
10	प्रस्तावित खान विस्तार के बाद क्षमता	6.15 मिलियन टन प्रति वर्ष अयस्क उत्पादन
11	स्ट्रिपिंग अनुपात	1:10.8
12	खनन की पद्धति	खुली खदान और भूमिगत खदान पद्धति
II	बेनिफिकेशन प्लांट	
1	वर्तमान क्षमता	5.0 मिलियन टन अयस्क सज्जीकरण प्रति वर्ष
2	प्रस्तावित क्षमता	6.5 मिलियन टन अयस्क सज्जीकरण प्रति वर्ष
3	खान और सज्जीकरण संयत्र के लिए बिजली की आवश्यकता	30मेद्यावाट(वर्तमान में) 50मेद्यावाट(प्रस्तावित विस्तार के बाद)
4	पानी की आवश्यकता(खान ओर प्लांट दोनों के लिए)	वर्तमान पानी की आवश्यकता 8500 घनमीटर प्रति दिन और विस्तार के बाद अतिरिक्त स्वच्छ पानी की आवश्यकता 3200 घनमीटर प्रतिदिन होगी कुल-11700 घनमीटर प्रति दिन
5	पानी का स्त्रोत	बनास नदी(60 कि.मी.) के तट पर कुँओं से

परियोजना से 10 किमी श्रैत्र के अध्ययन का मानचित्र



1.4 खान व अयस्क सज्जीकरण का संक्षिप्त विवरण

रामपुरा आगूचा खान मे ओपन पिट खनन प्रणाली मे overall striping ratio 1:10.8 रखा जाता हैं । खनन प्रणाली में ड्रिलिंग, विस्फोट, लोडिंग, परिवहन आदि कार्यों की श्रृंखला होती है।

खान से प्राप्त अयस्क को अयस्क सज्जीकरण संयंत्रा में सांद्रण कर सीसा व जस्ता सांद्र उत्पादित किया जाता है । अयस्क सज्जीकरण प्रणाली में प्राथमिक संदलक, द्वितियक / तृतीयक संदलक, रोड मिल, सेग मिल व बाल मिल में नम पिसाई, वायु उत्प्लावन/ फ्लोटेशन के बाद जल निकासी व छनाई आदि किये जाते हैं।

वर्तमान वर्ष 2008-09 मे कुल 40.97 मिलियन टन खनन् मे से 4.915 मिलियन टन अयस्क उत्पादन 1:7.3 के striping ratio मे किया ।

प्रस्तावित विस्तारीकरण के अंतर्गत, कुछ मशीनों व सुविधाओं मे बदलाव या संख्या में बढोतरी की जायेगी। अयस्क सज्जीकरण के संयन्त्र मे आधुनिकतम तकनिक का प्रयोग करते हुए सान्द्रता की गुणवता मे वृद्धि करके पुन:लाभ को बढा कर निम्नतम लागत प्राप्त की जाएगी । यह वर्तमान से प्रस्तावित विस्तारीकरण की सफलता मे सहायक सिद्व होगा ।

1.5 खनन

प्रस्तावित विस्तारीकरण के कारण अयस्क उत्पादन (भूमिगत सहित) की मात्रा बढने पर खान की आयु लगभग 30 साल होगी जो कि बाद मे बढ भी सकती हैं। यह इस बात पर निर्भर करेगा कि अयस्क की उपलब्धता कितनी गहराई तक खोज कर पाते है। ओपन कास्ट एवं भूमिगत खनन तीन साल के कार्यक्रम को **सारणी-1.3** में दर्शाया गया है।

सारणी - 1.3
तीन वर्ष का अयस्क उत्पादन कार्यक्रम (खुली खान और भूमिगत)

	2009-10	2010-11	2011-12
खुली खान (मिलियन टन)	5	6.15	6.05
भूमिगत (मिलियन टन)	0	0	0.1
कुल (मिलियन टन)	5	6.15	6.15

खान उत्पादन की क्षमता मे ओपन कास्ट व भूमिगत खान प्रणाली द्वारा 5.0 से 6.15 मीलियन टन प्रति वर्ष के विस्तारिकरण की पर्यावरणीय स्विकृति व भूमिगत खान डवलपमेंट का कार्य ओपन कास्ट खान उत्पादन की क्षमता के विस्तारिकरण के साथ-साथ और खान से उत्पादन 2011-12 तक पूर्ण क्षमता 6.15 होगा।

अयस्क सज्जीकरण सयंत्र की क्षमता 5.0 से 6.50 मीलियन टन प्रति वर्ष का विस्तारिकरण मे से 6.15 मीलियन टन प्रति वर्ष रामपुरा आगुचा खान से एवं 0.35 मीलियन टन प्रति वर्ष कायड लेड, जिंक भूमिगत खान से आएगा।

खनन के मापदंड सारणी-1.4 में दिए गए के अनुसार है

सारणी-1.4

खनन के मापदंड

क्र.सं.	विवरण	योजना
1	खनन कार्य स्थल की चौडाई	50 मीटर
2	अन्तिम पिट दीवारो का ढलान H/W F/W	 42^0 35^0
3	बर्म की चौडाई व बेंच कोण	F/W की ओर 60^0 के प्रत्येक बेंच कोण के साथ 7.6 एवं 9.6 की बर्म की चौडाई और H/W की ओर 60^0 एवं 70^0 के साथ 6 और 7.5 मी. की बर्म की चौडाई
4	रेंप	दो रेंप, 30 मी. चौडाई और 12 में 1 अनुपात के साथ H/Wएवं F/W में एक-एक
5	खान की अन्तिम गहराई	अयस्क स्त्रोत के पूर्ण स्ट्रोक को 155 mRL तक खनन किया जाएगा और अयस्क स्त्रोत के दक्षिण भाग में आगे 120 mRL तक खनन किया जाएगा। भविष्य में गहरी ढलान प्राचलों को अपनाने की साधयता हो तो इस गहराई को बढाया जा सकता है।
6	अयस्क व अपशिष्ट का अनुपात	1:10.8
7	अपशिष्ट प्रबंधन	खनन द्वारा उत्पन्न अपशिष्ट की अधिकतम 4X10 मी. बैचं में पूर्व निर्धारित स्थलों पर डंप किया जाएगा। प्रस्तावित विस्तार में, अलग अलग बेंच की 20मी की ऊंचाई और 27 डिग्री के ढलान के साथ कुल 100 मी. तक बढाने का प्रस्ताव है।

रामपुरा अगूचा निक्षेप 1550 मी. सीधी लंबाई व औसत 58-मी.की चौड़ाई के साथ अपेक्षाकृत सतही गहराई पर स्थित है जो सतह से 372मी.(18 mRL तक) की गहराई तक परंपरागत खनन उपकरणों के प्रचालन के साथ खुली खनन पद्धति के लिए बहुत ही उपयुक्त है। गहराई वाले अयस्क निक्षेप भूमिगत खनन पद्धति द्वारा खनन करना ज्यादा उपयुक्त होगा।

- **ओपन कास्ट खनन**

(क) मशीनीकृत ओपन कास्ट खनन प्रक्रिया के प्रस्तावित विस्तारीकरण मे खनन की मशीनों जैसे शोवेल, डंपर, ड्रिल मशीन इत्यादि को काम मे लेते हुए इनकी संख्या में बढोतरी की जायेगी। (शोवेल 30-34-m3 क्षमता और डंपर 177 to 218 टन क्षमता)

(ख) उच्च क्षमता के खनन उपकरणो को ध्यान मे रखते हुए और भू-प्रौधोगिकी अन्वेशण के आधार पर बेंच की ऊचाई 12 मी प्रस्तावित की गई है। और दोनो रेंप का ग्रेडियंट 1:10 व चौडाई 30 मी प्रस्तावित की गई है।
ओवर बरडन व अयस्क मे बेंच की ऊचाई 12 मी और प्रत्येक बेंच का कोण 60^0 in F/W और 60^0 & 70^0 in H/W मे रखने पर विचार किया हैं।

(ग) भू-प्रौधोगिकी क्षैत्र मे विभिन्न विशेषज्ञों द्वारा किये अध्यन जैसे कि SNC (1982), GCCE (1993), CMRS (1994), NIRM (2002), SRK (2007-08) and CMRI (2003 and 2008) से ओपन पिट स्लोप डिजाइन व रॉक स्टेबिलिटी का अध्यन करवाया गया । अध्यन के आधार पर व DGMS के permission के आधार पर रामपुरा आगुचा खान अपने कार्य मे बदलाव लाएगा । इन भू-प्रौधोगिकी अन्वेशण के आधार पर बाद मे ओपन पिट के साथ भूमिगत खनन प्रक्रिया चालू की जाएगी

(घ) खान में भारी भू-चलन मशीन और बेनिफिकेशन प्लांट की मरम्मत और रखरखाव के लिए खराद मशीन, ड्रिल मशीन, शिपिंग, मिलिंग, ग्राइंडिंग, हैड्रॉलिक प्रेस, प्लेट एंड पाइप बेंडिंग मशीन और ओवरहेड क्रेन आदि जैसे उपकरणों के साथ एक परिपूर्ण कर्मशाला है। खान में अपेक्षित सुविधाओं के साथ भारी वाहन सेवा केन्द्र और रिपेयर शॉप है।

खान के उत्पादन बढ़ाने के लिए **सारणी-1.5** में दिए गए अनुसार अतिरिक्त प्रमुख खनन उपकरणों की आवश्यकता होगी :

सारणी–1.5
खुली गर्त खनन उपकरण(वर्तमान एवं प्रस्तावित)

उपकरण	क्षमता	वर्तमान (नम्बर)	अतिरिक्त (नम्बर)	कुल (नम्बर)
एक्सक्वेटर	6.m^3	1	0	1
	9.m^3	2	0	2
	15.m^3	2	1	3
	30–34.m^3	0	3	3
डम्पर	95 टन	23	2	25
	177–218 टन	0	24	24
ड्रिल	165.mm	7	0	7
	165–200 mm	.	7	7
	115. mm	2	2	4
वॉटर स्प्रिंक्लर	28 & 40 KL	4	1	5
ट्रक डोजर	510 HP	5	3	8
मोटर ग्रेडर	280 HP	2	2	4
आरटी डोजर	318 HP	1	2	3

भूमिगत खनन

अवधारणात्मक अध्ययन के पश्चात, पुन: भरपाई के साथ ओपन स्टोपिंग द्वारा निक्षेप का खनन करने का प्रस्ताव है। भू-प्रौद्योगिक प्राचलों के आधार पर, भौतिक अयस्क की मात्रा, उपलब्ध प्रौद्योगिकी, उपकरण आदि, ओपन स्टोपिंग की दो धारणाएं आदि प्रस्तावित है।

1) सब लेवल ओपन स्टोपिंग (SLOS) जहा पर अयस्क की मोटाई 12–15 मी से ज्यादा है।
2) बेंचिंग /AVOCA स्टोपिंग जहा पर अयस्क की मोटाई 12–15 मी से कम है।

भूमिगत खनन मे सब लेवल ओपन स्टोपिंग (SLOS) करीब 80–85% काम आएगी। स्टोपिंग निचे से उपर व मध्य से बाहर की तरफ की जाएगी । स्टोपिंग के सामने का भाग उल्टा वी (V) की तरह दिखेगा । इस प्रणाली मे बीच मे कोई पिलर नहीं होगा।

सब लेवल ओपन स्टोपिंग (SLOS)

ट्रांसवर्स स्टोप बनाना ,सशक्त हेगिंग वॉल फिलीगं के पहले स्टोप को 25–30 मीटर तक खनन के दोरान खुला रहेने देगी । यह प्रणाली **Cannigton, Mount Isa Copper, Rosebery,** आदी मे सफलतापूर्वक काम कर रही हैं।

इसमे दो ड्रील ड्राइव होगी। ब्लास्ट होल हेगिंग वॉल के समानान्तर होगी ताकि हेगिंग वॉल कम से कम खराब हो। स्लोट रेंज के सामने रिगं ब्लास्ट करेगें। सब लेवल 25.30 मी के अन्तराल मे होगें। ब्लास्ट किये गये अयस्क को रीमोट प्रचालित लदान पविहन **(LHD)** मशीन द्वारा हटाया जाएगा और इसे ट्रक या ओर पास मे डाला जाऐगा । एक बार जब खनन हो जाऐगा तो इसे हेगिंग वॉल तक भर दिया जाएगा।

एक फुट वॉल ड्राइव 60-100मी के अन्तराल मे ओर बॉडी से 25-30 मी सुरक्षित दूरी स्ट्राइक लेंथ के समानान्तर बनाई जाएगी जिसमे अयस्क को ले जाने व वेंटीलेसन के काम आएगी । यह AVOCA स्टोपिगं प्रणाली का वेरियन्टे हैं। अयस्क बॉडी के अन्त मे खनन को सकडा कर दिया जाएगा । सम्पूर्ण चौडी अयस्क बॉडी को ड्रील करने के लिये एक सेन्ट्रल ड्रील ड्राइव या दो समानान्तर ड्रील ड्राइव बनायी जाएगी। ड्रील लेवल 15 मी vertical के अन्तराल मे होगें। स्टोपिग मध्य से चालू हो कर अन्त तक जाएगी । सब लेवल ओपन स्टोपिंग (SLOS) के लेवल अन्तरिम रिब पिलर को रहने देगे जब तक कि सब लेवल खत्म नही हो जाए। अयस्क को रिमोट एल एच डी से हटाया जाएगा । जैसे ही extraction complete हो जाएगा बेक फिलिगं center से चालू किया जाएगा।

(एवोका) पद्धति

सामान्यत: एवोका पद्धति में तीन 20–25मी. के स्तर विकसित किए जाते हैं जो निचले स्तर के प्रारंभ हो कर ऊपर की ओर बढ़ते हैं। निचला स्तर दहलीज स्तम्भ पर आधारित है। एवोका पद्धति का प्रयोग करते हुए तीन स्तरों का खनन स्थल पर स्थित दहलीज(सिल) स्तम्भ को छोड़ कर गहराई तक खनन जारी रखा जाता है। एक छिद्र(स्लॉट) जो स्वतंत्र फलक(फ्री फेस) के रूप में कार्य करता है, के ऊपर तक विकास किया जाता है। छिद्र विकास एवं वलय ड्रिलिंग में लचीलापन होता है जो उपकरण के आधार पर निखनन के निचले या ऊपर के ड्राइव से किया जा सकता है।

भूमिगत खनन

यथासंभव प्रचालनों को यंत्रीकृत करने का प्रस्ताव है। तद्नुसार ट्रैकलेस खनन प्रस्तावित है और सभी उपस्तरों को नीचे जोडने का लाभ लिया जाना है। ट्रैकलेस उपकरण(ड्रिल जंबो, ड्रिलिंग, मकिंग, परिवहन, वॉल सपोर्ट आदि) **सारणी–1.6** में दिए गए अनुसार लगाए जाएंगे ।

सारणी–1.6
प्रस्तावित भूमिगत खनन उपकरण

क्र.सं.	उपकरण	नग
	उपकरण	
1.	ड्रिल जंबो	2
2.	लोडर्स (LHD-8 m^3)	2
3.	ट्रक (LPDT-45-50T)	2
	उत्पादन	
4.	लांग होल ड्रिल (57-165-mm)	3
5.	लोडर्स (LHD-3.5-8 m3)	6
6.	खनन प्रकार के ट्रक (LPDT-50/60 T)	5
	सेवा उपकरण	
7.	वाईंडर	1
8.	वेंटिलेशन पंखा	2
9.	क्रशर एवं फीडर	1
10.	पम्प	6
11.	वाहन	2
12.	पुन:भरपाई गतिविधियां	
	विद्युत लोडर (8 m3)	2
	एजेक्टर ट्रक– 45T	4

1.6 वेस्ट / सब ग्रेड मेटिरियल का हेंडल करना

1.6.1 विस्तारित क्षमता के लिए प्रस्ताव

वेस्ट डंपिगं

निम्न क्षैत्र वर्तमान मे वेस्ट डालने के लिये उपलब्ध है।

- वर्तमान डंपिगं क्षैत्र
- टेलिगं डेम का बंड (ऊचाई को चरणो मे 51मीटर तक बढाना है)
- पिट के चारो ओर बंड / वॉल 5 से 10 मी ऊचाई व 30 से 40 मी चौडी बनाना
- मैन डपं क्षैत्र (पिट के उत्तर मे)

इसके अतिरिक्त वेस्ट को डालने (खान के विस्तार) के लिए 155 हैक्टर भूमि का अधिग्रहण उपलब्ध खनन पटटा क्षैत्र मे से किया जाएगा ।

योजना अवधि के लिए वर्षवार ढ़ेर करने की योजना **सारणी–1.7** में दी गई है। योजना अवधि के दौरान अपशिष्ट निपटान के लिए ये स्थल पर्याप्त है। उसके

परिरोध के लिए सभी प्रकार की सावधानियां ली जाएंगी, जैसे चरम गैर-चलन चोटियों छोरों पर वानस्पतिक द्वारा ढ़ेर का स्थिरीकरण का प्रावधान आदि।

सारणी -1.7
ओवर बर्डन ढ़ेर का वर्षवार कार्य प्रणाली

सभी आंकडें मिलियन टन में है

योजना अवधि	विवरण	अपशिष्ट ढ़ेर	टेलिंग डैम	बंड तैयार करना	कुल
	अधिकृत किए जाने वाला क्षेत्र(हे.)	250.40	189.60	.	440.00
	कुल क्षमता	443.08	73.43	7.14	523.65
	क्षमता (31.03.09)	112.79	49.38	5.12	167.29
	01.04.09 को यथास्थित प्रत्याशित क्षमता	330.29	24.05	2.02	356.36
वर्ष 1	वर्ष 2009.10	73.01	9.79	.	82.80
वर्ष 2	वर्ष 2010.11	87.14	14.26	.	101.40
वर्ष 3	वर्ष 2011.12	85.32	.	2.02	87.34
	कुल योग	**245.47**	**24.05**	**2.02**	**271.54**

भूमिगत अपशिष्ट

भूमिगत खनन से ओपन पिट के बजाए बहुत कम वेस्ट उत्पन्न होगा । आरंभिक वर्षों में 2011-12 तक (लगभग 1 मिलियन टन) ढलान, शाफ्ट, फुटवाल ड्राइव, वेंटिलेशन शाफ्ट आदि के विकास के दौरान उत्पन्न सभी प्रारंभिक विकासात्मक अपशिष्ट पत्थर सतह पर स्थित वर्तमान अपशिष्ट ढ़ेर में डाला जाएगा । उसके पश्चात उत्पन्न होने वाले अपशिष्ट पत्थर भूमिगत खदान में ही कार्य बंद किए गए क्षेत्रोंा में निपटान किया जाएगा।

1.7 भूमि की आवश्यकता

खनन पट्टा क्षेत्र 1200हे. है जिसमें से खनन और औद्योगिक प्रयोजनों के लिए अधिग्रहीत भूमि 869.5 हेक्टर है।

भेरुखेरा गांव के स्थानांतरण सहित अपशिष्ट ढ़ेर के निपटान के लिए 155-हे. की अतिरिक्त भूमि अधिग्रहीत की जाएगी। खान पट्टा क्षेत्र के अधिग्रहीत स्थिति प्रस्तावित अतिरिक्त अधिग्रहण का विवरण **सारणी-1.8** में दिया गया है :

सारणी–1.8
खान पट्टे के अंतर्गत अधिग्रहण की स्थिति और
प्रस्तावित अतिरिक्त अधिग्रहण का विवरण

	गांव	सरकारी भूमि(हे.)	निजी भूमि(हे.)	कुल (हे.)
अधिग्रहीत भूमि	आगुचा	138.30	325.00	463.30
	कोठियान	51.67	354.53	406.20
	उप कुल	**189.97**	**679.53**	**869.50**
प्रस्तावित अतिरिक्त अधिग्रहण	आगुचा	8.86	62.59	71.45
	कोठियान	0.97	82.58	83.55
	उप कुल	**9.83**	**145.17**	**155.00**
	कुल योग	**199.80**	**824.70**	**1024.50**
टाउनशिप के लिए खान पट्टा क्षेत्र से बाहर अधिग्रहीत भूमि	हुरडा(खान से 7 किमी)	74.00	–	74.00

1.8 वर्तमान और प्रस्तावित पर्यावरणीय प्रबन्धन

1.8.1 वायु प्रदूषण का प्रबन्धन

- वायु प्रदूषण को नियंत्रित करने के लिए वर्तमान खनन और बेनिफिकेशन प्लांट में विभिन्न निवारण उपाय अपनाए जाते हैं।
- ड्रिलिंग के लिए वेट ड्रिलिंग सिस्टम के साथ ट्रैक माउंटेड डीटीएच ड्रिल्स का प्रयोग किया जा रहा है।
- हानिकारक गैसों से युक्त विस्फोट धुआँओं के उत्पन्न होने को कम करने के लिए निम्नलिखित पद्धतियां अपनाई जाती है :

  - संपूर्ण विस्फोट को सुनिश्चित करने के लिए साइट मिक्सड स्लरी(एसएमएस) का समुचित मिश्रण
  - पर्याप्त बूस्टर/प्राइमर का उपयोग
  - विस्फोट छेदों का समुचित रूप से स्टेमिंग करना
  - विद्युत /गैर-विद्युत पहल करने(इनिशिएशन) की प्रणाली का उपयोग

- उत्सर्जनों के नियंत्रण हेतु वाहनों और मशीनों का नियमित रखरखाव के लिए संपूर्ण उपकरणों से युक्त एक कार्यशाला स्थापित की गई । धूल और गैसीय उत्सर्जनों के सीधे प्रभाव से प्रचालकों के संरक्षण के लिए शॉवलों और डम्परों में वातानुकूलित कैबिन प्रदान किए जाते हैं

- क्रशर और ऐसे स्थानों जहां क्षणिक धूल इकठ्ठा करना कठिन है, में वॉटर स्प्रे नाजिल्स की व्यवस्था की जाती है।
- अयस्क के दलन के दौरान धूल एकत्रित करने के लिए प्राइमरी, सेकेंडरी और ट्रशरी क्रशर्स में वेट वेंटुरी स्क्रबर का प्रावधान किया जाता है।
- खान सड़कों पर धूल नियंत्रण स्थायी परिवहन सड़कों पर संस्थापित पानी के स्प्रिंक्लर्स और 28 घनमीटर के दो और 40 घनमीटर क्षमता के दो, कुल चार पानी के स्प्रिक्लर्स द्वारा किया जाता है । दो मोटर ग्रेडर्स द्वारा परिवहन सड़कों का रखरखाव किया जाता है । इसके अलावा स्थाई हाउल रोड्स पर स्वचालित पानी छिड़काव प्रणाली स्थापित की गई है। इस बारंबारिता की वृद्धि की गई है और खान विकास के अनुसार इसमें और भी वृद्धि की जाएगी।
- धूल फैलने को नियंत्रित करने के लिए सभी भू-चलन मशीनों के निकासों को ऊपर की ओर रखा जाता है।
- ट्रकों के पहियों में लगने वाली धूल आदि सांद्रताओं को साफ करने के लिए वे-ब्रिज के समीप में ट्रक टायर वाशिंग सिस्टम है।
- यांत्रिक सडक स्वीपर द्वारा औद्योगिक सड़कों की सफाई
- वायुमंडल में धूल हानियों के नियंत्रण के लिए कन्वेयर बेल्टों को ढ़का जाता है।
- लदान और परिवहन के दौरान धूल उत्पन्न होने को रोकने के लिए सांद्रताओं में 7% से 8% के नमी तत्व का पालन किया जाता है । सामग्री व सांद्रों को ले जाने वाले ट्रकों को ऊपर और बाजू में तार्पलिन्स से ढ़का जाता है।
- खान क्षेत्र में तीन स्थानों पर और समीपवर्ती गांवों में तीन स्थानों पर परिवेशी वायु गुणवत्ता अनुवीक्षण कार्य नियमित रूप से किया जाता है। चिमनी के उत्सर्जनों का भी नियमित रूप से अनुवीक्षण किया जाता है।
- ग्रीनबेल्ट के विकास के लिए 1988-89 में पारिस्थितिकी योजना तैयार की गई है और 869.5हे. में से 260 हे.की भूमि में इस योजना को सख्ती से लागू किया गया है। वर्तमान खान और कॉलोनी में अब तक 3,05,000 पौधारोपण किया गया जिनका जीवन दर 80% से भी अधिक है।
- सांद्र ढ़ेर यार्डों के पास ट्रक टायरों पर सांद्रों के चिपकने के नियंत्रण के लिए ट्रक/टायर वाशिंग सिस्टम संस्थापित की जाएगी।
- ब्लॉस्टिंग के दौरान धूल उत्पन्न होने को नियंत्रित करने के लिए ब्लॉस्टिंग प्रचालनों से पूर्व ड्रिल कटिंग्स हटाई जाती है ।
- ओवर बर्डन का कम वायुवीय उठाव के साथ डम्प किया जाता है और क्रमगत डोजिंग द्वारा ग्रेडिंग किया जाता है। इससे अपशिष्ट के ढ़ेर करते समय अपशिष्ट ढेरों पर धूल उत्पन्न होने को कम करने के लिए सहायता मिलती है।
- ट्रिपर कन्वेयर्स से अयस्क गिराते समय धूल उत्पन्न होने को कम करने के लिए अयस्क भंडार ढ़ेर पर पानी का छिड़काव किया जाता है।

प्रस्तावित निवारण उपाय

वर्तमान में खान में वायु प्रदूषण के नियंत्रण के लिए अपनाए जा रहे निवारण उपाय प्रस्तावित विस्तार परियोजना में भी अपनाए जाएंगे। खान क्षेत्र में पौधारोपण खाली

जगहों में और अधिक वृक्षारोपण द्वारा सुधार किया जाएगा। निम्नलिखित अतिरिक्त उपाय प्रस्तावित है :

- परिवहन सड़कों पर पानी के छिडकाव की बारंबारित को बढ़ाना
- अपशिष्ट ढ़ेरों और टेलिंग डैम के समीप अतिरिक्त पौधारोपण किया जाएगा और ओवर बर्डन डम्प और खान क्षेत्र में पौधारोपण के लिए वर्षवार कार्यक्रम तैयार किया गया है। 2008-09 से 2012-2013 तक 17.4 हे. में ओवर बर्डन पर लगभग 14000 पौधारोपण और खान क्षेत्र के आसपास में 23-हे. में लगभग 19000 पौधारोपण परिकल्पित है, और
- धूल प्रदूषण के नियंत्रण के लिए सांद्र भंडारयार्डों के समीप अतिरिक्त ट्रक/टायर वाशिंग सिस्टम संस्थापित की जाएगी

1.8.2 जल प्रदूषण के लिए नियंत्रण उपाय

वर्तमान निवारण उपाय

- संयंत्र से उत्पन्न टेलिंग को टेलिंग डैम में विसर्जन किया जाता है, टेलिंग के पानी को एकत्रित कर प्रक्रिया में पुन:उपयोग के लिए बेनिफिकेशन प्लांट में वापस पम्प किया जाता है।
- खान से निकलने वाले पानी को पुनरुद्धार पानी रिजर्वायर में पंप किया जाता है जहां से उसकी री-साइक्लिंग की जाती है।
- औद्योगिक क्षेत्र से सभी प्रकार के छलकनों, अतिरिक्त बहावों और साफ-सफाई के पानी आदि को एकत्रित कर उसकी री-साइक्लिंग के लिए पुनरुद्धार पानी के रिजर्वायर में भेजा जाता है।
- मानसून के दौरान अपशिष्ट ढ़ेर से बहने वाले पानी को संग्रह कर उसे पुनरुद्धार पानी के रिजर्वायर में पंप किया जाता है ।
- भारी वाहन सेवा केन्द्र(एचवीएससी) से तेल व ग्रीज के प्रवाहों के संग्रहण के लिए तेल व ग्रीज ट्रैप का उपयोग किया जाता है
- घरेलू अपशिष्ट पानी के उपचार के लिए टाउनशिप में 425 केएल प्रति दिन की क्षमता और खान में 300 केएल प्रति दिन की क्षमता के मलजल उपचार संयंत्र स्थापित किया जाता है।
- टैलिंग डैम में बाष्पीय हानियों को कम करने के लिए टेलिंग डैम, खान और अन्य क्षेत्रों से पानी को एकत्रित कर उसे री-साइक्लिंग करने हेतु बेनिफिकेशन प्लांट के समीप 50000 घनमीटर की एक रिजर्वायर निर्मित की गई
- तेल छनन(ट्रैप) सहित भारी वाहन सेवा केन्द्र(एचवीएससी) में सुविकसित डम्पर सफाई प्रणाली की व्यवस्था
- पानी के संग्रहों में वृद्धि और स्वच्छ जल की खपत को कम करने के लिए उपचारित प्रवाहों की री-साइक्लिंग
- टैलिंग और सांद्रों से पानी के संग्रहण में सुधार के लिए उच्च क्षमता के थिकनर्स , एवं
- पानी के संग्रहण में सुधार के लिए थिकनर्स में फ्लोकुलेंट्स का उपयोग

इन उपायों के फलस्वरूप खान परिसरों से प्रभावित शून्य निकास मेंटेन किया जाता है । सुधारात्मक उपायों के भाग के रूप में, हाल ही में टैलिंग डैम में निपटान से पूर्व टैलिंग से पानी के संग्रहण के लिए हैड्रो-साइक्लोन्स द्वारा टैलिंग पानी को रोकने हेतु एक समुचित प्रणाली स्थापित की गई है।

खान क्षेत्र के अंदर और बाहर विभिन्न स्थानों में पानी की गुणवत्ता का अनुवीक्षण किया जाता है और देखा जाता है कि खनन गतिविधियों से पानी की गुणवत्ता प्रभावित न हो ।

प्रस्तावित निवारण उपाय

खान में वर्तमान में अपनाए जा रहे उपायों को प्रस्तावित विस्तार परियोजना में भी अपनाए जाएंगे। सिफारिश किए गए अतिरिक्त उपाय निम्नवत हैं :

- तेल ट्रैप सहित एचवीएससी में डम्पर की सफाई प्रणाली में सुधार
- टैलिंग डैम में बाष्पीय हानियों को कम करने के लिए टेलिंग डैम, खान और अन्य क्षेत्रों से पानी को एकत्रित कर उसे री-साइक्लिंग करने हेतु बेनिफिकेशन प्लांट के समीप 20000 घनमीटर की एक और रिजर्वायर का निर्माण
- टैलिंग और सांद्रों से पानी के संग्रहण में सुधार के लिए उच्च क्षमता के अतिरिक्त थिकनर्स की स्थापना , एवं
- पानी के संग्रहण में सुधार के लिए टैलिंग थिकनर्स में फ्लोकुलेंट्स का उपयोग करना
- खान परिवहन सड़कों पर धूल नियंत्रण के लिए गीले रसायनों का प्रयोग करना
- टेलिंग डैम और पानी के रिजर्वायर टैंक में बाष्पीय रोधक रसायनों का उपयोग करना

1.8.3 ध्वनि प्रदूषण व निवारण उपाय

वर्तमान निवारण उपाय

ध्वनि और भू-कंपनों के संबंध में अपनाए जा रहे निवारण उपाय निम्नलिखित :

- ध्वनि उत्पन्न होने को कम करने हेतु वाहनों एवं मशीनों के नियमित रखरखाव के लिए अच्छे उपकरणों से युक्त कार्यशाला स्थापित की गई है।
- बॉल मिल में स्टील लाइनर्स के स्थान पर रबर लाइनर्स प्रतिस्थापित किये गये
- डम्परों एवं एक्सकेवेटर्स में ए.सी. केबिन की व्यवस्था की गई
- ध्वनिरोधकों के रूप में परिसीमा दीवार(बैफल वॉल्स), अपशिष्ट तट और गहन वृक्षों की पंक्तियां लगाई गईं
- उपकरणों के समुचित रूप से माउंटिंग करते हुए और हवादारी प्रणालियों(वेंटिलेशन सिस्टम्स) द्वारा उनके स्त्रोत पर ही ध्वनि कम की जाती है और जहां कहीं आवश्यक हो, ध्वनि घेरे या पैडिंग की व्यवस्था की जाती है।

- डीजीएमएस के दिशा निर्देशों को सख्ती से पालन करते हुए ब्लॉस्टिंग की जाती है जैसे ब्लॉस्टिंक दिन में 2 बजे अपराह्न से 3 बजे अपराह्न के बीच में ही करना, जब तापमना के प्रत्यावर्तन अनूकूल नहीं है और विपरीत वायु स्थितियों के दौरान ब्लॉस्टिंग नहीं करना आदि।
- ओवरचार्जिंक बिलकुल नहीं की जाती है ।
- एक्सक्वेटर्स और डम्पर्स के आपूर्तिकर्ताओं द्वारा कैबिन के अंदर 85 डीबी(ए) के नीचे ध्वनि स्तरों को प्रदर्शित करना होता है और साथ ही उन्हें 5 वर्षों के लिए उपकरणों को अच्छी हालत में रखरखाव करना होता है ।
- गैर-विद्युत/विद्युत के आरंभिक(इग्निशियन) प्रणालियों द्वारा विस्फोट के प्रत्येक दौर में अतिरिक्त वायु दबाव को प्रभावित रूप से नियंत्रित किया जाता है
- प्रति अंतराल में चार्ज और कुल चार्ज को न्यूनतम स्तर तक रखा जाता है और संभवत: प्रत्येक विस्फोट में अधिक संख्या में अंतराल उपयोग किए जाते हैं, और
- ध्वनि प्रसारण को प्रतिरोध करने के लिए खान क्षेत्र में ओर उसके आसपास में ग्रीनबेल्ट का विकास किया जाता है। खान क्षेत्रों में ध्वनि रोधक के रूप में कार्य करने के लिए 30-40मी. की चौडाई में विभिन्न ऊंचाई की वृक्षों की पंक्तियां लगाई गयी है।

प्रस्तावित निवारण उपाय

वर्तमान निवारण उपायों के अलावा निम्नलिखित अतिरिक्त निवारण उपाय प्रस्तावित है :

- रॉक ब्रेकर द्वारा सेकेंडरी ब्लॉस्टिंग को दूर करना
- उपकरणों को खरीदने से पूर्व देखना कि उनकी डिजायन/प्रचालन अधिकतम ध्वनि उत्पन्न करने वाला न हो। उपकरणों को अच्छी हालत में रखने के लिए उनका समुचित अनुरक्षण/कार्य स्थिति को सुनिश्चित करना।
- ब्लॉस्टिंग से संबंधित ध्वनि एवं प्रकंपनों को आगे और कम करने के लिए ब्लॉस्टिंग में अत्याधुनिक तकनीकी का प्रयोग किया जाएगा, और
- ध्वनि स्तरों को कम करने के लिए अधिक संख्या में वृक्षारोपण कर वर्तमान ग्रीनबेल्ट में अधिक सुधार करना और खाली क्षेत्रों के वनस्पति में वृद्धि करना ।

1.8.4 ठोस अपशिष्ट प्रबंधन

ठोस अपशिष्टों को प्रणालीबद्ध तरीके से अपशिष्ट ढ़ेर जिनके उठाव 4X10 मी. और अधिकतम ऊंचाई 40मी. और समग्र ढलान 27^0 हो, में ढेर किया जाता है ।

वर्तमान निवारण उपाय

- ढ़ेर में पर्याप्त स्थिरता सुनिश्चित करने के लिए उनका समग्र ढलान 27^0 और अधिकतम ऊंचाई 40मी. रखा जाता है ।

- अपशिष्ट को प्रणालीबद्ध तरीके से परतों में ढ़ेर किया जाता है और उसका डोजर द्वारा क्रमबद्ध रूप से समतल किया जाता है
- बेंचों की अधिकतम ऊंचाई के बाद उन पर वृक्षारोपण किया जा रहा है
- ढ़ेर के चारों ओर जल निकासियों का निर्माण किया जाता है ताकि ढ़ेर से सतही बहाव को निगर्त (संप) में एकत्रित कर उसे टेलिंग डैम में पंपिंग की जा सके
- सतही बहाव को संग्रहित करने के लिए ठोस अपशिष्ट ढ़ेर के आसपास में निर्मित जल निकासियों का नियमित रखरखाव
- मृदा आवृत्त और वानस्पतिक पौधारोपण द्वारा ढ़ेर का स्थिरीकरण प्रगति पर है, और
- ढ़ेर की डाउनस्ट्रीम में कुँओं का मोनिटरिगं द्वारा संरक्षण उपायों के प्रभावता का अनुवीक्षण किया जाता है

प्रस्तावित निवारण उपाय

प्रस्तावित क्षमता विस्तार परियोजना में, उत्पन्न होनेवाले ओवरबर्डन को वर्तमान अपशिष्ट ढ़ेरों में प्रणालीबद्ध तरीके से ढ़ेर करना जारी रखा जाएगा। प्रति बेंच की ऊचाई 20मी व अधिकतम ऊचाई 100मी करने का प्रस्ताव है। वर्तमान निवारण उपाय भी चलते रहेंगे और इसके अलावा, ढ़ेर में जब कभी क्षेत्र उपलब्ध हो पौधारोपण किया जाएगा । बहाव के पानी को प्रभावित रूप से संग्रह करने के लिए अतिरिक्त जल निकासियों का निर्माण किया जाएगा।

1.8.5 ग्रीनबेल्ट

- खान क्षेत्र में लगभ 2,70,000 वृक्ष लगाए गए और कॉलोनी क्षेत्र में लगभग 35,000 वृक्ष लगाए गए
- उनके जीवन दर(सर्वाइवल) 80-90% के बीच पाया गया
- 2008-09 तक हरित पंक्ति(ग्रीनबेल्ट) के लिए आवृत्त क्षेत्र 260हे.(246.22हे. औद्योगिक क्षेत्र में . 33.5हे., कॉलोनी के क्षेत्र में)
- प्रस्तावित विस्तार कार्यक्रम के दौरान, ओवरबर्डन ढ़ेरों पर और खनन क्षेत्र में चरणबद्ध प्रक्रिया में 33,000 पौधों की अतिरिक्त कुल ग्रीनबेल्ट का विकास किया जाएगा

1.9 परियोजना अनुवीक्षण

वर्ममान अनुवीक्षण रणनीति को ध्यान में रखते हुए हि जि लि द्वारा एक समग्र अनुवीक्षण कार्यक्रम किया जाता है। विस्तार कार्यक्रम की आवश्यकताओं की पूर्ति के लिए वर्तमान अनुवीक्षण कार्यक्रम को अद्यतन(अपग्रेड) किया जाएगा।

सारणी –1.09
पर्यावरणीय प्राचलों के लिए अनुवीक्षण कार्यक्रम

क्र.स.	प्राचल Parameters	प्रमुख अनुवीक्षण प्राचल Parameters	अनुवीक्षण की बारंबारिता Frequency of Monitoring
1	वायु गुणवत्ता	SPM, RSPM, SO2, NOx, CO, लैड, जिंक,आयरन एवं केडमियम	24 घंटे मोनिटरींग कम से कम 6 फिक्स और 5 मोबाइल स्थानों पर सप्ताह मे दो बार, CO के सेम्पलस को 8 घंटे के आधार पर एकत्रित करते है।
2	डस्ट फॉल रेट	धूल की मात्रा	प्रत्येक ऋतु मे हर महिने 6 जगहो पर
3	मौसमविज्ञान	वायु गति एवं दिशा, तापमान, वर्षापात, सापेक्षित आर्द्धता, और दूसरे ओबजरवेशन जैसे पारदर्शिता. ओलावष्टी.बिजली गीरना.तूफान.कुहरा.	a] मौसमविज्ञान के स्टेशन द्वारा ऋतुओं तक लगातार प्रति घंटे रिकोडिंग कर b] Collection & Review of Data from secondary sources like IMD - Ajmer.
4	जल गुणवत्ता	भौतिक.रसायन एवं बेक्टीरियोलोजिकल पेरामीटरस	ऋतु मे एक बार (3 SW and 10 GW) 13 स्थानो से
5	पारिस्थितिकी	भू एवं जल पारिस्थितिकी	Through field visits (अध्यन के दौरान एक बार).
6	ध्वनि स्तर	ध्वनि स्तर dB (A).	अध्यन के दौरान दो बार.10 स्थानो पर (परिवहन सर्वे के साथ).
7	परिवहन सर्वे		अध्यन के दौरान दो बार. 2 स्थानो
8	मृदा लक्षण	मृदा प्रोफाइल.लक्षण. मृदा प्रकार और टेक्चर.भारी मेटल. NKP value इत्यादी	अध्यन के दौरान दो बार. 6 स्थानो

1.10 **परियोजना लाभ**

हिन्दुस्तान जिकं लिमिटेड ने वर्तमान खान परियोजना के अंतर्गत टाउनशिप में एक अस्पताल का निर्माण किया है। इस स्वास्थ्य सेवा केन्द्र में उपलब्ध सेवाएं आकस्मिक स्थितियों में समीपवर्ती गांवों में रहनेवाले लोगों के लिए भी प्रदान की जाएंगी । यह अस्पताल प्रस्तावित विस्तार परियोजना के बाद भी पर्याप्त है। अत: परियोजना के विस्तार में नए स्वास्थ्य केन्द्र प्रस्तावित नहीं है।

कर्मचारियों के बच्चों के लिए टाउनशिप में एक विद्यालय पहले से ही स्थापित है। समीपवर्ती गांवों के बच्चों को भी इस विद्यालय की सुविधा उपलब्ध है। भविष्य में प्रस्तावित विस्तार के बाद भी इस सुविधा को जारी रखा जाएगा।

प्रस्तावित क्षमता विस्तार परियोजना में , अतिरिक्त मेनपॉवर की भर्ती के दौरान स्थानीय कुशल व्यक्तियों को प्राथमिकता दी जाएगी।

हिन्दुस्तान जिकं लिमिटेड ने लोगों को लाभ पहुॅचाते हुए आसपास के गांवों में विभिन्न सामुदायिक विकास परियोजनाओं को कार्यान्वित किया है। भविष्य में भी प्रस्तावित क्षमता विस्तार परियोजना के अंतर्गत सामुदायिक विकास परियोजनाओं के लिए राशि प्रदान करने की प्रक्रिया जारी रहेगी ।

1.11 निष्कर्ष

प्रस्तावित परियोजना का स्थानीय पर्यावरण पर कुछ हद तक थोडे से प्रभाव होंगे। परियोजना में पुनर्वास एवं पुनर्स्थापना कार्यकलाप शामिल है। सरकार की आर एंड आर नीति के अनुसार आर एंड आर लागू की जाएगी । परियोजना में आवश्यकता और पात्रता के अनुसार जहां तक संभव हो अधिकतम स्थानीय जनसमुदाय को रोजगार प्रदान किया जाएगा।

अत: ऐसा निष्कर्ष किया जा सकता है कि नियंत्रण उपायों एवं निवारण उपायों के न्यायिक और समुचित कार्यान्वयन के साथ प्रस्तावित परियोजना समाज के लिए लाभकारी होगी और जिंक-लेड की मांग-आपूर्ति की दूरी को कम करेगी और यह विशेषकर क्षेत्र की और सामान्य रूप से देश के आर्थिक विकास में योगदान देने में सहायक होगी।

ANNEXURE-I
ENVIRONMENTAL CLEARANCE

No. J-11015/367/2006-IA.II(M)
Government of India
Ministry of Environment & Forests

Paryavaran Bhawan,
C.G.O. Complex, Lodi Road,
New Delhi – 110 003

Dated the 27th July, 2007

To,

M/s Hindustan Zinc Limited
Rampura – Agucha Mines,
P.O.- Agucha-311 029,
District- Bhilwara,
Rajasthan

Subject: Expansion of Rampura-Agucha Lead and Zinc Mining Project of M/s Hindustan Zinc Limited located in Village Agucha, Tehsil Hurda, District Bhilwara, Rajasthan - environmental clearance reg.

Sir,

This has reference to your letter No. HZL/RAM/Env/Exp/2006/338 dated 04.10.2006 and subsequent letters dated 08.11.2006, 02.03.2007, 03.04.2007, 06.04.2007, 09.05.2007 and 17.07.2007 on the subject mentioned above. It has been noted that the proposal is for grant of environmental clearance under the provisions of EIA Notification, 1994, for enhancement of production of mine and beneficiation of lead and zinc ore from 3.75million tonnes per annum (million TPA) to 5.0million TPA. The project was earlier accorded environmental clearance by the Ministry on 19th April, 1983 for (0.9million TPA production); 18th March, 1999 (1.35million TPA production) and on 1st March, 2005(3.75million TPA production). The total mine lease area of the project is 1200ha, out of which 923ha is an agricultural land, 15ha is wasteland, 70ha is grazing land, 116ha is surface water bodies and 76ha is others. No forestland is involved. Area proposed for mining 147ha, an area of 2ha is kept for storage of topsoil, 210ha for OB dumps, 4.5ha for mineral storage, 20ha for infrastructure, 4ha for roads, 241ha for green belt, 144.5ha for tailings pond, 70ha for mineral separation plant, 8ha for township and 349ha is others. In addition, township for company staff/employees is located at a distance of 7km from the mine lease area. No ecologically sensitive area such as National Park/Wildlife Sanctuary/Biosphere Reserve/Tiger Reserve/Elephant Reserve etc. is reported to be located in the core and buffer zone of the mine and that the area does not form corridor for Schedule I and II fauna. Unclassified forest is located in the buffer zone of the mine. Working will be opencast by mechanised method involving blasting. The targeted production capacity of the mine is 5million TPA production and beneficiation of lead and zinc ore and life of mine is 8years. The topography of the area is flat at an elevation of 390m AMSL. The present working depth of mine is 110m bgl and the ultimate working depth of mine will be 270m bgl. Water table in the core zone varies from 7mbgl to 12mbgl during post monsoon and pre monsoon. The mine working has already intersected the ground water table. There is no population in the core zone, therefore, no displacement of population and R&R is involved. Peak water requirement of the project is estimated as 11700m^3per day. The proponent has an approval of withdrawal of 11700 m^3per day of ground water. The water requirement for the expansion unit will be met by adopting water conservation measures and no additional water will be drawn. It is estimated that 157.63million tonnes of waste will be generated during the remaining life of the mine which will be dumped in the earmarked area. Backfilling is not proposed. The tailings emanating from the mine due to mining and beneficiation of the ore will be stored in a specially constructed tailing impoundment area. The water from the tailing dam will be recycled and reused. The mine will be operated on zero discharge basis. Plantation will be raised in an area of 670.7ha at the end of the mine life and an area of 25ha will be developed as water body at the post mining stage of opencast working.NOC from the Rajasthan State Pollution Control Board obtained on 28.12.2006 for mining of lead & zinc ore and lead & zinc beneficiation to 5milion tonnes per annum involving lease area of 1200ha. Public hearing of the project held on 11.10.2006. The Indian Bureau of Mines has approved mining scheme of the project on 27.02.2006 for lease area of 1200ha. The Government of Rajasthan vide their letter No. KHAA/BHIL/KHAP 8/99/3772 dated 16.07.2007 stated that the project area does not fall in the Aravalli Hills. The capital cost of the project is 20,000Lakhs.

2. The Ministry of Environment and Forests has examined the application in accordance with Section 12 of the EIA Notification 2006 read with para2.2.1(i)(a) of Circular No.J-11013/41/2006-IA.II(I) dated 13.10.2006 and hereby accords environmental clearance under the provisions thereof to the above mentioned Rampura-Agucha Lead and Zinc Mining Project of M/s Hindustan Zinc Limited for an annual production capacity of 5million tonnes of lead and zinc ore by opencast mechanised method involving total lease area of 1200ha and its beneficiation subject to implementation of the following conditions and environmental safeguards.

ANNEXURE-I
ENVIRONMENTAL CLEARANCE

A. Specific conditions

(i) All the conditions stipulated by the State Pollution Control Board in their NOC should be effectively implemented.

(ii) The project proponent shall obtain fresh environmental clearance while changing the scope of the project working from opencast to underground.

(iii) Top soil, if any, shall be stacked properly with proper slope with adequate safeguard measures and should be used for reclamation and rehabilitation of mined out areas.

(iv) Over burden shall be stacked at earmarked dump site(s) only and should not be kept active for long period. The maximum height of the dump should not exceed 40 m having 4 terraces of 10 m each. The over all slope of the dump shall not exceed 27^0. The OB dumps should be scientifically vegetated with suitable native species to prevent erosion and surface run off. Monitoring and management of rehabilitated areas should continue until the vegetation becomes self-sustaining. Compliance status should be submitted to the Ministry of Environment & Forests and its Regional Office, Lucknow on six monthly basis.

(v) The void left unfilled in an area of 25ha shall be converted into water body. The higher benches of excavated void/mining pit shall be terraced and plantation done to stabilize the slopes. The slope of higher benches shall be made gentler. Peripheral fencing shall be carried out along the excavated area.

(vi) Catch drains and siltation ponds of appropriate size should be constructed to arrest silt and sediment flows from mine working and over burden dumps. The water so collected should be utilized for watering the mine area, roads, green belt development etc. The drains should be regularly desilted particularly after monsoon and maintained properly.

Garland drain (size, gradient and length) shall be constructed for both mine pit and over burden dumps and sump capacity should be designed keeping 50% safety margin over and above peak sudden rainfall (based on 50 years data) and maximum discharge in the area adjoining the mine site. Sump capacity should also provide adequate retention period to allow proper settling of silt material. Sedimentation pits should be constructed at the corners of the garland drains and desilted at regular intervals.

(vii) Dimension of the retaining wall at the toe of dumps and OB benches within the mine to check run-off and siltation should be based on the rain fall data.

(viii) Plantation shall be raised in an area of 670.7ha including a green belt of adequate width by planting the native species around ML area, OB dumps, roads etc. in consultation with the local DFO / Agriculture Department. In addition, the township area shall also be adequately planted. The density of the trees should be around 1500 plants per ha.

(ix) Regular water sprinkling should be carried out in critical areas prone to air pollution and having high levels of SPM and RPM such as haul road, loading, unloading and transfer points and other vulnerable areas. It should be ensured that the Ambient Air Quality parameters conform to the norms prescribed by the Central Pollution Control Board in this regard.

(x) The project authority should implement suitable conservation measures to augment ground water resources in the area in consultation with the Regional Director, Central Ground Water Board.

(xi) Regular monitoring of ground water level and quality should be carried out in and around the mine lease by establishing a network of existing wells and constructing new piezometers during the mining operation. The monitoring should be carried out four times in a year ┬ pre-monsoon (April-May), monsoon (August), post-monsoon (November) and winter (January) and the data thus collected may be sent regularly to Ministry of Environment and Forests, its Regional Office located at Lucknow, Central Ground Water Authority and Regional Director, Central Ground Water Board.

(xii) The project proponent shall ensure that no additional water is drawn for the expansion project. The additional requirement of water will be met out of the water saved by adopting water conservation measures.

(xiii) Regular monitoring of groundwater quality around the tailing dam shall be carried out in consultation with Central Ground Water Authority and records maintained. It shall be ensured that the groundwater quality is not adversely affected due to the project.

(xiv) Groundwater and surface water in and around the mine shall be regularly monitored at strategic locations for heavy metals such as Ni, Co, Cu, Pb, Zn and Cd. The monitoring stations shall be established in consultation with the Regional Director, Central Ground Water Board and State Pollution Control Board.

(xv) Vehicular emissions should be kept under control and regularly monitored. Measures shall be taken for maintenance of vehicles used in mining operations and in transportation of mineral. The vehicles should be covered with a tarpaulin and shall not be overloaded.

(xvi) Blasting operation should be carried out only during the daytime. Controlled blasting should be practiced. The mitigative measures for control of ground vibrations and to arrest fly rocks and boulders should be implemented.

(xvii) Drills shall either be operated with dust extractors or equipped with water injection system.

(xviii) The decanted water from the tailing pond shall be re-circulated within the mine and there shall be zero discharge from the beneficiation plant.

(xix) Digital processing of the entire lease area using remote sensing technique should be done regularly once in three years for monitoring land use pattern and report submitted to Ministry of Environment and Forests and its Regional Office, Lucknow.

(xx) The tailing dam shall be lined by clay in the bottom and by LDPE lining on the sites. The ultimate height of the dam shall be maintained to 41m and provided with garland drains. The disaster management plan for tailing dam shall be prepared and implemented.

(xxi) The recommendations of the study report of NEERI, Nagpur on pollution vulnerability of aquifer shall be effectively implemented and action taken report submitted to the Ministry and its Regional Office, Lucknow on six monthly basis.

(xxii) The project proponent shall regularly analyse the waste generated from the mining (at least once a year) for heavy metals such as Ni, Co, Cu, Pb, Zn and Cd and the data thus collected may be sent regularly to Ministry of Environment and Forests and its Regional Office, Lucknow. It should be ensured that the parameters conform to the prescribed norms.

(xxiii) The recommendations of the study report on blood lead levels of children to monitor levels of lead in human system carried out by National Institute of Occupational Health, Ahemdabad shall be effectively implement and action taken report submitted to the Ministry and its Regional Office, Licknow on six monthly basis.

(xxiv) The project proponent shall also study the base level of lead in mother⁞ s milk in villages near the mining area and also in soil along the transportation route in the study area through National Institute of Occupational Health, Ahemdabad and submit report to the Ministry and its Regional Office, Lucknow within six months.

(xxv) Consent to operate should be obtained from State Pollution Control Board before starting enhanced production from the mine.

(xxvi) A Final Mine Closure Plan along with details of Corpus Fund should be submitted to the Ministry of Environment & Forests 5 years in advance of final mine closure for approval.

B. General conditions

(i) No change in mining technology and scope of working should be made without prior approval of the Ministry of Environment & Forests.

(ii) No change in the calendar plan including excavation, quantum of mineral lead and zinc and waste should be made.

(iii) Conservation measures for protection of flora and fauna in the core & buffer zone shall be drawn up in consultation with the local forest and wildlife department.

(iv) Periodic monitoring of ambient air quality should be carried out for RPM, SPM, SO_2 and NOx. Location of the monitoring stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets and frequency of monitoring should be undertaken in consultation with the State Pollution Control Board. The data so collected should be regularly submitted to the Ministry including its Regional office located at Lucknow and the State Pollution Control Board / Central Pollution Control Board once in six months.

(v) Measures should be taken for control of noise levels below 85 dBA in the work environment. Workers engaged in operations of HEMM, etc. should be provided with ear plugs / muffs.

(vi) Industrial waste water (workshop and waste water from the mine) should be properly collected, treated so as to conform to the standards prescribed under GSR 422 (E) dated 19th May, 1993 and 31st December, 1993 or as amended from time to time. Oil and grease trap should be installed before discharge of workshop effluents.

(vii) Personnel working in dusty areas should wear protective respiratory devices and they should also be provided with adequate training and information on safety and health aspects.

Occupational health surveillance program of the workers should be undertaken periodically to observe any contractions due to exposure to dust and take corrective measures, if needed.

(viii) The project authorities should inform to the Regional Office located at Lucknow regarding date of financial closures and final approval of the project by the concerned authorities and the date of start of land development work.

(ix) The funds earmarked for environmental protection measures should be kept in separate account and should not be diverted for other purpose. Year wise expenditure should be reported to the Ministry and its Regional Office located at Lucknow.

(x) The Regional Office of this Ministry located at Lucknow shall monitor compliance of the stipulated conditions. The project authorities should extend full cooperation to the officer (s) of the Regional Office by furnishing the requisite data / information / monitoring reports.

(xi) The project proponent shall submit six monthly report on the status of the implementation of the stipulated environmental safeguards to the Ministry of Environment and Forests, its Regional Office, Lucknow, Central Pollution Control Board and State Pollution Control Board.

(xii) A copy of clearance letter will be marked to concerned Panchayat / local NGO, if any, from whom suggestion/representation, if any, was received while processing the proposal.

(xiii) State Pollution Control Board should display a copy of the clearance letter at the Regional office, District Industry Centre and Collector`s office/ Tehsildar`s Office for 30 days.

(xiv) The project authorities should advertise at least in two local newspapers widely circulated, one of which shall be in the vernacular language of the locality concerned, within 7 days of the issue of the clearance letter informing that the project has been accorded environmental clearance and a copy of the clearance letter is available with the State Pollution Control Board and also at web site of the Ministry of Environment and Forests at **http://envfor.nic.in** and a copy of the same should be forwarded to the Regional Office of this Ministry located at Lucknow.

3. The Ministry or any other competent authority may alter/modify the above conditions or stipulate any further condition in the interest of environment protection.

4. Failure to comply with any of the conditions mentioned above may result in withdrawal of this clearance and attract action under the provisions of Environment (Protection) Act, 1986.

5. The above conditions will be enforced inter-alia, under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986 and the Public Liability Insurance Act, 1991 along with their amendments and rules made thereunder and also any other orders passed by the Hon‡ ble Supreme Court of India/ High Court of Rajasthan relating to the subject matter.

(SATISH C. GARKOTI)
Additional Director (S)

ANNEXURE-I
ENVIRONMENTAL CLEARANCE

Copy to:

(i) The Secretary, Ministry of Mines, Government of India, Shastri Bhawan, New Delhi.

(ii) The Secretary, Department of Mines & Geology, Government of Rajasthan, Secretariat, Jaipur.

(iii) The Secretary, Department of Environment, Government of Rajasthan, Secretariat, Jaipur.

(iv) The Chief Conservator of Forests, Central Region, Ministry of Environment and Forests, B-1/72, Sector-A, Aliganj, Lucknow-226020.

(v) The Chairman, Central Pollution Control Board, Parivesh Bhavan, CBD-cum-Office complex, East Arjun Nagar, New Delhi-1100032.

(vi) The Member Secretary, Central Ground Water Authority, A-2, W3, Curzon Road Barracks, K.G. Marg, New Delhi-110001.

(vii) The Chairman, Rajasthan State Pollution Control Board, 4, Institutional area, Jhalana, Doongri, Jaipur.

(viii) The Controller General, Indian Bureau of Mines, Indira Bhavan, Civil Lines, Nagpur-440 001.

(ix) The District Collector, Bhilwara District, Rajasthan.

(x) EI Division, Ministry of Environment and Forests, Paryavaran Bhavan, C. G. O. Complex, Lodi Road, New Delhi-110 003.

(xi) Monitoring File.

(xii) Guard File.

(xiii) Record File.

(SATISH C. GARKOTI)
Additional Director (S)

ANNEXURE-II
TERMS OF REFERENCE

By Speed Post

No. J-11015/267/2008-IA.II(M)
Government of India
Ministry of Environment & Forests

Paryavaran Bhavan,
C.G.O. Complex, Lodi Road,
New Delhi-110003.
Telefax. 2436 2434

Dated the 22nd December, 2008

To

M/s Hindustan Zinc Ltd.
Rampura Agucha Mine,
P.O. Agucha – 311 029
District Bhilwara, Rajasthan.

Sub: Expansion of Rampura Agucha Lead-Zinc Mine and beneficiation plant of M/s Hindustan Zinc Limited, P.O. Agucha, Tehsil-Hurda, District Bhilwara, Rajasthan – Prescribing of TOR - Regarding.

Reference is invited to your letter no. HZL/RAM/Env/Exp/2008/140 dated 11.6.2008 along with the application in the prescribed format (Form-I) and a copy of the pre-feasibility report to prescribe the TORs for undertaking detailed EIA study for the purpose of obtaining environmental clearance under the provisions of the EIA Notification, 2006 in respect of the above mentioned project.

2. The proposal is for enhancement of production of lead-zinc from 5 million TPA to 6.15 million TPA. Expansion of beneficiation plant from 5 million TPA to 6.5 million TPA is also part of the project. Earlier clearance was given in 2007 for 5 million TPA of mine by opencast method. The proposed working will be both opencast and underground. The mine lease area is 1200 ha. The life of the mine is 10 years for opencast and 32 years for underground. The water requirement will be 11,700 m3, which will be met from groundwater.

3. Based on the information contained in the documents submitted and the presentation made before the Expert Appraisal Committee (EAC) for mining projects during its Meeting held on November 19-21, 2008, the following TORs are prescribed:-

(i) Year-wise production details since 1994 onwards and clearly stating the highest production achieved in any one year prior to 1994. It may also be categorically informed whether there had been any increase in production after the EIA Notification, 1994 coming into force w.r.t. the highest production achieved prior to 1994.

(ii) All documents including approved mine plan, EIA and public hearing should be compatible with one another in terms of the production levels, waste generation and its management and mining technology.

ANNEXURE-II
TERMS OF REFERENCE

(iii) The study area will comprise of 10 km zone around the mine lease from lease periphery and the data contained in the EIA such as waste generation etc. should be for the life of the mine / lease period.

(iv) Land use of the study area delineating forest area, agricultural land, grazing land, wildlife sanctuary and national park, migratory routes of fauna, water bodies, human settlements and other ecological features.

(v) Land use plan of the mine lease area should be prepared to encompass pre-operational, operational and post operational phases.

(vi) Details of the land for OB dump outside the mine lease, if any, such as extent of land area, distance from mine lease, its land use, R&R issues, if any should be given.

(vii) Status of forestry clearance for the forestland involved in the project, if any.

(viii) A confirmation duly authenticated by the competent authority in the State Government to the effect whether the project falls in Aravalli and whether it is covered by the order of the Hon'ble Supreme Court dated 8.4.2005 in the contempt petition (c) 412/2004 in writ petition 202 of 1995 in the matter of Godavarman vs Union of India.

(ix) Location of National Parks, Sanctuaries, Biosphere Reserves, Wildlife corridors, Tiger/Elephant reserves (existing as well as proposed), if any, within 10 km of the mine lease should be clearly indicated. A location map duly authenticated by Chief Wildlife Warden should be provided in this regard. Necessary clearance, if any, as may be applicable to such projects due to proximity of the ecologically sensitive areas as mentioned above should be obtained from the State Wildlife Department/ Chief Wildlife Warden under the Wildlife (Protection) Act, 1972 and copy furnished.

(x) A detailed biological study for the study area [core zone and buffer zone (10 km radius of the periphery of the mine lease)] shall be carried out. Details of flora and fauna, duly authenticated, separately for core and buffer zone should be furnished based on field survey clearly indicating the Schedule of the fauna present. In case of any scheduled-I fauna found in the study area, the necessary plan for their conservation should be prepared in consultation with State Forest and Wildlife Department and details furnished. Necessary allocation of funds for implementing the same should be made as part of the project cost.

(xi) Impact of change of land use particularly agriculture land and gaucher / grazing land, if any.

(xii) R&R plan / compensation details for the project affected people. While preparing the R&R plan, the National Rehabilitation & Resettlement Policy should be kept in view.

(xiii) Collection of one season (non-monsoon) primary baseline data on ambient air quality, water quality, noise level, soil and flora and fauna. Site-specific meteorological data should also be collected. The location of the monitoring stations should be justified. Date wise collected baseline AAQ data should form part of EIA and EMP report.

ANNEXURE-II
TERMS OF REFERENCE

(xiv) Air quality modelling should be carried out for prediction of impact of the project on the air quality of the area. It should also take into account the impact of movement of vehicles for transportation of mineral. The details of the model used and input parameters used for modelling should be provided. The air quality contours may be shown on a location map clearly indicating the location of the site, location of sensitive receptors, if any and the habitation. The wind roses showing pre-dominant wind direction may also be indicated on the map.

(xv) The water requirement for the project, its availability and source to be furnished. A detailed water balance should also be provided. Fresh water requirement for the project should also be indicated.

(xvi) Necessary clearance from the Competent Authority for drawl of requisite quantity of water for the project should be provided.

(xvii) Details of water conservation measures proposed to be adopted in the project.

(xviii) Impact of the project on the water quality both surface and groundwater should be assessed and necessary safeguard measures, if any required should be provided.

(xix) Based on actual monitored data, it may clearly be shown whether working will intersect groundwater. Necessary data and documentation in this regard may be provided. In case the working will intersect groundwater table, a detailed hydro geological study should be undertaken and report furnished.

(xx) Details of first order stream, if any passing through lease area and modification/ diversion proposed, if any and the impact of the same on the hydrology should be brought out.

(xxi) Details of rainwater harvesting proposed, if any, in the project to be provided.

(xxii) Information on site elevation, working depth, groundwater table should be provided both in AMSL and bgl. A schematic diagram may also be provided for the same.

(xxiii) Quantity of solid waste generation to be estimated and details for its disposal and management be provided. Details of backfilling proposed, if any, should also be given. It may be clearly indicated that out of the total waste generation during the mine life, the quantity to be backfilled and the quantity to be disposed off in the form of external dump (number of dumps, their height, terraces etc.).

(xxiv) Impact of blasting during opencast working on underground working and vice-versa.

(xxv) The impact of accumulation of water in the open pit on underground working and the specific safeguard measures proposed in this regard along with their effectiveness.

(xxvi) Design of tailing dam including other parameters such as its height etc.

(xxvii) Adequacy of tailing dam for the entire life of the project.

ANNEXURE-II
TERMS OF REFERENCE

(xxviii) Safety of tailing pond to ensure no breech and no overflow under maximum rainfall condition.

(xxix) Chemical composition of the tailings.

(xxx) Data on water quality monitoring in the wells near the tailing pond.

(xxxi) The proposed height of 100 m for the waste dump to be examined based on safety of the dump and details furnished.

(xxxii) Subsidence study to be carried out and details furnished along with proposed safeguard measures in this regard.

(xxxiii) A note on acid mine drainage, its impact and related safeguard measures.

(xxxiv) Details of Plantation with rate of plantation, species planted and their survival rate.

(xxxv) The reclamation plan, post mine land use and progressive greenbelt development plan shall be prepared in tabular form (prescribed format) and submitted.

(xxxvi) Impact on local transport infrastructure due to the project. Projected increase in truck traffic as a result of the project in the present road network (including those outside the project area) and whether it is capable of handling the increased load. Arrangement for improving the infrastructure, if contemplated including action to be taken by other agencies such as State Government, if any, should be covered.

(xxxvii) Details of the infrastructure facilities to be provided for the mine workers.

(xxxviii) Conceptual post mine land use and Reclamation and Rehabilitation of mined out area (with plans and with adequate number of sections).

(xxxix) Phase-wise plan of greenbelt development, plantation and compensatory afforestation clearly indicating the area to be covered under plantation and the species to be planted. The details of plantation already done should be given.

(xl) Occupational health impact of the project. Details of pre-placement medical examination and periodical medical examination schedules should be incorporated in the EMP.

(xli) Measures of socio economic influence to the local community proposed to be provided by project proponent. As far as possible, quantitative dimension to be given.

(xlii) Detailed environmental management plan to mitigate the environmental impacts which, should inter-alia also include the impact due to change of land use, due to loss of agricultural land and grazing land, if any, besides other impacts of the projects.

(xliii) Disaster Management Plan should be prepared to take into account the breech of tailing pond.

(xliv) Public hearing points raised and commitment of the project proponent on the same along with time bound action plan to implement the same.

ANNEXURE-II
TERMS OF REFERENCE

(xlv) Any litigation pending against the project and /or any direction /order passed by any Court of Law against the project, if so, details thereof.

(xlvi) The cost of the project (capital cost and recurring cost) as well as the cost towards implementation of EMP should clearly be spelt out.

4. Besides the above, the below mentioned general points will also to be followed:-

a) All documents to be properly referenced with index, page numbers and continuous page numbering.

b) Where data are presented in the report especially in tables, the period in which the data were collected and the sources should be indicated.

c) Where the documents provided in a language other than English, an English translation should be provided.

d) The Questionnaire for environmental appraisal of mining projects as devised earlier by the Ministry shall also be filled and submitted.

e) Approved mine plan along with copy of the approval letter for the proposed capacity should also be submitted.

5. The EIA report should also include (i) surface plan of the area indicating contours of main topographic features, drainage and mining area, (ii) geological maps and sections and (iii) sections of the mine pit and external dumps, if any, clearly showing the land features of the adjoining area.

6. After preparing the draft EIA (as per the generic structure prescribed in Appendix-III of the EIA Notification, 2006) covering the above mentioned issues, the proponent will get the public hearing conducted and take further necessary action for obtaining environmental clearance in accordance with the procedure prescribed under the EIA Notification, 2006.

(Dr. S.K. Aggarwal)
Director

Copy to:-

(i) The Secretary, Department of Environment, Government of Rajasthan, Secretariat, Jaipur.
(ii) The Chief Conservator of Forests, Central Region, Ministry of Environment and Forests, B-1/72, Sector-A, Aliganj, Lucknow-226020.
(iii) The Chairman, Rajasthan State Pollution Control Board, 4, Institutional area, Jhalana, Doongri, Jaipur.
(iv) Guard File.

(Dr. S.K. Aggarwal)
Director

ANNEXURE-III
NOC-RAJASTHAN STATE POLLUTION CONTROL BOARD

Rajasthan State Pollution Control Board

4, Institutional Area , Jhalana Doongari, **Jaipur-302004**

F.12(8-109)RPCB/Gr.Mines/ 4865 Date: 23/10/08

M/s Hindustan Zinc Ltd.
Rampura Agucha Mine,
P.O. Agucha, Distt.- Bhilwara

Sub.:-Extension of Consent to Operate under Air Act-1981 & Water Act-1974 for ML No. **1/2000** N/V-**Agucha** Teh.-**Hurda** Distt.- **Bhilwara** in the name of **M/s Hindustan Zinc Ltd.** .

Ref.:-i) Consent to Operate granted vide this office letter No.F.12(8-109) RPCB/Gr. Mines/ 1738-1744 Date 05/03/08
ii) Your letter dated nil received on 19/08/08.

Sir,

Consequent upon the examination, validity of consent to operate issued by above referred letter dated **05/03/08** is hereby extended from **01/09/2008 to 28/02/2010** under the provisions of section 21 of Air Act,1981 & 25/26 of Water Act alongwith following specific condition:

1. All the other conditions imposed in Consent to Operate letter No. **F.12(8-109)RPCB/Gr. Mines/ 1738-1744** dated **05/03/08** will remain same.
2. That the occupier/operator of mine shall ensure that all the conditions imposed in **NOC for ground water withdrawal** granted by Central Ground Water Authority vide letter No. **21-4(2)/WR/CGWA/05-417** dated **13/05/08** shall be strictly complied with.
3. That the occupier/operator of mine shall ensure that all the conditions imposed in **NOC for ground water intersection & withdrawal** granted by Central Ground Water Authority vide letter No.**21-4(2)/WR/CGWA/08-632** dated **06/08/08** shall be strictly complied with.
4. That Occupier/ operator of mine shall submit a report regarding rehabilitation / livelihood of the persons whose land has been acquired.

It must, however be noted that the non-compliance of any of the referred conditions would be tantamount to revocation of consent to operate and you shall be liable for prosecution under relevant provisions of the aforesaid Act.

Yours' Sincerely

Group Incharge (Mines)

ANNEXURE-IV

COMPLIANCE OF ENVIRONMENT CLEARANCE GRANTED BY MINISTRY OF ENVIRONMENT & FOREST, NEW DELHI

Env. Clearance vide no. J-11015/367/2006-IA II(M) dtd. 27/07/2007

Sr. No.	Condition	Status/Action Taken
A.	**Specific Conditions**	
1	All the conditions stipulated by the State Pollution Control Board in their NOC should be effectively implemented.	Complied.
2	The project proponent shall obtain fresh environmental clearance while changing the scope of the project working from opencast to underground.	Noted
3	Top soil, if any, shall be stacked properly with proper slope with adequate safeguard measures and should be used for reclaimation and rehabilitation of mined out areas.	Stacked separately & utilized for waste dump stabilisation by planting saplings. Presently no top soil is available.
4	Over burden shall be stacked at earmarked sites only and should not be kept active for long period. The maximum height of the dump should not exceed 40 m having 4 terraces of 10 m each. The overall slope of the dump shall not exceed 27^0. The OB dumps shou	Overburden is stored at the earmarked sites in 4 x 10 m lifts with overall slope of 27^0. Plantation of native species is done on inactive benches and slopes of the waste dumps. Six monthly compliance report was submitted to MoEF and its Regional Office on
5	The void left unfilled in an area of 25 ha shall be converted into water body. The higher benches of excavated void/mining pit shall be terraced and plantation done to stabilize the slopes. The slope of higher benches shall be made gentler. Pripheral fenc	Noted
6	Catch drains, and siltation ponds of appropriate size should be constructed to arrest silt and sediment flows from mine working and over burden dumps. The water so collected should be utilized for watering the mine area, roads, green belt development etc.	Garland drain all around the waste dump & mine pit was constructed with collection pit of 15,000 m^3 capacity and pipeline to pump water to reclaim reservoir to use in Beneficiation plant.
7	Dimension of the retaining wall at the toe of dumps and OB benches within the mine to check run-off and siltation should be based on the rain fall data.	Stone masonary wall was constructed all around the mine area with garland drain for collection of run-off water in the lined storage tank.
8	Plantation shall be raised in an area of 670.7 ha including a green belt of adequate width by planting the native species around ML area, OB	Plantation is done on regular basis around the mine lease area. Matured OB dump are revegetated by planting suitable species. Roadside plantation

ANNEXURE-IV

Sr. No.	Condition	Status/Action Taken
	dumps, roads etc. in consultation with the local DFO / Agriculture Department. In addition, the township area shal	(along public roads outside ML area) is also our regular programme.
9	Regular water sprinkling should be carried out in critical areas prone to air pollution and having high levels of SPM and RPM such as haul road, loading, unloading and transfer points and other vulnerable areas. It should be ensured that the Ambient Air Q	Water is sprinkled regularly on the haul roads with two 28 KL and one 40 KL sprinklers. Automatic water sprinklers are also installed along the permanent haul roads. Ambient air quality in the mine area & nearby villages is below permissible limits and si
10	The project authority should implement suitable conservation measures to augment ground water resources in the area in consultation with the Regional Director, Central Ground Water Board.	Request letter written to Regional Director (CGWB) for advise / suggetion for augmentation of water resources. Number of water conservation measures are taken to reduce fresh water consumption. Water harvesting structures were constructed in the Banas riv
11	Regular monitoring of ground water level and quality shall be carried out in and around the mine lease by establishing a network of existing wells and constructing new piezometers during the mining operation. The monitoring should be carried out four time	Agreed, Groundwater is regularly monitored on monthly basis through piezometers within ML area and wells inside as well as outside the lease area. Six monthly report is sent to MoEF, CPCB and quarterly report being sent to RSPCB, CGWA and CGWB. Last quart
12	The proponent shall ensure that no additional water is drawn for the expansion project. The additional requirement of water will be met out of the water saved by adopting water conservation measures.	No additional water will be drawn for the expansion project. The additional requirement of water will be met out of water conservation measures.
13	Regular monitoring of ground water quality around the tailing dam shall be carried out in consultation with Central Ground Water Authority and records maintained. It shall be ensured that the groundwater quality is not adversely affected due to the projec	Ground water is regularly monitored on monthly basis from piezometers and wells. We have requested CGWA for approval of existing monitoring locations / suggestion for new locations. It will be ensured that ground water quality is not adversly affected due
14	Groundwater and surface water in and around the mine shall be regularly monitored at strategic locations for heavy metals such as Ni, Co, Cu, Pb, Zn and Cd. The monitoring stations shall be established in consultation with the Regional Director, Central G	Ground and surface water is regularly monitored for heavy metals on monthly basis. CGWA and RSPCB are requested to approve / suggest for the locations.
15	Vehicular emissions should be kept under control and regularly	Periodic maintenance of vehicles is part of our operations. All the trucks are

ANNEXURE-IV

Sr. No.	Condition	Status/Action Taken
	monitored. Measures shall be taken for maintenance of vehicles used in mining operations and in transportation of mineral. The vehicles should be covered with a tarpaulin and shall not be over	covered with tarpaulin while transportation of concentrates to the smelters and not allowed overloading.
16	Blasting operatios should be carried out only during daytime. Controlled blasting should be practiced. The mitigative measures for control of ground vibrations and to arrest the fly rocks and boulders should be implemented.	Blasting operation is carried out at fixed time in daytime. All mitigation measures are taken to reduce the ground vibration.
17	Drills shall either be operated with dust extractors or equipped with water injection system.	All the drills are equiped with water injection system. One drill machine is operated with dust extractor.
18	The decanted water from the tailing dam shall be re-circulated within the mine and there shall be zero discharge from the beneficiation plant.	All the decanted water from tailing dam is reused in the Beneficiation plant. Zero discharge is being maintained.
19	Digital processing of the entire lease area using remote sensing technique should be done regularly once in three years for monitoring land use pattern and report submitted to Ministry of Environment and Forests and its Regional Office, Lucknow.	Land use / cover chane study is performed by SRSAC, Jodhpur using remote sensing technique in 2007. Report submitted to MoEF, Regional Office on 15.01.2008.
20	The tailing dam shall be lined by clay in the bottom and by LDPE lining on the sites. The ultimate height of the dam shall be maintained to 41 m and provided with garland drains. The disaster management plan for tailing dam shall be prepared and implement	Tailing dam is lined with impervious clay at the bottom. The sides of the tailing dam are lined with LDPE. Ultimate height of the Tailing Dam will be 41 m. Disaster management for tailing dam was prepared and is in place.
21	The recommendations of the study report of NEERI, Nagpur on pollution vulnerability of aquifer shall be effectively implemented and action taken report submitted to the Ministry and its Regional Office, Lucknow on six monthly basis.	Monthly monitoring of Groundwater quality through Peizometers and borewells. No impact on ground water quality
22	The project proponent shall regularly analyse the waste generated from the mining (at least once a year) for heavy metals such as Ni, Co, Cu, Pb, Zn and Cd and the data thus collected may be sent regularly to Ministry of Environment and Forests and its Re	Being analysed and report submitted on six monthly basis.
23	The recommendations of the study	Noted, recommendations will be

ANNEXURE-IV

Sr. No.	Condition	Status/Action Taken
	report on blood lead levels of children to monitor levels of lead in human system carried out by National Institute of Occupational Health, Ahmedabad shall be effectively implement and action taken report submitted to the	implemented in phase manner to monitor the impact.
24	The project proponent shall also study the base level of lead in mother's milk in villages near the mining area and also in soil along the tranportation route in the study area through National Institute of Occupational Health, Ahmedabad and submit report	Work order placed to National Institute of Occupational Health, Ahmedabad for the study work.
25	Consent to operate should be obtained from State Pollution Control Board before starting enhanced production from the mine.	Consent to Operate was issued by RSPCB on 05.03.2008.
26	A Final Mine Closure Plan along with details of Corpus Fund should be submitted to the ministry of Environment & Forests 5 years in advance of final mine closure for approval.	Noted

Sr. No.	Condition	Status/Action Taken
A.	**General Conditions**	
1	No change in mining technology and scope of working should be made without prior approval of the Ministry of Environment & Forests.	Noted
2	No change in the calendar plan including excavation, quantum of mineral and waste should be made.	Noted
3	Conservattion measures for protection of flora and fauna in the core & buffer zone shall be drawn up in consultation with the local forest and wildlife department.	Noted, letter written to DFO on 10.08.2007.
4	Periodic monitoring of ambient air quality should be carried out for RPM, SPM, SO2 and Nox. Location of the monitoring stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targe	Monitoring is being carried out on weekly basis at three locations within ML area and three outside ML area. Report is submitted to RSPCB, CPCB and MoEF regularly. Rajasthan State Pollution Control Board carried out the Ambient Air, Stack and Noise Monito
5	Measures should be taken for control of noise levels below 85 dBA in the work environment. Workers engaged	Complied

ANNEXURE-IV

Sr. No.	Condition	Status/Action Taken
	in operations of HEMM, etc. should be provided with ear plugs / muffs.	
6	Industrial waste water (workshop and waste water from the mine) should be properly collected, treated so as to conform to the standards prescribed under GSR 422 (E) dated 19th May, 1993 and 31st December, 1993 or as amended from time to time. Oil and grease	Complied
7	Personnel working in dusty areas should wear protective respiratory devices and they should be provided with adequate training and information on safety and health aspects. Occupational health surveillance program of the workers should be undertaken perio	Voccational training for Occupational Health, Safety and Environment is imparted to all the personnel working in the unit once in five years. Initial and periodical medical checkup (once in 5 years) is done for all the persons. It includes audiometry, spi
8	The project authorities should inform to the Regional Office located at Lucknow regarding date of financial closures and final approval of the project by the concerned authorities and the date of start of land development work.	Noted
9	The funds earmarked for environmental protection measures should be kept in separate account and should not be diverted for other purpose. Year wise expenditure should be reported to the Ministry and its Regional Office located at Lucknow.	Being complied regularly. Environmental expenditure is regularly reported to MoEF.
10	The Regional Office of this Ministry located at Lucknow shall monitor compliance of the stipulated conditions. The project authorities should extend full cooperation to the officer (s) of the Regional Office by furnishing the requisite data / information	Noted
11	The project proponent shall submit six monthly report on the status of the implementation of the stipulated environmental safeguards to the Ministry of Environment and Forests, its Regional Office, Lucknow, Central Pollution Control Board and State Pollut	Six monthly report is regularly submitted to MoEF, its regional office Lucknow and CPCB and quarterly report submitted to RSPCB.
12	A copy of clearance letter will be marked to concerned panchayat / local NGO, if any, from whom and	Copy sent to Panchayat, Agucha on 9th August 2007.

ANNEXURE-IV

Sr. No.	Condition	Status/Action Taken
	suggestion / representation, if any, was received while processing the proposal.	
13	State Pollution Control Board should display a copy of the clearance letter at the Regional office, District Industry Centre and Collector's office / Tehsildar's office for 30 days.	Copy sent to RSPCB Bhilwara & Jaipur on 08.08.2007.
14	The project authorities should advertise at least in two local newspapers widely circulated around the project, one of which shall be in the vernacular language of the locality concerned, within 7 days of the issue of clearance letter informing that the p	Published on 02.08.2007 in Dainik Navjyoti and Dainik Bhasker.

ANNEXURE-V
MINING PLAN APPROVAL FOR EXISTING MINE

ई–मेल: c_ibm_ajm@yahoo.co.in फैक्स: 145-2441244*28

पंजीकृत पार्सल एडी

भारत सरकार
खान मंत्रालय
भारतीय खान ब्यूरो
खान नियंत्रक (उत्तर) का कार्यालय
***

सं.: 584(6) (3) (249) /2005–अजम

आईबीएम कॉलोनी, आदर्श नगर,
अजमेर – 305002
दिनांक 27–2–2006

प्रेषिति : सर्वश्री हिन्दुस्तान जिंक लिमिटेड,
रामपुरा आगुचा खदान
पोस्ट– आंगुचा– 311029
जिला– भीलवाड़ा

विषय: खनिज संरक्षण एवं विकास नियमावली, 1988 के नियम 12 के अंतर्गत सर्वश्री हिन्दुस्तान जिंक लिमिटेड की जिला भीलवाड़ा (राजस्थान) में स्थित रामपुरा आगुचा लेड जिंक खान (क्षेत्रफल 1200 हे.) की खनन स्कीम का अनुमोदन।

संदर्भ : आपका पत्र दिनांक 27–11–2005, व 23–02–2006 एवं इस कार्यालय का पत्र दिनांक 14–02–2006

महोदय,

खनिज संरक्षण एवं विकास नियमावली, 1988 के नियम 12 के उप–नियम 4 के अंतर्गत प्रदत्त अधिकार का प्रयोग करते हुए मैं एतद्द्वारा उल्लेखित खनन स्कीम का अनुमोदन करता हूँ। यह अनुमोदन निम्नलिखित शर्तों के अधीन हुआ है –

1. इस खनन स्कीम का अनुमोदन केन्द्र सरकार अथवा अन्य किसी प्राधिकारी द्वारा खान पर समय–समय पर लागू किए गए कानूनों पर प्रतिकूल प्रभाव डाले बिना किया गया है।
2. यह भी स्पष्ट किया जाता है कि इस खनन स्कीम के अनुमोदन में खान एवं खनिज (विकास और विनियम) अधिनियम, 1957 या खनिज रियायत नियमावली, 1960 या और किसी अन्य कानून जिनमें वन (संरक्षण) अधिनियम, 1980, पर्यावरण संरक्षण अधिनियम, 1986 सहित अन्य किन्हीं कानूनों के किसी अन्य प्रावधान की शर्तों के अनुसार किसी भी प्रकार से सरकार का अनुमोदन समाविष्ट नहीं हुआ है।
3. इस खनन स्कीम का अनुमोदन किसी भी न्यायालय के सक्षम क्षेत्राधिकार के किसी आदेश या निर्देश पर प्रतिकूल प्रभाव डाले बिना किया गया है।
4. Provisions of the Mines Act, 1952 and Rule and Regulations made thereunder including submission of notice of opening, appointment of manager and other statutory officials as required by the Mines Act, 1952 shall be complied with.
5. The execution of mining plan/scheme of mining shall be subjected to vacation of prohibitory orders/notices, if any.
6. If any thing is found to be concealed as required by the Mines Act in the contents of the mining plan/scheme of mining and the proposal for rectification has not been made, the approval shall be deemed to have been withdrawn with immediate effect.
7. The lessee shall submit the financial assurance in favour of Regional Controller of Mines, IBM, Ajmer, before the expiry of existing financial assurance on 20.12.2006.

संलग्न : अनुमोदित खनन स्कीम ।

भवदीय

(वी के अरोड़ा)
खान नियंत्रक

कृ.प.उ.

ANNEXURE-V
MINING PLAN APPROVAL FOR EXISTING MINE

ई–मेल: c_ibm_ajm@yahoo.co.in फैक्स: 145-2441244*28

पंजीकृत पार्सल एडी

भारत सरकार
खान मंत्रालय
भारतीय खान ब्यूरो
खान नियंत्रक (उत्तर) का कार्यालय
***

सं.: 584(6) (3) (249) /2005–अजम

आईबीएम कॉलोनी, आदर्श नगर,
अजमेर – 305002
दिनांक 27–2–2006

प्रेषिति : सर्वश्री हिन्दुस्तान जिंक लिमिटेड,

फैक्स: 145-2441244*28
ई–मेल: c_ibm_ajm@yahoo.co.in

प्रतिलिपि : –

1. मुख्य खान नियंत्रक, भारतीय खान ब्यूरो, नागपुर।
2. क्षेत्रीय खान नियंत्रक, भारतीय खान ब्यूरो, अजमेर को अनुमोदित खनन स्कीम की प्रति सहित। फाइनल प्रस्तुति–23.2.2006.
3. निदेशक, खान व भूविज्ञान विभाग, राजस्थान सरकार, शास्त्री सर्कल, उदयपुर को अनुमोदित खनन स्कीम की प्रति पंजीकृत पार्सल द्वारा।
4. निदेशक, खान सुरक्षा महानिदेशालय, तिरूपति भवन, 60, बाहुबलि कालोनी,बोहरा गणेश मार्ग, उदयपुर–313001 को अनुमोदित खनन स्कीम की प्रति पंजीकृत पार्सल द्वारा ।

संलग्न : यथोपरि।

खान नियंत्रक

ANNEXURE-VI
CENTRAL GROUND WATER ALLOCATION LETTER

जल वर्ष 2007 Water Year 2007

स्वच्छ सुरक्षित जल - सुन्दर खुशहाल कल

CONSERVE WATER - SAVE LIFE

भारत सरकार
केन्द्रीय भूमि जल प्राधिकरण
जल संसाधन मंत्रालय

Government of India
Central Ground Water Authority
Ministry of Water Resources

CGWA/IND/Proj/2005-116 -R

No.21-4(2)/WR/CGWA/05 – 417 Dated : 13 MAY 2008

To

M/s Hindustan Zinc Ltd.
Rampura Agucha Mine
P.O. Agucha, District Bhilwara-311029
(Rajasthan)

Sub:- Renewal of NOC for ground water withdrawal in respect of existing mining project of M/s Hindustan Zinc Ltd. at Rampura Agucha Mine, Kotri, Block District Bhilwara (Rajasthan) – reg

Sir,

Kindly refer to your letter no. HZL/RAM/ENV/EXP/2007/3934 dated 09-08-07 on the above cited subject. The renewal of NOC of Central Ground Water Authority is hereby accorded to M/s Hindustan Zinc Ltd. for abstraction of ground water in respect of its existing mining project at Rampura Agucha Mine, Kotri, Block District Bhilwara (Rajasthan). The renewal is, however subject to the following conditions :-

1. The industry may continue to abstract 11,700 m^3/day of ground water through existing radial well/tubewells. No additional ground water abstraction structures to be constructed for this purpose without prior approval of the CGWA.
2. Monitoring of the ground water extraction through tubewells to be continued through the water meter by the industry at its own cost on regular basis, at least once in a month. The ground water quality to be monitored twice in a year during pre monsoon and post monsoon periods.
3. The industry shall, in consultation with the Regional Director, Central Ground Water Board, Western Region, Jaipur implement ground water recharge measures to the tune of 4.27 MCM/year for augmenting the ground water resources of the area. The completion of the artificial recharge structures may be done within one year period from the date of issuance of this letter.
4. The photographs of the recharge structures after completion of the same are to be furnished immediately to the Regional Director, Central Ground Water Board, Western Region, Jaipur for verification and under intimation to this office.
5. The industry shall continue to execute ground water regime monitoring programme in and around the project area through piezometers on

A2 W3 Curzon Road Barracks, Kasturba Gandhi Marg, New Delhi-110001
Phone No. (011) 23387582, 23385620, Fax No. 23388310 E-mail : cgwa@vsnl.com

ANNEXURE-VI
CENTRAL GROUND WATER ALLOCATION LETTER

regular basis in consultation with the Central Ground Water Board, Western Region, Jaipur.

6. The ground water monitoring data in respect of S.No. 2 & 5 to be submitted to Central Ground Water Board, Western Region, Jaipur on regular basis at least once in a year.
7. The industry shall ensure proper recycling and reuse of waste water after adequate treatment.
8. Action taken report in respect of S.No. 1 to 7 may be submitted to CGWA within one year period.
9. The renewal is liable to be cancelled in case of non-compliance of any of the conditions as mentioned in S.No. 1 to 8.
10. This renewal is valid for two years from date of issuance of this letter. Upon review of status of compliance of the above conditions after two years, decision for revalidation of approval will be conveyed accordingly.

Yours sincerely

Member Secretary

Copy to :

1. The Regional Director, CGWB, Western Region, Jaipur for information and necessary action. This has reference to your letter no. TS/21B(73)/CGWA/WR/2006-169 dated 19-2-07.
2. The Rajasthan Pollution Control Board, 4, Institutional Area, Jhalana Doongri, Jaipur.

Member Secretary

ANNEXURE-VI
CENTRAL GROUND WATER ALLOCATION LETTER

जल वर्ष 2007 Water Year 2007

स्वच्छ सुरक्षित जल - सुन्दर खुशहाल कल

CONSERVE WATER - SAVE LIFE

भारत सरकार
केन्द्रीय भूमि जल प्राधिकरण
जल संसाधन मंत्रालय

Government of India
Central Ground Water Authority
Ministry of Water Resources

CGWA/IND/Proj/2008-400

No.21-4 (2)/WR/CGWA/2008- 672 Dated:- 26 AUG 2008

To

M/s Hindustan Zinc Ltd
Rampura Agucha Mine
P.O. Agucha- 311029
District Bhilwara, Rajasthan

Sub: - NOC for ground water withdrawal from mine pit in respect of M/s Hindustan Zinc Ltd., Rampura Agucha Mine at Vilage Agucha, Tehsil Hurda, Bhilwara, Rajasthan-reg.

Sir,

Kindly refer to your letter No. HZL/RAM/ENV/EXP/2008/10191 dated 5.3.2008 on the above-cited subject. This office has No Objection for the proposed ground water intersection and withdrawal of **250 m^3/day** of ground water from the mine pit by **M/s Hindustan Zinc Ltd., Rampura Agucha Mine at Village Agucha, Tehsil Hurda, Bhilwara, Rajasthan. The NOC is however** subject to the following conditions:-

1. The firm may abstract **250 m^3/day** of ground water from the mine pit. No new/additional ground water abstraction structures to be constructed for this purpose without prior approval of the CGWA.
2. The pump to be fitted with water meter by the industry at its own cost and monitoring of the ground water regime to be undertaken accordingly on regular basis, at least once in a month. The ground water quality to be monitored twice in a year during pre-monsoon and post-monsoon periods.
3. **M/s Hindustan Zinc Limited,** shall in consultation with the Regional Director, Central Ground Water Board, Western Region, Jaipur implement ground water recharge measures for augmenting the ground water resources of the area. The completion of the artificial recharge structures may be done within six months period from the date of issuance of this letter.
4. The photographs of the recharge structures after completion of the same are to be furnished immediately to the Regional Director, Central Ground Water Board, Western Region, Jaipur for verification and under intimation to this office.
5. The firm at its own cost shall install piezometers at suitable locations and execute ground water regime monitoring programme in and

ANNEXURE-VI
CENTRAL GROUND WATER ALLOCATION LETTER

around the project area on regular basis to keep a close watch on water level trends for taking suitable measures to keep water level under controlled conditions, in consultation with the Central Ground Water Board, Western Region, Jaipur.

6. The ground water monitoring data in respect of S. No. 2 & 5 to be submitted to Central Ground Water Board, Western Region, Jaipur on regular basis at least once in a year.
7. The firm shall ensure proper recycling and reuse of water extracted from mine pit.
8. Action taken report in respect of S. No. 1 to 7 may be submitted to CGWA within one-year period.
9. The permission is liable to be cancelled in case of non-compliance of any of the conditions as mentioned in S. No. 1 to 8.
10. This approval is valid for two years from date of issuance of this letter. Upon review of status of compliance of the above conditions after two years, decision for revalidation of approval will be conveyed accordingly.

Yours faithfully

Member Secretary

Copy for information to:

1. The Group Incharge (Mine), Rajasthan State Pollution Control Board, 4 Instututional Area, Jhalana Doongri, Jaipur, Rajasthan. this has reference to your letter no. F.12(8-109)RPCB/Gr.Mines/696 dated 15-01-2007.
2. The Regional Director, CGWB, Western Region, Jaipur.
3. The TS to Chairman, CGWB, NH-IV, Faridabad.

Member Secretary

ANNEXURE-VII
LETTER REGARDING ARAVALLI NOTIFICATION

राजस्थान सरकार

कार्यालय खनि अभियन्ता, भीलवाड़ा (राज.)

क्रमांकः खअ/भील/खप 8/99/3772 दिनांकः1607.2007

प्रमाण–पत्र

यह प्रमाणित किया जाता है कि सर्वश्री हिन्दुस्तान जिंक लिमिटेड के पक्ष में स्वीकृत प्रथम नवीनीकरण खनन पट्टा वास्ते खनिज लेड, जिंक एवं एसोसिएटेड मिनरल निकट ग्राम रामपुरा, आगुचा तहसील हुरडा जिला भीलवाड़ा का क्षैत्रफल 1200.00 हैक्टर जिसकी अवधि दिनांक 13.03.2000 से 12.03.2020 तक हैं। यह क्षैत्र अरावली हिल्स में नहीं आता हैं। उक्त प्रमाण पत्र प्रतिष्ठान द्वारा चाहे जाने पर जारी किया गया हैं।

16/07/07

खनि अभियन्ता
भीलवाड़ा (राज.)

ANNEXURE-VIII
APPLICABLE STANDARDS

1.0 Ambient Air Quality Standards

National Ambient Air Quality Standards for ambient air has been prescribed by Central Pollution Control Board vide Gazette Notification dated 11th April, 1994. The prescribed Indian standards are given below in **Table-1**.

TABLE-1
NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Time Weighted Average	Concentration in Ambient Air ($\mu g/m^3$)		
		Industrial Area	Residential, Rural & Other Areas	Sensitive Areas
Sulphur dioxide (SO_2) ($\mu g/m^3$)	Annual Average*	80	60	15
	24 Hours**	120	80	30
Oxides of Nitrogen (NOx) ($\mu g/m^3$)	Annual Average*	80	60	15
	24 Hours**	120	80	30
Suspended Particulate Matter (SPM) ($\mu g/m^3$)	Annual Average*	360	140	70
	24 Hours**	500	200	100
Respirable Particulate Matter (Size less than 10 microns) ($\mu g/m^3$)	Annual Average*	120	60	50
	24 Hours**	150	100	75
Lead (Pb) ($\mu g/m^3$)	Annual Average*	1.0	0.75	0.50
	24 Hours**	1.5	1.0	0.75
Carbon monoxide (CO) ($\mu g/m^3$)	8 Hours	5000	2000	1000
	1 Hour**	10000	4000	2000

Note:
* *Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.*
** *24 hourly/8 hourly values should be met 98% of the time in a year. However 2% of the time, it may exceed but not on two consecutive days.*

2.0 Ambient Noise Standards

Ambient standards with respect to noise have been notified by the Ministry of Environment and Forests vide gazette notification dated 26th December 1989 (Amended on February, 2000). It is based on the A weighted equivalent noise level (L_{eq}). The standards are presented in **Table-2.**

TABLE-2
AMBIENT NOISE STANDARDS

Area Code	Category of Area	Noise Levels dB(A) eq	
		Day time*	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone**	50	40

Note :
* *Day time is from 6 am to 9 pm.*
** *Silence zone is defined as area up to 100 meters around premises of hospitals, educational institutions and courts. Use of vehicle horns, loud speakers and bursting of crackers are banned in these zones.*

ANNEXURE-VIII
APPLICABLE STANDARDS

3.0 Noise Standards for Occupational Exposure

Noise standards in the work environment are specified by Occupational Safety and Health Administration (OSHA-USA) which are being enforced by Government of India through model rules framed under Factories Act. These are given in **Table-3** below.

TABLE-3
STANDARDS FOR OCCUPATIONAL EXPOSURE

Total Time of Exposure per Day in Hours (Continuous or Short term Exposure)	Sound Pressure Level in dB(A)
8	90
6	92
4	95
3	97
2	100
3/2	102
1	105
¾	107
½	110
¼	115
Never	>115

Note:
1. No exposure in excess of 115 dB(A) is to be permitted.
2. For any period of exposure falling in between any figure and the next higher or lower figure as indicated in column (1), the permissible level is to be determined by extrapolation on a proportionate scale.

4.0 Wastewater Discharge Standards

The wastewater discharge standards for "discharge on land for irrigation" are stipulated under the Environment Protection Rules (1993) and are given below in **Table-4.**

TABLE-4
WASTE WATER DISCHARGE STANDARDS

Sr. No.	List of Parameters	Units	Standard (On land Irrigation)
1	Color and Odor	--	All efforts should be made to remove color and unpleasant odor as far as practicable.
2	Suspended Solids	Mg/l	200
3	Particle size of Suspended Solids	--	Shall pass 850 micron IS sieve.
4	pH value	--	5.5 to 9.0
5	Temperature	^{o}C	Not specified.
6	Oil and grease, Max.	mg/l	10.0
7	Total residual chlorine, Max.	mg/l	Not specified
8	Ammonical nitrogen (as N), Max.	mg/l	Not specified
9	Total Kjeldhal nitrogen (as N),Max	mg/l	Not specified
10	Free ammonia (as NH_3), Max.	mg/l	Not specified
11	Biochemical oxygen demand (3 days at 27°C), Max.	mg/l	100.0
12	Chemical oxygen demand, Max.	mg/l	Not specified
13	Arsenic (as As), Max.	mg/l	0.2
14	Mercury (as Hg), Max.	mg/l	Not specified
15	Lead (as Pb), Max.	mg/l	Not specified
16	Cadmium (as Cd), Max.	mg/l	Not specified
17	Hexavalent chromium (as Cr^{+6}), Max.	mg/l	Not specified
18	Total chromium (as Cr), Max.	mg/l	Not specified
19	Copper (as Cu), Max.	mg/l	Not specified
20	Zinc (as Zn), Max.	mg/l	Not specified
21	Selenium (as Se), Max.	mg/l	Not specified

ANNEXURE-VIII
APPLICABLE STANDARDS

Sr. No.	List of Parameters	Units	Standard (On land Irrigation)
22	Nickel (as Ni), Max.	mg/l	Not specified
23	Cyanide (as CN), Max.	mg/l	0.2
24	Fluorides as F	mg/l	Not specified
25	Dissolved phosphates (as P),Max	mg/l	Not Specified
26	Sulphides as (S), Max.	mg/l	Not specified
27	Phenolic compounds (as C_2H_5OH), Max.	mg/l	Not specified
28	Radioactive Materials		
a]	Alpha Emitters, Max.	mC/ml	10^{-7}
b]	Beta Emitters, Max.	mC/ml	10^{-7}
29	Bio-assay test	--	90% survival of fish after 96 hours in 100% effluent.
30	Manganese (as Mn)	mg/l	Not specified
31	Iron (as Fe)	mg/l	Not specified
32	Vanadium (as V)	mg/l	Not specified
33	Nitrate nitrogen	mg/l	Not specified

Note: These standards shall be applicable for industries, operations or processes other than those industries, operations or process for which standards have been specified in Schedule of the Environment Protection Rules, 1989.

ANNEXURE-IX
DETAILS OF BLASTING & VIBRATIONS

1.0 Blast Induced Ground Vibration and Control Measures

Blasting represents one of the most relevant unit operations in open cast mine to obtain an adequate final fragment size distribution such that the combined drilling, blasting, excavation, transportation and crushing/grinding operations are optimized without causing any adverse effect on surrounding structures and buildings.

The strong influence of drilling and blasting in the excavation chain and as a parameter of importance in maintaining harmony with the surrounding environment has called for evaluation and optimization of this unit operation at every stage of design so that the environmental norms are adhered to at all levels of operations.

The use of vibration monitoring techniques is of paramount importance as it offers a number of benefits in terms of its ability to examine any blasting process in detail. In effect, the measurement of peak particle velocity levels that result from the detonation of an explosive charge offers a means by which it is possible to measure the relative efficiency of the blast and gives a definitive indication of general performance of any given blast design and its implementation technique.

The monitoring of blast vibrations during blasting, can be used as a diagnostic tool, to determine the level of interaction between the design and operational variables of the blast event. This makes it possible to evaluate the blast and vibration levels in terms of peak particle velocity, acceleration, and displacement.

Another important use of the vibration data is in the compilation of a database, relating vibration levels to Maximum Charge per delay, distance of firing, for any given rock type and predicting the effects of blasting.

Knowledge of the blast induced vibration levels, combined with the geomechanical competence of a rock mass makes it possible to estimate the probability of producing blast induced structural deformations as vibration is considered to be a dynamic stress provoking strain in the rock mass.

Vibration monitoring technique is applied for good blast design and optimization, with an aim to control blast induced ground vibrations and structural deformations. It has been assessed in the context of achieving substantial techno-economic improvements in development of good blasting results, with an aim to increase the output whilst minimising the unit cost of operation working within the preview of adhering to all statutory norms laid under for a good and healthy environment.

1.1 Blasting

Blasting causes ground vibrations that travel through the ground in the form of energy waves away from the blast or point of initiation of the charge.

These waves have energy and are called ground vibrations as they have displacement and acceleration.

ANNEXURE-IX
DETAILS OF BLASTING & VIBRATIONS

The velocity of propagation of the ground vibration depends on the medium of traverse i.e. the strata, the rock properties, strength characteristics and structural discontinuities in the rock mass.

The amount of vibration can be measured in mm (terms of displacement) of movement per second and is directly related to the maximum charge per delay and the distance from the blast i.e. point of initiation of the charge. The maximum blast vibration levels permitted at Rampura-Agucha Mine has been done, by the blast vibration and blast optimization study done by NIRM, a premier Rock-Mechanic Research Institution under the Ministry of Mines, and the actual PPV measured for every blast is much lower than the specified limits by NIRM and all other known international standards for blast vibrations.

To control ground vibrations produced, blast is monitored at specific locations wherein there is a probability of causing structural deformations. Fixed Monitoring Station have been located at sites, like Agucha village, Bherukhera village and Tailing Dam.

Instantel make Blastmate Series II is used for measurement of ground vibration. Information from blast is recorded and becomes a reference for future blasts. Actual Vibration levels observed from the readings of Blastmate taken at these specific locations are well below the levels specified to cause either superficial damage, such as cracking of plaster or structural damage to any of the building elements.

The maximum blast vibration levels established by NIRM was by taking into consideration the villages, structures nearby and for ensuring no deterioration or deformation to any of the structures do occur as a result of vibrations induced from blasting.

1.2 Blast Vibration Control Measures

Blast vibration control measures at Rampura-Agucha Mines have been initiated right from the Mine planning stage itself. Drill and blast design parameter are under continuous review at every stage of design by competent persons to ensure optimum blast with safe vibration and Air Over Pressure (AOP) limits.

Every design parameter is critically analysed for its contribution for optimization of blast, and reduction of ground vibrations. Rampura-Agucha Mine uses various techniques to limit blast vibration.

1.3 Mine Planning

Measures have been implemented to reduce potential impacts due to blasting. Uppermost part of the Mine extending in softer weathered rock is being excavated by excavators without blasting.

Vibration levels have reduced as the pit has deepened by 90 m (390 mRL to 300 mRL) from surface and is bound to decrease more in future as Mine workings would be extended down with increase in depth of mining, the areas being blasted will progressively be further away from residences and structures of the surrounding villages, so the effects of vibration will decrease as mining proceeds.

ANNEXURE-IX
DETAILS OF BLASTING & VIBRATIONS

1.4 Drill Design parameters to reduce blast vibration

Drilling plays a very important role in ground vibrations. All design variables of drilling like, burden, spacing, holedepth, degree of sub-grade drilling, toe, verticality of benches, free face for muck movement etc is highly controlled and monitored.

Drilling of the holes for blasting is done after preparation on a drill plan. Blasting operations are done under the personal supervision of qualified engineer holding the required certificate of competency under mines regulation.

The charge is planned depending upon the lithology and other parameters so as to get the desired fragmentation. The maximum charge at any point of blast is planned keeping the provision given Director General Mines Safety requirement keeping the PPV below DGMS level

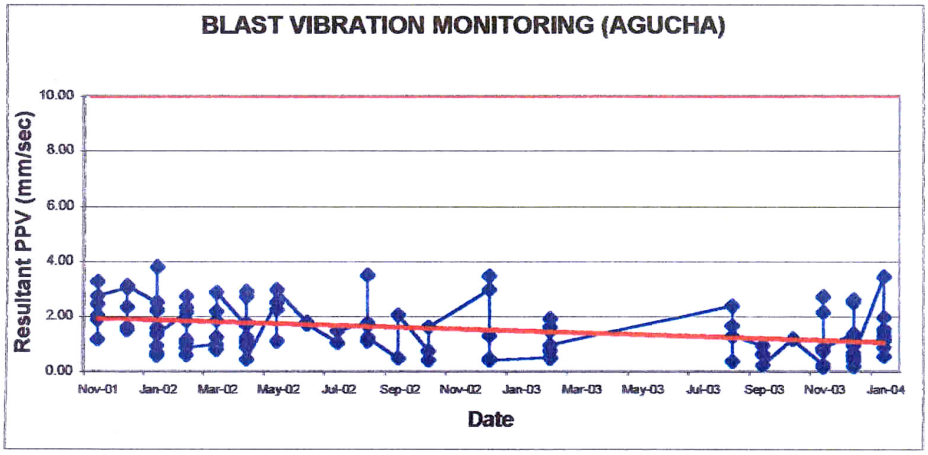
Blast is monitored from fixed locations for PPV and AOP by Instantel made Blastmate Series-II. The readings of PPV and AOP obtained are further analyzed by the blast results obtained on the field based on drill and blast design parameter, which is taken in consideration while planning the drill blast plan.

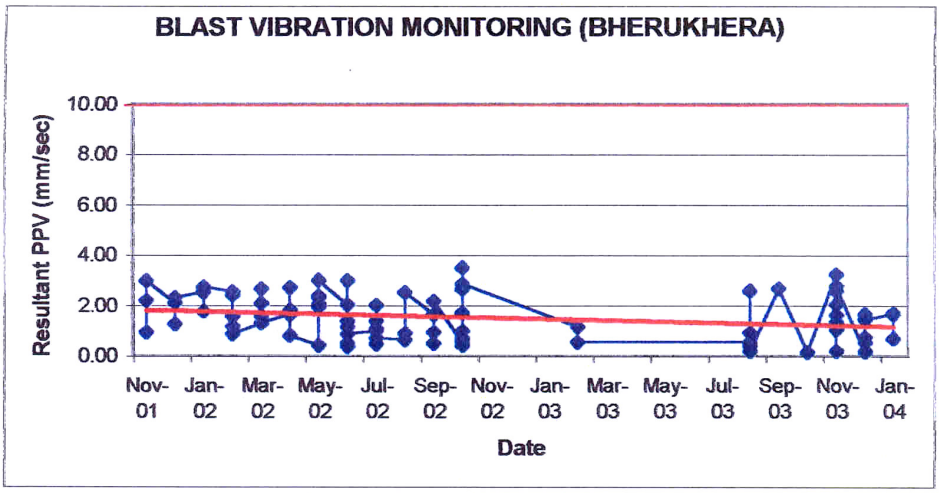
Thus at Rampura-Agucha Mine every unit operation in Drilling and Blasting is thoroughly planned, designed and executed to have optimum results and to ensure the vibration and AOP limits are well below the recommended limits as per statute and the environmental norms applicable.

.

The blast vibration results monitored at Agucha village, Bherukhera village and neat tailing dam are shown in **Figure-1.**

ANNEXURE-IX
DETAILS OF BLASTING & VIBRATIONS





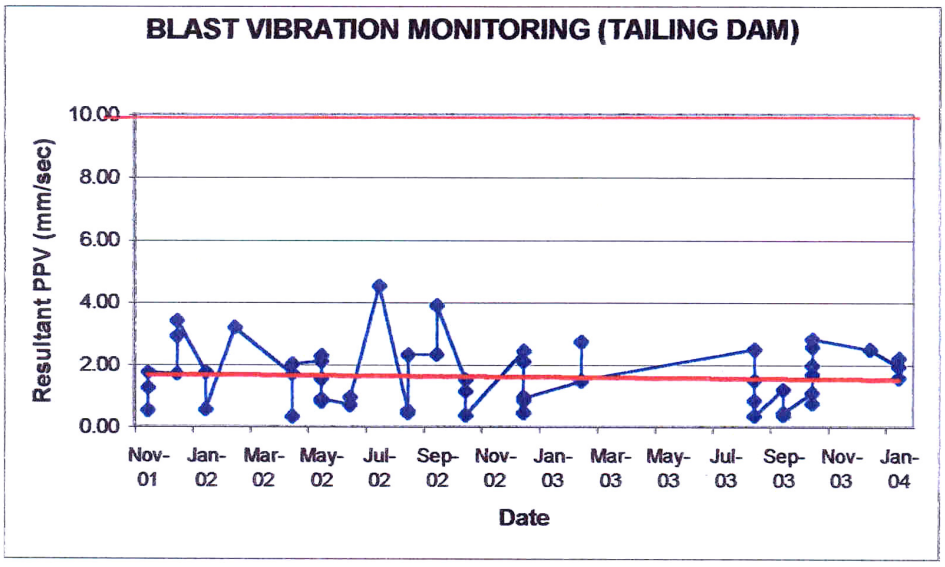


FIGURE-1
BLAST VIBRATION RESULTS

ANNEXURE-X
AMBIENT AIR QUALITY LEVELS

AAQ-1: HZL Mine Area										
	TSPM	RPM	SO_2	NOx	Lead	Zinc	Cadmium	CO		
								I	II	III
01.12.2008	187.9	76.1	12.2	15.5	0.34	0.43	BDL	147	137	119
03.12.2008	210.9	86.4	17.7	22.5	0.27	0.30	BDL	213	169	143
08.12.2008	198.5	78.2	16.7	21.3	0.30	0.34	BDL	201	159	135
10.12.2008	225.3	91.6	11.8	15.1	0.32	0.35	BDL	233	165	116
15.12.2008	220.1	87.4	17.1	23.6	0.34	0.43	BDL	226	179	151
17.12.2008	200.6	81.3	13.4	17.0	0.18	0.27	BDL	161	128	108
22.12.2008	213.4	86.7	15.5	19.7	0.26	0.30	BDL	186	148	125
24.12.2008	217.0	87.4	12.1	15.4	0.30	0.42	BDL	251	126	107
29.12.2008	183.8	74.2	11.7	16.0	0.22	0.27	BDL	230	171	112
31.12.2008	181.2	71.2	16.4	20.8	0.29	0.40	BDL	197	156	132
05.01.2009	186.7	75.4	14.6	18.6	0.30	0.40	BDL	176	139	118
07.01.2009	190.3	77.3	12.8	16.2	0.18	0.26	BDL	153	121	107
12.01.2009	203.7	80.5	15.9	20.2	0.34	0.46	BDL	191	151	128
14.01.2009	196.5	79.8	17.0	21.7	0.29	0.35	BDL	205	163	137
19.01.2009	183.2	72.3	12.8	16.3	0.30	0.38	BDL	154	122	114
21.01.2009	213.8	86.3	18.3	23.4	0.24	0.30	BDL	221	175	148
26.01.2009	197.2	77.9	13.7	17.4	0.18	0.26	BDL	165	131	110
28.01.2009	232.1	93.6	12.0	15.3	0.34	0.40	BDL	145	133	106
02.02.2009	202.1	79.7	17.2	22.8	0.29	0.35	BDL	207	164	139
04.02.2009	193.5	78.8	13.1	14.1	0.24	0.29	BDL	158	125	117
09.02.2009	182.3	71.9	15.2	19.4	0.32	0.38	BDL	183	134	123
11.02.2009	193.1	78.2	16.3	20.8	0.27	0.40	BDL	197	156	132
16.02.2009	227.5	89.9	18.1	23.5	0.24	0.29	BDL	218	173	146
18.02.2009	185.3	75.1	11.7	14.9	0.30	0.41	BDL	141	121	113
23.02.2009	198.7	78.4	13.2	16.8	0.29	0.38	BDL	158	126	106
25.02.2009	224.8	88.6	18.3	23.3	0.18	0.26	BDL	220	174	147
Maximum	**232.1**	**93.6**	**18.3**	**23.6**	**0.34**	**0.46**	**BDL**	**251**		
Minimum	**181.2**	**71.2**	**11.7**	**14.1**	**0.18**	**0.26**	**BDL**	**106**		
Average	**201.9**	**80.9**	**14.8**	**18.9**	**0.27**	**0.35**	**BDL**	**154**		
98th %le	**229.8**	**92.6**	**18.3**	**23.5**	**0.34**	**0.45**	**BDL**	**231**		
All units are in $\mu g/m^3$										

AAQ-2: Agucha Village										
Date	TSPM	RPM	SO_2	NOx	Lead	Zinc	Cadmium	CO		
								I	II	III
01.12.2008	154.2	56.5	10.7	13.3	BDL	BDL	BDL	199	128	115
03.12.2008	147.4	53.4	11.6	12.7	BDL	BDL	BDL	203	143	97
08.12.2008	133.1	47.3	12.6	11.4	BDL	BDL	BDL	172	128	106
10.12.2008	125.6	45.4	13.5	11.0	BDL	BDL	BDL	169	144	130
15.12.2008	122.4	44.1	14.2	15.1	BDL	BDL	BDL	198	145	116
17.12.2008	135.7	48.2	12.5	12.0	BDL	BDL	BDL	178	156	101
22.12.2008	141.6	51.3	11.4	13.0	BDL	BDL	BDL	190	142	127
24.12.2008	151.3	54.5	11.9	11.1	BDL	BDL	BDL	184	150	136
29.12.2008	165.8	61.4	9.4	11.7	BDL	BDL	BDL	180	123	102
31.12.2008	160.9	58.5	11.1	14.4	BDL	BDL	BDL	200	151	146
05.01.2009	151.4	55.8	11.9	13.0	BDL	BDL	BDL	184	143	109
07.01.2009	162.3	59.1	12.8	14.8	BDL	BDL	BDL	217	157	96
12.01.2009	168.8	62.7	13.6	14.4	BDL	BDL	BDL	189	142	102
14.01.2009	163.1	60.4	14.3	13.1	BDL	BDL	BDL	179	151	107
19.01.2009	162.8	59.2	13.2	10.9	BDL	BDL	BDL	214	125	121
21.01.2009	156.6	56.9	12.2	14.2	BDL	BDL	BDL	180	135	113
26.01.2009	143.3	52.1	11.7	12.1	BDL	BDL	BDL	213	167	144
28.01.2009	138.1	50.1	10.6	11.9	BDL	BDL	BDL	171	157	93
02.02.2009	145.3	52.7	9.7	13.3	BDL	BDL	BDL	191	152	105
04.02.2009	156.2	57.4	10.1	12.5	BDL	BDL	BDL	210	151	129
09.02.2009	155.4	56.7	11.8	10.9	BDL	BDL	BDL	166	101	97
11.02.2009	149.9	53.5	12.9	12.2	BDL	BDL	BDL	197	146	107
16.02.2009	157.1	57.8	13.4	10.8	BDL	BDL	BDL	186	138	116
18.02.2009	163.6	60.7	14.1	14.0	BDL	BDL	BDL	213	124	94
23.02.2009	170.5	64.3	12.7	12.9	BDL	BDL	BDL	206	155	117
25.02.2009	175.1	67.4	10.3	15.2	BDL	BDL	BDL	187	110	107
Maximum	**175.1**	**67.4**	**14.3**	**15.2**	**BDL**	**BDL**	**BDL**	**217**		
Minimum	**122.4**	**44.1**	**9.4**	**10.8**	**BDL**	**BDL**	**BDL**	**93**		
Average	**152.2**	**55.7**	**12.1**	**12.8**	**BDL**	**BDL**	**BDL**	**148**		
98th %le	**172.8**	**65.9**	**14.3**	**15.2**	**BDL**	**BDL**	**BDL**	**213**		
All units are in $\mu g/m^3$										

ANNEXURE-X
AMBIENT AIR QUALITY LEVELS

AAQ-3:Kothiyan Village										
Date	**TSPM**	**RPM**	**SO_2**	**NOx**	**Lead**	**Zinc**	**Cadmium**	**CO**		
								I	**II**	**III**
01.12.2008	151.6	53.6	10.5	13.0	0.19	0.23	BDL	135	118	107
03.12.2008	146.3	50.2	12.4	15.4	0.20	0.22	BDL	145	127	115
08.12.2008	143.6	48.6	11.7	14.5	0.14	0.20	BDL	162	122	100
10.12.2008	159.2	56.7	12.3	16.4	0.18	0.22	BDL	156	136	124
15.12.2008	146.8	51.3	13.1	16.0	0.19	0.20	BDL	117	102	92
17.12.2008	157.7	55.9	11.8	14.6	0.13	0.20	BDL	138	110	99
22.12.2008	165.5	59.7	12.6	15.6	0.22	0.22	BDL	146	128	116
24.12.2008	173.8	63.8	12.8	15.8	0.15	0.25	BDL	163	98	88
29.12.2008	181.5	65.3	10.8	10.7	0.17	0.28	BDL	130	113	103
31.12.2008	163.9	57.6	10.7	13.2	0.18	0.24	BDL	139	123	110
05.01.2009	157.6	55.6	12.0	14.8	0.22	0.2	BDL	154	135	122
07.01.2009	136.5	45.7	11.2	13.9	0.14	0.14	BDL	100	87	111
12.01.2009	141.8	47.6	12.0	14.8	0.15	0.22	BDL	112	98	91
14.01.2009	129.8	43.5	11.6	14.3	0.21	0.20	BDL	156	136	123
19.01.2009	142.5	48.9	11.4	14.1	0.14	0.22	BDL	175	109	96
21.01.2009	157.4	55.7	12.6	15.6	0.20	0.22	BDL	151	132	119
26.01.2009	148.2	50.8	11.6	14.4	0.20	0.22	BDL	142	124	113
28.01.2009	159.7	56.8	13.0	16.9	0.13	0.20	BDL	109	98	89
02.02.2009	169.3	60.2	11.9	14.7	0.15	0.2	BDL	165	139	127
04.02.2009	179.6	65.4	11.4	14.1	0.18	0.22	BDL	114	99	90
09.02.2009	180.6	66.8	10.3	12.7	0.19	0.28	BDL	132	115	104
11.02.2009	171.6	61.3	11.4	14.1	0.15	0.28	BDL	160	133	94
16.02.2009	156.9	53.7	13.4	16.6	0.13	0.20	BDL	143	118	115
18.02.2009	144.8	49.6	10.8	13.4	0.20	0.22	BDL	140	122	101
23.02.2009	151.5	52.3	11.7	14.5	0.18	0.22	BDL	124	109	98
25.02.2009	142.1	47.6	13.2	16.4	0.14	0.26	BDL	108	94	86
Maximum	**181.5**	**66.8**	**13.4**	**16.9**	**0.22**	**0.28**	**BDL**	**175**		
Minimum	**129.8**	**43.5**	**10.3**	**10.7**	**0.13**	**0.14**	**BDL**	**86**		
Average	**156.1**	**54.8**	**11.9**	**14.6**	**0.17**	**0.22**	**BDL**	**120**		
98th %le	**181.1**	**66.1**	**13.3**	**16.8**	**0.22**	**0.28**	**BDL**	**164**		
All units are in $\mu g/m^3$										
AAQ-4: Barantiya										
Date	**TSPM**	**RPM**	**SO_2**	**NOx**	**Lead**	**Zinc**	**Cadmium**	**CO**		
								I	**II**	**III**
01.12.2008	119.7	46.7	7.5	12.9	BDL	BDL	BDL	142	127	113
03.12.2008	126.9	51.5	9.0	12.1	BDL	BDL	BDL	158	141	125
08.12.2008	113.4	44.2	9.9	10.1	BDL	BDL	BDL	102	91	81
10.12.2008	129.4	52.5	9.5	12.5	BDL	BDL	BDL	115	102	91
15.12.2008	137.3	55.5	7.7	10.8	BDL	BDL	BDL	161	142	127
17.12.2008	142.7	57.7	10.7	13.6	BDL	BDL	BDL	106	95	85
22.12.2008	139.8	56.5	9.6	12.4	BDL	BDL	BDL	154	138	123
24.12.2008	129.4	52.5	10.4	14.8	BDL	BDL	BDL	146	130	116
29.12.2008	115.8	45.2	11.4	12.9	BDL	BDL	BDL	103	92	80
31.12.2008	128.4	52.1	10.3	12.3	BDL	BDL	BDL	164	146	130
05.01.2009	117.8	45.9	9.5	11.1	BDL	BDL	BDL	117	104	93
07.01.2009	125.4	50.9	8.3	12.3	BDL	BDL	BDL	135	120	107
12.01.2009	136.6	55.3	9.9	14.6	BDL	BDL	BDL	126	97	84
14.01.2009	141.6	57.2	10.5	10.7	BDL	BDL	BDL	113	95	81
19.01.2009	130.4	52.9	11.3	12.8	BDL	BDL	BDL	143	127	113
21.01.2009	125.1	50.8	10.9	14.3	BDL	BDL	BDL	127	113	101
26.01.2009	109.8	40.8	8.6	11.3	BDL	BDL	BDL	111	99	88
28.01.2009	117.4	45.8	10.2	13.4	BDL	BDL	BDL	139	123	110
02.02.2009	110.5	43.1	8.2	10.2	BDL	BDL	BDL	149	132	118
04.02.2009	125.4	50.9	10.9	14.3	BDL	BDL	BDL	112	100	89
09.02.2009	127.5	51.7	10.8	14.0	BDL	BDL	BDL	160	143	127
11.02.2009	131.6	53.3	9.7	12.8	BDL	BDL	BDL	120	106	95
16.02.2009	145.7	58.8	8.0	10.5	BDL	BDL	BDL	105	93	83
18.02.2009	141.7	57.3	10.5	13.8	BDL	BDL	BDL	150	133	119
23.02.2009	132.4	53.6	8.9	11.7	BDL	BDL	BDL	114	102	84
25.02.2009	138.7	56.1	8.8	14.3	BDL	BDL	BDL	133	118	105
Maximum	**145.7**	**58.8**	**11.4**	**14.8**	**BDL**	**BDL**	**BDL**	**164**		
Minimum	**109.8**	**40.8**	**7.5**	**10.1**	**BDL**	**BDL**	**BDL**	**80**		
Average	**128.5**	**51.5**	**9.7**	**12.6**	**BDL**	**BDL**	**BDL**	**116**		
98th %le	**144.2**	**58.2**	**11.4**	**14.7**	**BDL**	**BDL**	**BDL**	**160**		
All units are in $\mu g/m^3$										

ANNEXURE-X
AMBIENT AIR QUALITY LEVELS

AAQ-5: Bherukhera village										
Date	**TSPM**	**RPM**	**SO_2**	**NOx**	**Lead**	**Zinc**	**Cadmium**	**CO**		
								I	**II**	**III**
01.12.2008	151.7	55.6	11.1	13.6	0.12	0.17	BDL	149	129	102
03.12.2008	161.1	59.2	9.8	12.3	0.15	0.14	BDL	129	106	96
08.12.2008	170.9	62.9	10.9	11.2	<0.1	0.13	BDL	160	139	113
10.12.2008	182.4	67.3	10.1	14.7	<0.1	0.14	BDL	120	104	94
15.12.2008	187.3	63.9	7.4	13.5	<0.1	0.13	BDL	105	91	90
17.12.2008	178.5	62.5	11.0	11.8	<0.1	0.13	BDL	150	130	112
22.12.2008	166.1	57.3	10.1	13.2	<0.1	0.14	BDL	162	135	98
24.12.2008	162.1	59.6	11.9	15.5	0.12	0.17	BDL	133	115	114
29.12.2008	159.9	55.5	10.2	13.5	0.18	0.22	BDL	143	127	122
31.12.2008	143.3	52.4	7.2	14.6	0.14	0.16	BDL	158	137	104
05.01.2009	135.9	49.6	9.0	11.6	<0.1	<0.1	BDL	136	97	87
07.01.2009	146.1	53.5	9.9	11.1	<0.1	0.13	BDL	125	102	93
12.01.2009	157.3	57.8	11.7	15.2	<0.1	0.14	BDL	160	138	107
14.01.2009	145.9	53.4	9.4	12.2	<0.1	0.13	BDL	137	92	91
19.01.2009	137.3	50.2	7.2	11.8	0.12	0.14	BDL	155	134	132
21.01.2009	124.5	45.3	12.1	15.4	<0.1	0.16	BDL	146	126	125
26.01.2009	112.1	42.6	9.7	11.9	<0.1	0.14	BDL	103	90	89
28.01.2009	126.3	46.1	10.8	14.1	<0.1	0.13	BDL	164	144	123
02.02.2009	137.2	50.1	10.2	10.9	<0.1	<0.1	BDL	117	101	100
04.02.2009	145.1	53.1	11.6	15.0	<0.1	0.14	BDL	135	117	116
09.02.2009	153.2	56.2	7.8	10.5	0.17	0.14	BDL	126	103	91
11.02.2009	148.7	54.5	11.4	13.4	0.16	0.23	BDL	153	109	88
16.02.2009	158.5	58.2	7.1	14.2	<0.1	0.13	BDL	143	124	123
18.02.2009	160.9	59.2	11.2	14.5	<0.1	0.14	BDL	127	111	109
23.02.2009	136.2	49.8	11.8	11.4	<0.1	0.14	BDL	111	96	95
25.02.2009	134.2	48.5	9.3	12.2	0.16	0.17	BDL	139	120	120
Maximum	**187.3**	**67.3**	**12.1**	**15.5**	**0.18**	**0.23**	**BDL**	**164**		
Minimum	**112.1**	**42.6**	**7.1**	**10.5**	**<0.1**	**<0.1**	**BDL**	**87**		
Average	**150.9**	**54.8**	**10.0**	**13.1**	**0.15**	**0.15**	**BDL**	**120**		
98th %le	**184.9**	**65.6**	**12.0**	**15.5**	**0.18**	**0.23**	**BDL**	**161**		
All units are in $\mu g/m^3$										
AAQ-6: Barla (Shahpura)										
Date	**TSPM**	**RPM**	**SO_2**	**NOx**	**Lead**	**Zinc**	**Cadmium**	**CO**		
								I	**II**	**III**
01.12.2008	127.4	49.7	6.8	11.0	BDL	BDL	BDL	173	154	134
03.12.2008	139.1	55.2	10.3	12.2	BDL	BDL	BDL	123	109	95
08.12.2008	142.5	55.7	9.5	11.9	BDL	BDL	BDL	142	126	110
10.12.2008	127.5	50.7	11.1	13.2	BDL	BDL	BDL	122	110	88
15.12.2008	112.6	43.9	6.9	11.5	BDL	BDL	BDL	146	96	82
17.12.2008	107.6	41.2	9.3	9.4	BDL	BDL	BDL	151	121	110
22.12.2008	120.1	47.8	8.4	10.0	BDL	BDL	BDL	134	119	104
24.12.2008	118.7	46.3	6.5	9.1	BDL	BDL	BDL	117	103	91
29.12.2008	112.5	44.9	10.9	13.0	BDL	BDL	BDL	146	129	113
31.12.2008	102.1	39.8	8.8	9.3	BDL	BDL	BDL	157	138	122
05.01.2009	110.6	44.1	9.5	11.3	BDL	BDL	BDL	118	104	92
07.01.2009	125.9	49.1	7.1	12.8	BDL	BDL	BDL	169	149	131
12.01.2009	138.6	55.1	8.5	10.2	BDL	BDL	BDL	126	111	98
14.01.2009	121.4	47.3	10.1	12.2	BDL	BDL	BDL	145	98	86
19.01.2009	110.8	44.2	9.5	9.5	BDL	BDL	BDL	158	140	123
21.01.2009	125.4	48.9	10.8	13.4	BDL	BDL	BDL	121	107	94
26.01.2009	122.6	47.8	10.6	12.6	BDL	BDL	BDL	140	124	109
28.01.2009	112.1	44.7	9.8	11.5	BDL	BDL	BDL	150	133	89
02.02.2009	118.9	46.4	10.2	12.2	BDL	BDL	BDL	166	147	129
04.02.2009	120.9	48.2	10.4	12.4	BDL	BDL	BDL	107	95	83
09.02.2009	102.4	39.9	9.3	10.8	BDL	BDL	BDL	155	130	105
11.02.2009	100.8	39.3	8.7	10.3	BDL	BDL	BDL	168	149	130
16.02.2009	113.3	44.2	7.0	11.6	BDL	BDL	BDL	112	99	87
18.02.2009	126.5	50.3	9.1	10.9	BDL	BDL	BDL	163	144	126
23.02.2009	137.9	54.8	9.8	9.6	BDL	BDL	BDL	154	136	119
25.02.2009	129.8	51.6	9.4	11.2	BDL	BDL	BDL	144	97	84
Maximum	**142.5**	**55.7**	**11.1**	**13.4**	**BDL**	**BDL**	**BDL**	**173**		
Minimum	**100.8**	**39.3**	**6.5**	**9.1**	**BDL**	**BDL**	**BDL**	**82**		
Average	**120.3**	**47.4**	**9.2**	**11.3**	**BDL**	**BDL**	**BDL**	**123**		
98th %le	**140.8**	**55.5**	**11.0**	**13.3**	**BDL**	**BDL**	**BDL**	**168**		
All units are in $\mu g/m^3$										

ANNEXURE-X
AMBIENT AIR QUALITY LEVELS

MOBILE LOCATIONS										
MA-1:Paparikhera										
Date	**TSPM**	**RPM**	**SO_2**	**NOx**	**Lead**	**Zinc**	**Cadmium**	**CO**		
16.12.2008	187.2	62.4	11.8	12.1	0.12	0.24	BDL	237	121	113
08.01.2009	205.3	75.5	12.9	15.6	0.15	0.31	BDL	165	141	118
12.02.2008	191.1	64.7	10.3	11.6	0.21	0.37	BDL	155	136	111
Maximum	**205.3**	**75.5**	**12.9**	**15.6**	**0.21**	**0.37**	**BDL**	**237**		
Minimum	**187.2**	**62.4**	**10.3**	**11.6**	**0.12**	**0.24**	**BDL**	**111**		
Average	**194.5**	**67.5**	**11.7**	**13.1**	**0.16**	**0.31**	**BDL**	**147**		
98th %le	**187.8**	**67.3**	**12.2**	**15.5**	**0.22**	**0.33**	**BDL**	**226**		
MA-2:Deoliya										
Date	**TSPM**	**RPM**	**SO_2**	**NOx**	**Lead**	**Zinc**	**Cadmium**	**CO**		
16.12.2008	139.5	47.5	13.3	14.3	BDL	BDL	BDL	144	124	99
08.01.2009	168.3	54.7	14.8	15.9	BDL	BDL	BDL	153	126	103
12.02.2008	129.3	45.3	11.8	13.4	BDL	BDL	BDL	169	139	107
Maximum	**168.3**	**54.7**	**14.8**	**15.9**	**BDL**	**BDL**	**BDL**	**169**		
Minimum	**129.3**	**45.3**	**11.8**	**13.4**	**BDL**	**BDL**	**BDL**	**99**		
Average	**145.7**	**49.2**	**13.3**	**14.5**	**BDL**	**BDL**	**BDL**	**135**		
98th %le	**195.6**	**68.3**	**13.0**	**15.6**	**BDL**	**BDL**	**BDL**	**166**		
MA-3:Rajiyas										
Date	**TSPM**	**RPM**	**SO_2**	**NOx**	**Lead**	**Zinc**	**Cadmium**	**CO**		
16.12.2008	104.3	45.2	8.8	12.8	BDL	BDL	BDL	166	127	110
08.01.2009	102.8	44.5	10.6	13.6	BDL	BDL	BDL	151	137	98
12.02.2008	113.5	47.4	8.6	11.2	BDL	BDL	BDL	182	142	107
Maximum	**113.5**	**47.4**	**10.6**	**13.6**	**BDL**	**BDL**	**BDL**	**182**		
Minimum	**102.8**	**44.5**	**8.6**	**11.2**	**BDL**	**BDL**	**BDL**	**98**		
Average	**106.8**	**45.7**	**9.3**	**12.5**	**BDL**	**BDL**	**BDL**	**141**		
98th %le	**196.8**	**69.2**	**13.5**	**15.6**	**BDL**	**BDL**	**BDL**	**179**		
MA-4:Manakakhera										
Date	**TSPM**	**RPM**	**SO_2**	**NOx**	**Lead**	**Zinc**	**Cadmium**	**CO**		
16.12.2008	136.4	53.8	11.1	14.4	BDL	BDL	BDL	154	130	108
08.01.2009	153.5	67.7	8.4	11.1	BDL	BDL	BDL	171	148	125
12.02.2008	123.1	53.5	9.3	11.4	BDL	BDL	BDL	190	139	120
Maximum	**153.5**	**67.7**	**11.1**	**14.4**	**BDL**	**BDL**	**BDL**	**190**		
Minimum	**123.1**	**53.5**	**8.4**	**11.1**	**BDL**	**BDL**	**BDL**	**108**		
Average	**137.7**	**58.3**	**9.6**	**12.3**	**BDL**	**BDL**	**BDL**	**150**		
98th %le	**198.0**	**70.1**	**13.7**	**15.6**	**BDL**	**BDL**	**BDL**	**187**		
MA-5:Barla(Hurda)										
Date	**TSPM**	**RPM**	**SO_2**	**NOx**	**Lead**	**Zinc**	**Cadmium**	**CO**		
16.12.2008	119.5	46.9	12.5	11.8	BDL	BDL	BDL	156	139	126
08.01.2009	135.4	55.5	11.9	12.2	BDL	BDL	BDL	142	129	101
12.02.2008	112.9	44.3	12.2	15.3	BDL	BDL	BDL	177	152	137
Maximum	**135.4**	**55.5**	**12.5**	**15.3**	**BDL**	**BDL**	**BDL**	**177**		
Minimum	**112.9**	**44.3**	**11.9**	**11.8**	**BDL**	**BDL**	**BDL**	**101**		
Average	**122.6**	**48.9**	**12.2**	**13.1**	**BDL**	**BDL**	**BDL**	**144**		
98th %le	**199.1**	**70.9**	**13.8**	**15.7**	**BDL**	**BDL**	**BDL**	**174**		

ANNEXURE-XI
ECOLOGICAL DETAILS

TABLE-1
LIST OF PLANT SPECIES RECORDED DURING STUDY PERIOD

Sr. No	Technical Name	Family	Local Name
I. Agricultural crops			
1	*Hordium vulgare*	Poaceae	Jav
2	*Sorghum vulgare*	Poaceae	Jowar
3	*Triticum vulgare*	Poaceae	Gehun
4	*Zea mays*	Poaceae	Makka
5	*Pennisetum typhoideum*	Poaceae	Bajra
6	*Sacharum officinarum*	Poaceae	Ganna
II**Commercial crops(including vegetables)**			
7	*Abelomoschus indicus*	Malvaceae	Bhendi
8	*Allium cepa*	Liliaceae	Pyaas
9	*Allium sativum*	Liliaceae	Lasand
10	*Arachis hypogia*	Fabaceae	Moongphali
11	*Brassica oleracea var botrydis*	Cruciferae	Cauliflower
12	*Brassica oleracea* var capitata	Cruciferae	Cabbage
13	*Cajanus cajan*	Fabaceae	Dal
14	*Carica papaya*	Caricaceae	Papitha
15	*Catharanthes pusillus*	Compositae	Sankhupuli
16	*Cicer arietinum*	Fabaceae	Chana
17	*Citrus lemon*	Ruataceae	Nimbu
18	*Colacasia esculenta*	Areaceae	Arvi, Kachalu
19	*Coreandrum sativum*	Umbelliferae	Dhaniya
20	*Daucus carota*	Umbelliferae	Gajar
21	*Lycopersicum esculentus*	Solanaceae	Tamatar
22	*Memordia charantia*	Cucurbitaceae	Bitter guard
23	*Pepaver somneferrum*	Pepavaraceae	Karela
24	*Pisum sativum*	Fabaceae	Chanabatana
25	*Psidium guava*	Myrtaceae	Amrud
26	*Raphanus sativa*	Cruciferae	Muli
27	*Trichosanthes anguina*	Cucurbitaceae	Chachinda
III. Plantations			
28	*Acacia nilotica*	Mimosaceae	Babul
29	*Albizia lebbeck*	Mimosaceae	Siris
30	*Albizia odorattissima*	Mimosaceae	Kala siris
31	*Albizia procera*	Mimosaceae	Safed siris
32	*Azadirachta indica*	Meliaceae	Neem
33	*Bauhinia variegate*	Caesalpinaceae	Kachnar
34	*Bauhinia purpuria*	Caesalpinaceae	Khariwal
35	*Bambusa arundanaceae*	Poaceae	Bans
36	*Butea superb*	Caesalpinaceae	Palas
37	*Butea frondosa*	Caesalpinaceae	Palas
38	*Delonix regia*	Caesalpinaceae	Gulmohar
39	*Peltoforrum ferrusinum*	Caesalpinaceae	Copper pod
40	*Dalberia sissoo*	Caesalpinaceae	Sissum
41	*Leucena leucophloe*	Caesalpinaceae	Leucena
42	*Pongamia pinnata*	Caesalpinaceae	Karanj
IV. Natural Vegetation/Forest Tyepe			
43	*Abrus precatorius*	Fabaceae	Gunchi
44	*Abutilon indicum*	Malvaceae	Kanghi
45	*Acacia Arabica*	Mimosaceae	Babul
46	*Acacia auriculiformis*	Mimosaceae	Babul
47	*Acacia catechu*	Mimosaceae	Khair
48	*Acacia fernacea*	Mimosaceae	Vilayati babul
49	*Acacia leucophloe*	Mimosaceae	Safed kikar
50	*Acacia Senegal*	Mimosaceae	Kumata
51	*Acalypha ciliate*	Mimosaceae	Haritha manjari
52	*Acalypha lanceolata*	Euphorbiaceae	Acalypha
53	*Acanthospermum hispidum*	Compositae	-
54	*Achyranthes aspera*	Amaranthaceae	Latjira
55	*Aegle marmelos*	Rutaceae	Bel

ANNEXURE-XI
ECOLOGICAL DETAILS

Sr. No	Technical Name	Family	Local Name
56	*Aerva lanata*	Compositae	Dholimundi
57	*Agave wightii*	Agavaceae	Banskeora
58	*Ageratum conyzoides*	Compositae	Ghanera osadi
59	*Ailanthes excela*	Simaroubaceae	Maharuk
60	*Alangium salivus*	Alangiceae	Akola
61	*Albizia odoratissima*	Caesalpinaceae	Kalasiris
62	*Albizia procera*	Caesalpinaceae	Safed siris
63	*Aloe barbedensis*	Agavaceae	Ghee kunvar
64	*Alstonia scholaris*	Apocyanaceae	Chatian
65	*Alternanthera sessilis*	Amaranthaceae	Kanchari
66	*Alysicarpus hamosus*	Fabaceae	-
67	*Ammania baccafera*	Lytharaceae	Dadmari
68	*Anoegeissus pendula*	Combretaceae	Dhav
69	*Anogeissus latifolia*	Combretaceae	Dhawa
70	*Argemone mexicana*	Papevaraceae	Bharband
71	*Arthraxon prionoites*	Poaceae	Sweet vernal grass
72	*Asparagaus racemosus*	Liliaceae	Nag-down
73	*Atalantia monophylla*	Rutaceae	Atavi-jambhira
74	*Azadirachta indica*	Meliaceae	Neem
75	*Barleria prionoites*	Acanthaceae	Jhintikhasareya
76	*Bidens biternata*	Compositae	Chaupatia
77	*Blepharis asperima*	Acanthaceae	Chaupatia
78	*Blepharis madaraspatens*	Acanthaceae	Chaupatia
79	*Blumea lacera*	Compositae	Kkaranda
80	*Boerheavia chinensis*	Nycataginaceae	Sant
81	*Boerheavia diffusa*	Nyctaginaceae	-
82	*Bombax ceiba*	Bombacaceae	Semul
83	*Borreria hispida*	Rubiaceae	Guthari
84	*Borreria stricta*	Rubiaceae	-
85	*Brassica camprestris*	Cruciferae	Asal rai
86	*Caesalpina pulcherima*	Caesalpinaceae	Gulutora
87	*Calotropis gigantia*	Asclepiadaceae	Ak
88	*Calotropis procera*	Asclipiadaceae	Akada
89	*Canna indicda*	Cannaceae	sabbajaya
90	*Cannabis sativa*	Cannabinaceae	Bhang, ganja
91	*Canthium diddynum*	Rubiaceae	Arsul
92	*Capparis aphylla*	Capparidaceae	Karer
93	*Capparis deciduas*	Capparidaceae	Kabra
94	*Capsicum annulatum*	Solanaceae	Lalmirchi
95	*Careya arborea*	Palmae	Kumbhi
96	*Carissa carandus*	Apocyanaceae	Karaunda
97	*Carissa spinarium*	Apocyanaceae	Karaunda
98	*Casearia graveolens*	Samydiaceae	Kulkulta
99	*Cassia absus*	Caesalpinaceae	Chaksu
100	*Cassia auriculata*	Caesalpinaceae	Tarwar
101	*Cassia obtuse*	Caesalpinaceae	Dog senna
102	*Cassia occidentalis*	Caesalpinaceae	Kasondi
103	*Cassia pumella*	Caesalpinaceae	Sarmal
104	*Cassia tora*	Caesalpinaceae	Chakunda
105	*Cayratia terifolia*	Vitaceae	Amal-bel
106	*Ceiba pentandra*	Bombacaceae	Safed simal
107	*Cestrum diurnum*	Rubiaceae	Day queen
108	*Cestrum noctrunum*	Rubiaceae	Rat-kirani
109	*Chloris varigata*	Poaceae	Ghraniagas
110	*Chrysanthemum sp*	Compositae	Guldaudi
111	*Cissus quadrangularis*	Vitaceae	Hadjora
112	*Citrus liminoites*	Rutaceae	Methanembu
113	*Citrus limon*	Rutaceae	Baranimbu
114	*Citrus media*	Rutaceae	Baranimbu
115	*Cleome gynandra*	Capparidaceae	Hulhul
116	*Cleome viscose*	Capparidaceae	Panwar
117	*Clitoria ternate*	Fabaceae	Aparaji

ANNEXURE-XI
ECOLOGICAL DETAILS

Sr. No	Technical Name	Family	Local Name
118	*Cocculus villosa*	Cucurbiataceae	Jamtikibel
119	*Commelina benghalensis*	Commelinaceae	Kanchara
120	*Cordia dichotoma*	Rubiaceae	Lasora, chota lasora
121	*Cordia myxa*	Rubiaceae	Dahipalas
122	*Cordia rothri*	Rubiaceae	-
123	*Crataeva adsoni*	Capparidaceae	Barnabilisi
124	*Crotalaria burhia*	Fabaceae	Ghagari
125	*Crotalaria medicagenia*	Fabaceae	Gulabi
126	*Croton bonplandinum*	Amaryllidaceae	Croton
127	*Cryptostegia grandiflora*	Orchidaceae	Vilayati vakhandi
128	*Cuscuta reflexa*	Cuscutaceae	Akasbel
129	*Daemia extensa*	Fabaceae	Uttaranjutaka
130	*Dalbergia paniculata*	Fabaceae	Shisham
131	*Datura alba*	Solanaceae	Datura
132	*Datura fastulosa*	Solanaceae	Sadadatura
133	*Datura metal*	Solanaceae	Datura
134	*Delphinium ajacus*	Ranunculaceae	Rocket larksapur
135	*Dendrophthe falcate*	Loranthaceae	Banda
136	*Desmodium triflorum*	Asclepiadaceae	Kudaliya
137	*Echinops echinatus*	Compositae	Gokru
138	*Eclipta alba*	Compositae	Bhangra, babri
139	*Eclipta prostrate*	Compositae	-
140	*Emilia lajerium*	Compositae	Hirankhuri
141	*Erythrina indica*	Papillionaceae	Madar
142	*Euphorbia geniculata*	Euphorbiaceae	Tredahra sehund
143	*Euphorbia hirta*	Euphorbiaceae	Dudhi
144	*Euphorbia hyperocifolia*	Euphorbiaceae	Hashkaradana
145	*Euphorbia nerifolia*	Euphorbiaceae	-
146	*Euphorbia neruri*	Euphorbiaceae	Potatanokesad
147	*Euphorbia piluliflora*	Euphorbiaceae	-
148	*Euphorbia thymiflora*	Euphorbiaceae	Choti-dhudhi
149	*Euphorbia tricauli*	Euphorbiaceae	Kompal sehund
150	*Evolvulus alsinoides*	Convolvulaceae	Shyamakantha
151	*Evolvulus numalaris*	Convolvulaceae	-
152	*Fagonia cretica*	Zygophyllaceae	Uastarakar
153	*Feronia elephantum*	Rutaceae	Bilin
154	*Ficus benghalensis*	Moraceae	Bar
155	*Ficus carica*	Moraceae	Anjir
156	*Ficus glomerata*	Moraceae	Gular
157	*Ficus hispida*	Moraceae	Daduri
158	*Ficus racemosus*	Moraceae	Gular
159	*Ficus relisiosa*	Moraceae	Pipal
160	*Ficus gibbosa*	Moraceae	Udamber
161	*Flacourtia indica*	Flacourtiaceae	Paniala
162	*Flacourtia latifolia*	Flacourtiaceae	Bilangra`
163	*Flacourtia Montana*	Flacourtiaceae	Pitpapra
164	*Fumaria indica*	Papillionaceae	-
165	*Gardenia latifolia*	Rubiaceae	Papra
166	*Gardenia lucida*	Rubiaceae	Dikamali
167	*Garuga pinnata*	Burseraceae	Kharpat
168	*Glossocardia bosvellia*	Compositae	Seri
169	*Gmelina arborea*	Rubiaceae	Gambhar
170	*Gomphrena globosa*	Amaranthaceae	Globe amaranth
171	*Grewia hirta*	Tiliaceae	Kakarrundah
172	*Grewia salivifolia*	Tiliaceae	-
173	*Grewia subinaqualis*	Tiliaceae	Biul
174	*Gynandropis gynandra*	Capparidaceae	-
175	*Haplanthus tentaculatus*	Acanthaceae	Kastula
176	*Haplanthus verticillatus*	Acanthaceae	-
177	*Helictris isora*	Rubiaceae	Marophali
178	*Heliotropium indicum*	Rubiaceae	Hattajuri
179	*Helitropium ovalifolium*	Rubiaceae	Chittiphul

ANNEXURE-XI
ECOLOGICAL DETAILS

Sr. No	Technical Name	Family	Local Name
180	*Hemidesmus indicus*	Asclepiadaceae	Anantamul
181	*Hibiscus gibbosa*	Malvaceae	Jasut
182	*Hibiscus micronthus*	Malvaceae	Chineserose
183	*Hibiscus ovalifolia*	Malvaceae	-
184	*Hibiscus rosa-cianensis*	Malvaceae	Jasut
185	*Hibsicus caesus*	Malvaceae	-
186	*Holarrhena antidycenterica*	Asclepiadaceae	Kurchi
187	*Holostemma annularia*	Aslepiadaceae	Chhirvel
188	*Hygrophylla auriculata*	Acanthaceae	-
189	*Hyptis suavalens*	Labiatae	Vilayati tulasi
190	*Ichnocarpus frutens*	Poaceae	Kalidudhi
191	*Impatiens balasamania*	Balsaminaceae	Gulmendhi
192	*Ipomea aquatica*	Convolvulaceae	Karmi
193	*Ipomea carnea*	Convolvulaceae	Railway creeper
194	*Ipomea coccinea*	Convolvulaceae	Bilaikand
195	*Ipomea tuba*	Convolvulaceae	Nakhari
196	*Ixora parviflora*	Rubiaceae	Kotagandhal
197	*Ixora singapuriens*	Rubiaceae	Ixora
198	*Jacarandra jacquimontii*	Bignoniaceae	Jacarandra
199	*Jasmimum arborens*	Oleaceae	Chameli
200	*Jatropha gossypifolia*	Euphorbiaceae	Bheerenda
201	*Justia simplex*	Acanthaceae	Udisanabhalu
202	*Justia diffusa*	Acanthaceae	-
203	*Justicia diffusa*	Acanthaceae	-
204	*Lannea asplenifolia*	Anacardiaceae	Jhingaram
205	*Lantana camara*	Verbinacaee	Lantana
206	*Lathyrus sativus*	Papillionaceae	Khesari
207	*Lawsonia inermis*	Lythraceae	Mehandi
208	*Leucas aspera*	Labiatae	Chota halkulasa
209	*Leucas longifolia*	Labiatae	-
210	*Leucas stelligera*	Labiatae	
211	*Lindernbergia ciliate*	Scrophulariaceae	Bhinta chatti
212	*Lophophora tridinatus*	Scrophulariaceae	-
213	*Loranthus sp*	Loranthaceae	Loranthus
214	*Luffa acutangularia*	Cucurbitaceae	Kali tori
215	*Lygodium flexosum*	Schiaceae	Bhut-raj
216	*Mallotus philippinus*	Euphorbiaceae	Komala sindhur
217	*Malvastrum coramandalicum*	Malvaceae	Nagkeshar
218	*Mangifera indica*	Anacardiaceae	Aam
219	*Medicago aureus*	Papillionaceae	Wilayati gawath
220	*Medicago indica*	Papillionaceae	-
221	*Medicago polymorpha*	Papillionaceae	-
222	*Melia azadirachta*	Meliaceae	Bakain
223	*Memordica diocea*	Cucurbitaceae	Kaksa
224	*Mentha piperata*	Labiatae	Podina
225	*Merremia emerginata*	Convolvulaceae	Musakani
226	*Mimosa hamata*	Mimosaceae	Natchnapath
227	*Mitrgyna parviflora*	Rubiaceae	Kalmi
228	*Mollugo cerviana*	Aizoaceae	Ghimasak
229	*Mollugo hirta*	Aizoaceae	-
230	*Moringa oleifera*	Moringaceae	Munaga
231	*Morus alba*	Moraceae	Turti
232	*Mucuna prurita*	Papillionaceae	Kiwach
233	*Murraya exotica*	Rutaceae	Kamini,marchulo
234	*Murraya koenigii*	Rutaceae	Mitha neem
235	*Musa paradisica*	Musaceae	Kela
236	*Nerium indicum*	Apocyanaceae	Kaner
237	*Nicotiana plumbaginifolia*	Solanaceae	Tambaku
238	*Ocimum americanum*	Labiatae	Kala tulasi
239	*Ocimum basillum*	Labiatae	Babui tulasi
240	*Ocimum canum*	Labiatae	Ramtulasi
241	*Ocimum sanctum*	Labiatae	Tulsi

ANNEXURE-XI
ECOLOGICAL DETAILS

Sr. No	Technical Name	Family	Local Name
242	*Oldenlandia umbellate*	Convolvulaceae	Damanpapar
243	*Opuntia dillinii*	Opuntiaceae	Nagphana
244	*Opuntia elator*	Cacataceae	Nagphana
245	*Panicum turgidum*	Poaceae	Munt, muruta grass
246	*Panicum maximus*	Poaceae	Guidnea grass
247	*Papaver somniferum*	Papaveraceae	Hafim
248	*Parkinsonia aculata*	Mimosaceae	Vilayati kikar
249	*Parthenium hysterophorus*	Compositae	Congress grass
250	*Paspalum strobilanthus*	Passifloraceae	Kodo,kodra
251	*Passiflora foetida*	Passifloraceae	passion flower
252	*Peristrophe bicalculata*	Acanthaceae	Atrilal
253	*Phoenix aculis*	Palmae	Khajur
254	*Phyllanthes nirurii*	Euphorbiaceae	Jaramla
255	*Phyllanthes urinaria*	Euphorbiaceae	Lal bhui anaalah
256	*Physalis minima*	Solanaceae	Tulati pati
257	*Pithocolobium dulce*	Mimosaceae	Jangle jilebe
258	*Polyalthia longifolia*	Annonaceae	Asokam
259	*Polygala chinensis*	Polygalaceae	Meradu
260	*Pongamia pinnata*	Fabaceae	Karanj
261	*Portulaca oleracea*	Portulaccaceae	Baarlaniya
262	*Prosopis cineraria*	Mimosaceae	Khejra
263	*Prosopis juliflora*	Mimosaceae	Kabuli kikar
264	*Psidium guava*	Myrtaceae	Amrud
265	*Punica granulatum*	Puniaceae	Anar
266	*Raphanus sativus*	Cruciferae	Muli
267	*Rosa indica*	Rosaceae	Rose
268	*Saccharum munja*	Poaceae	Pandi, paunda
269	*Salmalia malabarica*	Salmaliaceae	Rui
270	*Sapindus emerginatus*	Sapindaceae	Rita
271	*Sida cordifolia*	Malvaceae	Kungyi
272	*Sida rhombifolia*	Malvaceae	Bhiunli
273	*Sida vernanicaefolia*	Malvaceae	Bananiyar
274	*Sesamum indicum*	Pedaliaceae	Til
275	*Solanum nigrum*	Solanaceae	Kakamachi
276	*Solanum suratensis*	Solanaceae	Kateli, katai,
277	*Solanum xanthocarpum*	Solanaceae	Ringani
278	*Sterculia villosa*	Tiliaceae	Udal, udar
279	*Sygygium cumini*	Myrtaceae	Jamun
280	*Tamarindus indica*	Caesalpinaceae	Imli
281	*Tectona grandis*	Verbinaceae	Sagvan
282	*Tephrosia purpuria*	Fabaceae	Dhamasia
283	*Tinospora cordifolia*	Rhamnaceae	Amrita
284	*Tragus biflorus*	Poaceae	Kantigrass
285	*Trapa bispinosa*	Trapaceae	Shingada
286	*Trapa natans*	Trapaceae	Shingada
287	*Tribulus terrestris*	Zygophyllaceae	Gokhru
288	*Tridax procumbens*	Compositae	Mexican daisy
289	*Trigonella cornuculata*	Fabaceae	Kasuri methi
290	*Triumferta pilosa*	Tiliaceae	Kura
291	*Vernonia cinera*	Compositae	Daudotpala
292	*Vicoa indica*	Compositae	Sona Sali
293	*Vitex Negundo*	Verbinaceae	Shambalu
294	*Wrightia tomentosa*	Apocyanaceae	Dudhi
295	*Xanthium strumarium*	Compositae	Banokra
296	*Yucca gloriosa*	Agavaceae	Agave
297	*Zizyphus jujube*	Rhamnaceae	Ban ber
298	*Zizyphus mauritiana*	Rhamanaceae	Ber
299	*Zizyphus nummalaris*	Rhamnaceae	Jhahrber
300	*Zizyphus oenoplica*	Rhamnaceae	Makai
301	*Zornia gobbosa*	Compositae	Roonkari
V. Grasslands			
302	*Cenchurus ciliaris*	Poaceae	Anjan, dhaman

ANNEXURE-XI
ECOLOGICAL DETAILS

Sr. No	Technical Name	Family	Local Name
303	*Apluda mutica*	Poaceae	Ponai
304	*Chloris dolichosta*	Poaceae	Bamna
305	*Cyanodactylon sp*	Poaceae	Bermuda grass
306	*Dichanthium annulatum*	Poaceae	Jaunerea
307	*Inperata cylendrica*	Poaceae	Dharba, dabh
308	*Sachharum spontanseum*	Poaceae	Kans, khas
309	*Themeda quadrivalvis*	Poaceae	Kapur ghas
310	*Aristida adscensionsis*	Poaceae	Grass
311	*Cymbopogon jwarancusa*	Cyperaceae	Lamajjakka
312	*Cyperus aristatus*	Cyperaceae	Guinea rush
313	*Cyperus rotundus*	Cyperaceae	Mutha, motha
314	*Cyperus triceps*	Cyperaceae	Nirbisi
315	*Dactylectinium aegypticum*	Poaceae	Makra,makri
316	*Eragrostis diahena*	Poaceae	Grass
317	*Setaria glauca*	Cyperaceae	Bandra
VI	**Endemic species**	**No endemic species recorded/reported as per Botanical survey of India records**	
VII	**Endangered species**	**No endangered species reported/recorded as per Botanical survey of India records**	

APPENDIX-I

ANNEXURE-XI
ECOLOGICAL DETAILS

कार्यालय उप वन संरक्षक
सामाजिक वानिकी
भीलवाडा

कमांक एफ / तक / 09 / 2969 दिनांकः 17-4-09

निमित,

जनरल मेनेजर
हिन्दुस्तान जिंक लिमिटेड
रामपुरा आगुचा माईन्स
जिला भीलवाडा।

विषयः - फ्लोरा एवं फोना की जानकारी बाबत।

प्रसंगः - आपका पत्रांक HZL/RAM/Env/2009 दि 23/03/2009 के कम मे।

महोदय,

उपरोक्त प्रासांगिक विषयांतर्गत आप द्वारा रामपुरा आगुचा माईन्स तहसील हुरडा, जिला भीलवाडा मे एम एल सख्या 1/2000 के कोर जोन तथा बफर जोन मे अवस्थित फ्लोरा एवं फोना की चाही गयी जानकारी सलग्न कर प्रेषित है ।

भवदीय

संलग्नः - उक्तानुसार

उप वन संरक्षक
सामाजिक वानिकी
भीलवाडा

ANNEXURE-XI
ECOLOGICAL DETAILS

Office Of the Assistant Conservater Of Forests Bhilwara

S.No. F4( ) Tech/ACF/2009-10 / 33 dated 9.4.09

Dy C.F Sb.
Bhilwara

Sub:- Information about species of flora and fauna in the Core and Buffer Zone of Rampra Agucha Mines,

Ref:- Your instructions dated 23.3.09

Sir,

In compliance of your instructions , I visited the said area in the a/n of 8.4.09 and morning of 9.4.09 .

I have prepared the list of plant species and flora and fauna in the Core and Buffer Zone of Rampra Agucha Mines sepearately, the list includes Trees, Grasses, Floristic, composition, mammals ,Ambhibions, Reptilep,Avifauna etc. It is being submitted for necessary action

Encl- Ann. 1 to 4.

Asst. Conservater Of Forests
Bhilwara

1554
13-4-09

ANNEXURE-XI
ECOLOGICAL DETAILS

Government of Rajasthan
Office of Deputy Conservator of Forest , Bhilwara

ANNEXURE-1

List of Plant Species found in Core Zone of Mining Lease No.1/2000 of M/s Hindustan Zinc Limited at Rampura Agucha Mine Dist- Bhilwara (Rajasthan)

(A) Trees

Sr. No.	Local Name	Botanical Name	Family
1	Khejri	Prosopis cineraria Linn	Mimosaceae
2	Ber	Zizyphus mauritiana	Rhamnaceae
3	Thor	Euphorbia caduaifalia. Linn.	Euphorbiaceae
4	Neem	Azadirachta indica	Meliaceae
5	Pipal	Ficus religiosa	Urticaceae
6	Desi Babool	Acacia nelotica	Leguminos
7	Vilayati Babool	Prosopis Juliflora	Leguminos
8	Khejra	Prosopis Cineraria	
9	Hingot	Velanite Egyptica	

(B) Grasses

Sr. No.	Local Name	Botanical Name	Family
1	Karad	Dichanthium annulatum	Graminae
2	Lapla	Aristida hystrix Linnf	Graminae
3	Dhaman	Cenchrus ciliaris	-do-

(C) **Floristic Composition (Cryptogamic Vegetation)**

The area shows algae, fungi, bryophytes and ferns, Algae are found in aquatic bodies. Fungi, particularly from ascomycetes and basidiomycetes are located either on ground or epiphytically. Lichens of crustose, foliose and fruticose types are present on different sub-startas (Lichens, Ascomycetes and Basidiomycetes near residential houses/ habitations).

Ethnobotanical Important Plant Species
No Ethnobotanical Important Plant Species found.

(D) Endangered Plant :

There is no threatened, endangered, vulnerable and rare plant species in the core zone of proposed mine site.

सहायक वन संरक्षक
भीलवाड़ा

ANNEXURE-XI
ECOLOGICAL DETAILS

Government of Rajasthan
Office of Deputy Conservator of Forest , Bhilwara

ANNEXURE-:

List of Fauna found in Core Zone of Mining Lease No1/2000 of M/s Hindustan Zinc Limited at Rampura Agucha Mine Dist- Bhilwara (Rajasthan)

(A) Mammals

Sr.No	English Name	Vernacular Name	Latin Name
1	Blue Bull or Nilgai	Neel Gai, Roghri	Boselapus tragocamelus

(B) **Amphibians and Reptiles**:

Sr.No	English Name	Vernacular Name	Latin Name
1	Common Frog	Rana tigriana	
2	Toad	Buto melanosticus	

(C) Avifauna :

Sr.No	Hindi Name	English Name	Zoological Name
1	Bhat Titar	Common sand grouse	Peterocles exustus
2	Teetar	Grey Patridge	Francolinus pondicerian
3	Bater	Common Quail	Coturnix
4	Kowwa	House crow	Corvus spendens
5	Tota	Roseringed Parakeet	Psittacula Krameri

(D) Migratory Birds and Mammals :

No Migratory birds path or animal corridors are there in the core zone of Rampura Agucha Mine

सहायक वन संरक्षक
भीलवाड़ा

ANNEXURE-XI
ECOLOGICAL DETAILS

Government of Rajasthan
Office of Deputy Conservator of Forest , Bhilwara

ANNEXURE-3

List of Plant Species found within Buffer Zone (10 Km radius) of Mining Lease No.1/2000 of M/s Hindustan Zinc Limited at Rampura Agucha Mine Dist- Bhilwara (Rajasthan)

(A) Trees

Sr. No.	Local Name	Botanical Name	Family
1	Kumtha	Acacia Senegal wild	Mimosaceae
2	Khejri	Prosopis cineraria Linn	Mimosaceae
3	Khair	Acacia catechu, wild	Mimosaceae
4	Ber	Zizyphus mauritiana	Rhamnaceae
5	Jinja	Bauhinia racemosa lamk	Caesalpiniaceae
6	Koulassi	Dichrostadhys cineraria W&A	Mimosaceae
7	Aranja	Acacia leucophloea, wild	Leguminosae
8	Senjna	Meringa oleifalia Linn	Eupherbiaceae
9	Thor	Euphorbia caduaifalia. Linn.	Euphorbiaceae
10	Hingot	Velanite Egyptica	
11	Jharbhor	Zizyphus numalarica Zizyphus Mauritiana Zizyphus xylopura	
12	Dassen	Rhus mysoorensis Heyne	Anacardiaceae
13	Neem	Azadirachta indica	Meliaceae
14	Pipal	Ficus religiosa	Urticaceae
15	Siris safed	Albizzia odoratissima Benth	Mimmosacea
16	Kanti	Flacourtia indica (Burm F.) Merr	Bixaceae
17	Amaltas	Cassia fistula line	Leguminos
18	Desi Babool	Acacia nelotica	Leguminos
19	Vilayati Babool	Prosopis Juliflora	Leguminos

(B) Grasses

Sr. No.	Local Name	Botanical Name	Family
1	Dhaman	Cenchrus ciliaris Linn.	Graminae
2	Karad	Dichanthium annulatum	Graminae
3	Lapla	Aristida hystrix Linnf	Graminae
4	Doob	Cynodon Dactylon pers.	Graminae
5	Dharba Dabh	Inperata cylendrica	Graminae
6	Kans, khas	Sachharum spontanseum	Graminae
7	Lammajjakka	Cymbopogon	Graminae
8	Motha	Cyperus difformis	Graminae
9	Grass	Eragrostis bifeia	Graminae
10	Salia Grass	Heterogan Contourtis	Graminae

सहायक वन संरक्षक
भीलवाड़ा

ANNEXURE-XI
ECOLOGICAL DETAILS

(C) Floristic Composition (Cryptogamic Vegetation):

The area shows algae, fungi, bryophytes and ferns. Algae are found in aquatic bodies, Fungi particularly from ascomycetes and basidiomycetes are located either on ground or epiphytically. Lichens of crustose, foliose and fruticose types are present on different substratas (Lichens, Ascomycetes and Basidiomycetes near residential houses/ habitations.

(D) Ethno botanical Important Plant Species:
There is no Ethno botanical Important Plant Species in the core zone of Rampura Agucha Mine.

सहायक वन संरक्षक
भीलवाड़ा

ANNEXURE-XI
ECOLOGICAL DETAILS

Government of Rajasthan
Office of Deputy Conservator of Forest , Bhilwara

ANNEXURE-4

List of Fauna found within Buffer Zone (10 Km radius) of Mining Lease No.1/2000 of M/s Hindustan Zinc Limited at Rampura Agucha Mine Dist- Bhilwara (Rajasthan)

(A) Mammals

Sr.No	English Name	Vernacular Name	Latin Name
1	Blue Bull or Nilgai	Neel Gai, Roghri	Boselapus tragocamelus
2	Common fox	Lomri	Valpeus bangalensis
3	Five stripped squirrel	Gilhari	Funambuless pennanti
4	Hyaena	Jarakh	Hyaena hyaena (Linn)
5	Hare Indian	Khargosh	Lepus nigricollisa ruficaudatus (Geoffroy)
6	Jackal	Gidar, sayalia	Canis aureus (Linn)
7	Mongoose	Nevla	Herpester edwardail (dufransna)

(B) Amphibians and Reptiles:

Sr.No	English Name	Vernacular Name	Latin Name
1	Cobra	Nag	Naja tripudians
2	Krait	Sanp	Bungarus coerulens
3	Viper	Sanp	Vipera russelli

(C) Avifauna :

Sr.No	Hindi Name	English Name	Zoological Name
1	Bhat Titar	Common sand grouse	Peterocles exustus
2	Kabootar	Blue Rock Pigion	Treron phoenicoptera
3	Koal	Koel	Eudynamys scolopacae
4	Geedh	White backed Vulture	Gyps bengalensis
5	Teetar	Grey Patridge	Francolinus pondicerian
6	Bater	Common Quail	Coturnix
7	Kowwa	House crow	Corvus spendens
8	Gauriyya	House sparrow	Passer domesticus
9	Katphora	Pied woodpecker	Denrocopos mahrattensis
10	Tota	Roseringed Parakeet	Psittacula Krameri

ANNEXURE-XI
ECOLOGICAL DETAILS

(D) Migratory Birds and Mammals :

No Migratory birds path or animal corridors are there within 10Km radius from the Buffer zone of Rampura Agucha Mine

सहायक वन संरक्षक
भीलवाड़ा

ANNEXURE-XI
ECOLOGICAL DETAILS

Name of the plant species	**R.B**	**R.D**	**R.FR**	**IVI**
Alysicarpus moniliformis	4.55	1.06	4.35	9.96
Apluda sp	0.04	7.80	3.48	11.32
Aristida sp	0.06	12.23	4.35	16.64
Bidens sp	2.36	4.96	3.48	10.80
Boerheavia diffusa	2.63	0.89	2.61	6.13
Borreria strictus	6.82	1.60	4.35	12.77
Bothriochloe pusella	0.03	6.74	4.35	11.12
Brachirio racemosa	0.05	10.46	2.61	13.12
Calotropis procera	1.10	2.30	4.35	7.75
Cassia occidentalis	9.48	3.19	3.48	16.15
Cassia tora	4.21	1.42	2.61	8.24
Chenopodium album	2.02	1.06	2.61	5.69
Convolvulus microphylla	0.02	4.96	2.61	7.60
Dactylolecterium aegypticum	0.03	6.91	3.48	10.43
Datura metal	7.22	2.66	5.22	15.10
Euphorbia hirta	7.33	2.30	3.48	13.11
Euphorbia nivula	8.34	1.95	4.35	14.64
Jatropha sp	6.82	1.60	3.48	11.90
Justicia simplex	6.82	1.60	1.74	10.16
Parthenium hysterophorus	6.44	6.03	2.61	15.08
Phyla nudiflora	1.05	0.35	1.74	3.15
Solanum surattensis	0.76	1.60	4.35	6.70
Sporolobus diander	0.76	0.71	3.48	4.95
Tephrosia purpuria	5.29	2.48	3.48	11.25
Thymus vulgaris	5.27	1.77	3.48	10.52
Tridax procumbens	6.63	6.21	2.61	15.45
Vernonia conyzoides	0.12	2.84	4.35	7.31
Xanthium strumarium	0.05	1.06	3.48	4.59
Zizyphus jujuba	3.69	1.24	3.48	8.41
COLUMN IDENTIFICATION				
R.B	*Relative Basal area*			
R.D	*Relative Density*			
R.Fr	*Relative Frequency*			
IVI	*Importance Value Index*			

ANNEXURE-XI
ECOLOGICAL DETAILS

Name of the plant species	**R.B**	**R.D**	**R.FR**	**IVI**
Alysicarpus moniliformis	6.89	1.11	3.74	11.73
Apluda sp	0.05	6.76	3.74	10.54
Aristida sp	0.09	13.64	3.74	17.47
Bidens sp	1.96	2.83	3.74	8.52
Blumea sp	1.02	0.37	1.87	3.26
Boerheavia diffusa	4.25	0.98	1.87	7.11
Borreria strictus	4.59	0.74	2.80	8.13
Bothriochloe pusella	0.09	13.02	4.67	17.79
Brachirio racemosa	0.05	7.74	2.80	10.60
Calotropis procera	0.68	0.98	4.67	6.34
Cassia occidentalis	9.04	2.09	4.67	15.80
Cassia tora	6.91	1.60	5.61	14.12
Convolvulus microphylla	0.06	7.99	4.67	12.71
Dactylolecterium aegypticum	0.10	14.74	4.67	19.52
Datura metal	5.85	1.35	3.74	10.94
Euphorbia nivula	8.42	1.35	4.67	14.45
Jatropha sp	6.89	1.11	3.74	11.73
Justicia simplex	11.48	1.84	3.74	17.06
Parthenium hysterophorus	11.68	7.49	3.74	22.91
Phyla nudiflora	2.66	0.61	3.74	7.01
Physalis minima	1.59	0.37	0.93	2.90
Solanum surattensis	0.26	0.37	1.87	2.49
Sporolobus diander	1.53	0.98	4.67	7.19
Tephrosia purpuria	5.34	1.72	3.74	10.80
Tridax procumbens	6.70	4.30	2.80	13.80
Vernonia conyzoides	0.18	2.83	2.80	5.81
Xanthium strumarium	0.05	0.74	3.74	4.52
Zizyphus jujuba	1.59	0.37	2.80	4.77
COLUMN IDENTIFICATION				
R.B	*Relative Basal area*			
R.D	*Relative Density*			
R.Fr	*Relative Frequency*			
IVI	*Importance Value Index*			

ANNEXURE-XI
ECOLOGICAL DETAILS

Name of the plant species	R.B	R.D	R.FR	IVI
Apluda sp	0.04	9.38	3.67	13.09
Aristida sp	0.05	11.63	4.59	16.27
Bidens sp	1.53	3.47	3.67	8.67
Blumea so	7.76	7.81	4.59	20.16
Boerheavia diffusa	2.40	0.87	2.75	6.02
Borreria strictus	6.21	1.56	4.59	12.36
Bothriochloe pusella	0.03	6.60	4.59	11.21
Brachirio racemosa	0.04	9.90	2.75	12.69
Cassia tora	3.83	1.39	2.75	7.97
Cassia occidentalis	9.10	3.30	5.50	17.90
Datura metal	6.57	2.60	5.50	14.68
Thymus vulgaris	5.75	2.08	3.67	11.50
Tephrosia purpuria	7.30	3.65	3.67	14.62
Dactylolecterium aegypticum	0.03	6.77	3.67	10.47
Euphorbia hirta	6.67	2.26	3.67	12.59
Euphorbia nivula	2.76	0.69	1.83	5.29
Justicia simplex	10.35	2.60	3.67	16.62
Solanum surattensis	0.08	0.17	0.92	1.17
Sporolobus diander	0.69	0.69	3.67	5.05
Tridax procumbens	2.93	2.95	2.75	8.64
Vernonia conyzoides	0.10	2.60	3.67	6.38
Parthenium hysterophorus	8.80	8.85	5.50	23.15
Calotropis procera	1.00	2.26	4.59	7.84
Xanthium strumarium	0.04	1.04	3.67	4.75
Jatropha sp	8.28	2.08	3.67	14.03
Zizyphus jujuba	1.92	0.69	1.83	4.45
Phyla nudiflora	5.75	2.08	4.59	12.42
COLUMN IDENTIFICATION				
R.B	*Relative Basal area*			
R.D	*Relative Density*			
R.Fr	*Relative Frequency*			
IVI	*Importance Value Index*			

ANNEXURE-XI
ECOLOGICAL DETAILS

Name of the plant species	**R.B**	**R.D**	**R.FR**	**IVI**
Apluda sp	0.04	7.94	3.81	11.79
Aristida sp	0.07	16.61	4.76	21.44
Bidens sp	1.63	3.61	3.81	9.05
Boerheavia diffusa	5.08	1.81	3.81	10.70
Borreria strictus	6.59	1.62	4.76	12.98
Bothriochloe pusella	0.03	6.86	4.76	11.65
Brachirio racemosa	0.05	11.91	2.86	14.82
Cassia tora	1.02	0.36	0.95	2.33
Cassia occidentalis	6.10	2.17	2.86	11.12
Datura metal	7.67	3.07	5.71	16.45
Thymus vulgaris	7.12	2.53	4.76	14.41
Tephrosia purpuria	5.10	2.53	3.81	11.44
Dactylolecterium aegypticum	0.03	7.04	3.81	10.88
Euphorbia hirta	7.08	2.35	3.81	13.23
Euphorbia nivula	8.05	1.99	4.76	14.80
Justicia simplex	10.98	2.71	3.81	17.50
Solanum surattensis	0.73	1.62	4.76	7.12
Sporolobus diander	0.37	0.36	1.90	2.63
Tridax procumbens	1.83	1.81	0.95	4.59
Vernonia conyzoides	0.12	3.07	2.86	6.05
Parthenium hysterophorus	7.87	7.76	4.76	20.39
Calotropis procera	1.06	2.35	4.76	8.17
Xanthium strumarium	0.04	1.08	3.81	4.94
Jatropha sp	6.59	1.62	3.81	12.02
Zizyphus jujuba	6.10	2.17	4.76	13.03
Phyla nudiflora	8.64	3.07	4.76	16.47
COLUMN IDENTIFICATION				
R.B	*Relative Basal area*			
R.D	*Relative Density*			
R.Fr	*Relative Frequency*			
IVI	*Importance Value Index*			

ANNEXURE-XI
ECOLOGICAL DETAILS

Name of the plant species	R.B	R.D	R.FR	IVI
Alysicarpus moniliformis	3.76	0.98	3.65	8.39
Apluda sp	0.03	7.17	2.92	10.12
Aristida sp	0.05	11.24	3.65	14.94
Bidens sp	1.11	2.61	3.65	7.37
Boerheavia diffusa	2.17	0.81	2.19	5.18
Borreria strictus	5.64	1.47	3.65	10.75
Bothriochloe pusella	0.03	6.19	3.65	9.87
Brachirio racemosa	0.04	10.26	2.19	12.49
Brassica comprestris	2.37	5.54	4.38	12.28
Calotropis procera	0.90	2.12	3.65	6.67
Cassia occidentalis	9.57	3.58	4.38	17.53
Cassia tora	3.48	1.30	2.19	6.97
Chenopodium album	0.84	0.49	1.46	2.78
Convolvulus microphylla	0.02	4.89	2.92	7.83
Crotalaria medicagenia	13.78	3.58	6.57	23.93
Dactylolecterium aegypticum	0.03	6.35	2.92	9.30
Datura metal	6.09	2.28	3.65	12.02
Euphorbia hirta	6.06	2.12	2.92	11.09
Euphorbia nivula	6.89	1.79	3.65	12.33
Indigofera cordifolia	0.90	2.12	4.38	7.40
Jatropha sp	5.64	1.47	2.92	10.02
Justicia simplex	9.40	2.44	2.92	14.76
Parthenium hysterophorus	2.98	3.09	2.19	8.26
Phyla nudiflora	3.91	1.47	2.19	7.57
Physalis minima	1.30	0.49	0.73	2.52
Solanum surattensis	0.63	1.47	3.65	5.74
Sporolobus diander	0.63	0.65	2.92	4.20
Tephrosia purpuria	3.53	1.79	2.92	8.24
Tridax procumbens	5.48	5.70	2.19	13.37
Vernonia conyzoides	0.10	2.61	3.65	6.36
Xanthium strumarium	0.04	0.98	1.46	2.47
Zizyphus jujuba	2.61	0.98	3.65	7.24

COLUMN IDENTIFICATION			
R.B	*Relative Basal area*		
R.D	*Relative Density*		
R.Fr	*Relative Frequency*		
IVI	*Importance Value Index*		

ANNEXURE-XI
ECOLOGICAL DETAILS

TABLE-2.6				
PHYTOSOCIOLOGICAL STUDIES NEAR VILLAGE KOTHIYA				
Name of the plant species	**R.B**	**R.D**	**R.FR**	**IVI**
Acacia nilotica	3.37	1.64	1.72	6.73
phoenix aculis	2.58	1.64	1.72	5.94
Albazia amara	2.96	3.28	3.45	9.69
Albazia procera	2.13	3.28	3.45	8.86
Annona muricata	11.27	4.92	5.17	21.36
Annona squamosa	3.65	3.28	3.45	10.37
Anogeissus pendula	6.16	8.20	8.62	22.98
Azadirachta india	7.58	1.64	1.72	10.94
Boswellia serrata	4.26	6.56	6.90	17.72
Butea monosperma	2.13	3.28	3.45	8.86
Cassia fistula	3.82	6.56	6.90	17.27
Dalbergia sisoo	3.37	4.92	3.45	11.74
Delonix regia	1.07	1.64	1.72	4.43
Dendrocalamus strictus	1.07	1.64	1.72	4.43
Diospyros melanoxylon	2.13	3.28	3.45	8.86
Grewia robusta	8.53	3.28	3.45	15.26
Lannea coramandalica	3.79	3.28	3.45	10.52
Leucena leucophloe	2.13	3.28	3.45	8.86
Peltophorum ferrusinum	7.16	4.92	5.17	17.25
Acacia leucophloe	2.13	3.28	3.45	8.86
Carissa spinarum	6.40	9.84	8.62	24.85
Pithocolobium dulce	2.13	3.28	3.45	8.86
Pongamia glabra	4.26	6.56	6.90	17.72
Prosopis spicegera	3.79	3.28	1.72	8.79
Sterculia urens	2.13	3.28	3.45	8.86
COLUMN IDENTIFICATION				
R.B	*Relative Basal area*			
R.D	*Relative Density*			
R.Fr	*Relative Frequency*			
IVI	*Importance Value Index*			

ANNEXURE-XI
ECOLOGICAL DETAILS

Name of the plant species	**R.B**	**R.D**	**R.FR**	**IVI**
Acacia nilotica	7.30	6.06	5.17	18.53
Phoenix aculis	2.63	1.52	1.72	5.87
Albazia amara	3.02	3.03	3.45	9.50
Albazia procera	2.17	3.03	3.45	8.65
Annona squamosa	3.72	3.03	3.45	10.19
Anogeissus pendula	2.17	3.03	3.45	8.65
Azadirachta india	7.73	1.52	1.72	10.97
Boswellia serrata	3.26	4.55	5.17	12.98
Butea monosperma	2.17	3.03	3.45	8.65
Cassia fistula	3.89	6.06	6.90	16.85
Dalbergia sisoo	8.69	7.58	6.90	23.16
Delonix regia	5.43	7.58	6.90	19.90
Dendrocalamus strictus	3.43	1.52	1.72	6.67
Grewia robusta	8.69	3.03	3.45	15.17
Lannea coramandalica	3.86	3.03	3.45	10.34
Leucena leucophloe	2.17	3.03	3.45	8.65
Peltophorum ferrusinum	8.76	10.61	8.62	27.99
Acacia leucophloe	2.17	3.03	3.45	8.65
Carissa spinarum	3.03	4.55	5.17	12.75
Pithocolobium dulce	4.83	7.58	6.90	19.30
Pongamia glabra	7.00	10.61	10.34	27.95
Prosopis spicegera	3.86	3.03	1.72	8.62
COLUMN IDENTIFICATION				
R.B	*Relative Basal area*			
R.D	*Relative Density*			
R.Fr	*Relative Frequency*			
IVI	*Importance Value Index*			

ANNEXURE-XI
ECOLOGICAL DETAILS

Name of the plant species	R.B	R.D	R.FR	IVI
Acacia nilotica	6.65	5.97	5.08	17.70
phoenix aculis	2.40	1.49	1.69	5.58
Albazia amara	2.75	2.99	3.39	9.12
Albazia procera	1.98	2.99	3.39	8.35
Aegle marmelos	8.80	8.96	6.78	24.53
Anogeissus pendula	1.98	2.99	3.39	8.35
Azadirachta india	7.04	1.49	1.69	10.23
Boswellia serrata	2.97	4.48	5.08	12.53
Butea monosperma	3.96	5.97	6.78	16.71
Cassia fistula	1.56	2.99	3.39	7.94
Dalbergia sisoo	7.92	7.46	6.78	22.16
Delonix regia	4.95	7.46	6.78	19.19
Grewia robusta	7.92	2.99	3.39	14.29
Lannea coramandalica	3.52	2.99	3.39	9.89
Leucena leucophloe	1.98	2.99	3.39	8.35
Peltophorum ferrusinum	7.98	10.45	8.47	26.90
Acacia leucophloe	1.98	2.99	3.39	8.35
Carissa spinarum	2.76	4.48	5.08	12.32
Pithocolobium dulce	4.40	7.46	6.78	18.64
Pongamia glabra	2.97	4.48	5.08	12.53
Prosopis spicegera	13.54	5.97	6.78	26.29
COLUMN IDENTIFICATION				
R.B	*Relative Basal area*			
R.D	*Relative Density*			
R.Fr	*Relative Frequency*			
IVI	*Importance Value Index*			

ANNEXURE-XI
ECOLOGICAL DETAILS

Name of the plant species	R.B	R.D	R.FR	IVI
Acacia nilotica	3.48	5.17	5.45	14.10
Phoenix aculis	2.50	1.72	1.82	6.05
Albazia amara	2.87	3.45	3.64	9.96
Albazia procera	2.07	3.45	3.64	9.15
Anogeissus pendula	5.98	8.62	9.09	23.69
Azadirachta india	23.36	5.17	5.45	33.98
Butea monosperma	5.17	8.62	9.09	22.89
Cassia fistula	3.71	6.90	7.27	17.87
Dalbergia sisoo	3.27	5.17	3.64	12.08
Delonix regia	1.03	1.72	1.82	4.58
Grewia robusta	10.12	5.17	5.45	20.75
Leucena leucophloe	2.07	3.45	3.64	9.15
Ficus hispida	5.11	1.72	1.82	8.65
Peltophorum ferrusinum	6.95	5.17	5.45	17.58
Acacia leucophloe	2.07	3.45	3.64	9.15
Carissa spinarum	6.21	10.34	9.09	25.65
Pithocolobium dulce	2.07	3.45	3.64	9.15
Pongamia glabra	4.14	6.90	7.27	18.31
Prosopis spicegera	3.68	3.45	1.82	8.95
Sterculia urens	4.14	6.90	7.27	18.31
COLUMN IDENTIFICATION				
R.B	*Relative Basal area*			
R.D	*Relative Density*			
R.Fr	*Relative Frequency*			
IVI	*Importance Value Index*			

ANNEXURE-XI
ECOLOGICAL DETAILS

Name of the plant species	**R.B**	**R.D**	**R.FR**	**IVI**
Acacia nilotica	8.99	9.46	6.45	24.90
Phoenix aculis	8.47	4.05	4.84	17.36
Albizia amara	7.32	8.11	8.06	23.49
Albizia a procera	1.94	2.70	3.23	7.87
Annona squamosa	3.31	2.70	3.23	9.24
Anogeissus pendula	1.94	2.70	3.23	7.87
Azadirachta india	6.89	1.35	1.61	9.85
Boswellia serrata	2.91	4.05	4.84	11.80
Butea monosperma	3.23	6.76	6.45	16.44
Cassia fistula	1.73	2.70	3.23	7.66
Dalbergia sisoo	7.75	6.76	6.45	20.96
Delonix regia	4.84	6.76	6.45	18.05
Dendrocalamus strictus	3.06	1.35	1.61	6.03
Grewia robusta	7.75	2.70	3.23	13.68
Lannea coramandalica	3.44	2.70	3.23	9.37
Leucena leucophloe	1.94	2.70	3.23	7.87
Peltophorum ferrusinum	7.81	9.46	8.06	25.33
Acacia leucophloe	1.94	2.70	3.23	7.87
Carissa spinarum	2.70	4.05	4.84	11.60
Pithocolobium dulce	4.30	6.76	6.45	17.51
Pongamia glabra	4.30	6.76	6.45	17.51
Prosopis spicegera	3.44	2.70	1.61	7.76
	100	**100**	**100**	**300**
COLUMN IDENTIFICATION				
R.B	*Relative Basal area*			
R.D	*Relative Density*			
R.Fr	*Relative Frequency*			
IVI	*Importance Value Index*			

ANNEXURE-XII
LANDUSE PATTERN

Sr. No.	Name of Tehsil & District	Name of Village	Forest Land	Total Irrigated Land	Un Irrigated Land	Cultivable Waste Land	Area not Available for Cultivation	Total Land
0-3 Km	**Hurda**							
1	(Bhilwara)	Agoocha	0.00	325.00	790.00	1111.00	1065.00	3291.00
2		Bhairoon Khera	0.00	37.19	26.02	119.08	22.16	204.45
3		Amartiya	0.00	139.30	31.18	273.12	120.63	564.23
4		Balapura	0.00	73.08	18.00	243.06	30.07	364.21
5		Bhagwanpura	0.00	150.91	163.30	88.23	139.13	541.57
6		Deopura	0.00	63.17	47.03	71.04	33.05	214.29
7		Gajsinghpura	0.00	83.14	45.16	115.22	50.03	293.55
8	**Shahpura**	Khera Palola	0.00	38.00	169.00	125.00	40.27	372.27
9	(Bhilwara)	Kothiya	0.00	432.00	606.00	603.00	659.80	2300.80
10		Kalyanpura	0.00	82.00	144.52	35.00	47.00	308.52
11		Purani Rajyas	0.00	322.00	85.00	136.36	280.00	823.36
		Sub Total	**0.00**	**1745.79**	**2125.21**	**2920.11**	**2487.14**	**9278.25**
3-7 Km								
12	**Hurda**	Hurda Magra	266.74	6.68	1341.17	1223.26	196.66	3034.51
13	(Bhilwara)	Anandipura	0.00	39.00	93.40	25.00	28.00	185.40
14		Lachhmipura	0.00	37.00	101.00	88.65	32.00	258.65
15		Kotri	0.00	140.00	553.00	339.00	123.44	1155.44
16		Barantiya	0.00	113.08	352.04	734.12	341.10	1540.34
17		Jaisinghpura	0.00	192.34	213.33	11.03	82.17	498.87
18		Sultanpura	0.00	132.24	200.13	222.17	426.13	980.67
19		Chainpuriya	0.00	146.00	301.00	73.41	127.00	647.41
20	**Shahpura**	Araniya Chauhan	0.00	97.44	110.92	125.93	24.39	358.68
21	(Bhilwara)	Daulatpura	0.00	26.94	17.14	5.44	8.21	57.73
22		Ranjeetpura	0.00	15.20	15.29	10.63	14.89	56.01
23		Bagthala	0.00	76.38	97.46	87.40	40.82	302.06
24		Kayampura	0.00	29.52	39.00	71.00	19.00	158.52
25		Itariya	0.00	118.53	366.99	183.94	235.60	905.06
26		Purani Arwar	0.00	373.00	76.00	344.12	380.00	1173.12
27		Nai Arwar	0.00	20.00	146.00	69.92	78.00	313.92
28		Sardarpura	0.00	19.00	97.00	60.98	52.00	228.98
29		Beh Ka Khera	0.00	31.01	43.07	185.28	22.13	281.49
		Sub Total	**266.74**	**1613.36**	**4163.94**	**3861.28**	**2231.54**	**12136.86**
7-10 Km								
30	**Hurda**	Gulabpura (Rural)	0.00	0.00	0.00	0.00	0.00	0.00
31	(Bhilwara)	Hurda Seja	0.00	317.27	681.59	42.47	125.55	1166.88
32		Barla	0.00	78.05	77.05	731.08	270.05	1156.23
33		Chatarpura	0.00	98.09	126.11	143.04	164.05	531.29
34		Balwantpura	0.00	89.00	42.00	6.80	54.00	191.80
35		Bhojras	0.00	458.00	237.54	188.83	481.87	1366.24
36		Lachhmanpura	0.00	77.00	136.00	14.00	30.61	257.61
37		Apaliyas	0.00	353.00	44.00	56.00	97.17	550.17
38		Roopaheli	0.00	290.92	412.46	1280.79	466.96	2451.13
39		Haripura	0.00	93.31	122.15	82.84	37.93	336.23
40	**Shahpura**	Baori	0.00	191.67	85.02	118.68	43.40	438.77
41	(Bhilwara)	Barla (Arwar Ka)	0.00	65.00	81.00	100.33	157.00	403.33
42		Sangariya	0.00	305.00	531.00	465.00	384.44	1685.44
43		Khera Rajpura	0.00	50.00	61.86	48.00	45.00	204.86
44		Panotiya	0.00	340.27	225.78	172.75	152.81	891.61
45		Nathriyas	0.00	29.34	256.12	82.80	89.49	457.75
46		Diyas	0.00	106.00	157.00	127.84	275.00	665.84
47		Rampura	0.00	54.12	103.49	199.33	114.81	471.75
48		Khamor	0.00	142.82	1205.05	752.81	711.95	2812.63
49	**Banera**	Jasoriya	0.00	72.58	372.48	353.58	362.28	1160.92
50	(Bhilwara)	Dabla	0.00	208.24	1141.98	531.41	320.49	2202.12
51		Gharta	0.00	127.92	772.83	237.01	135.76	1273.52
52	**Masuda**	Mokhampura	0.00	22.98	132.17	0.00	77.25	232.40
53	(Ajmer)	Nagar	0.00	120.55	462.96	0.00	367.00	950.51
54	**Bhinay**	Ganahera	0.00	165.00	345.00	75.00	63.39	648.39
55	(Ajmer)	Barli	0.00	525.00	751.00	769.00	508.00	2553.00
56		Mataji Ka Khera	0.00	76.02	281.03	119.60	80.40	557.05
57		Deoliya Kalan	0.00	330.05	1690.36	391.05	532.05	2943.51

ANNEXURE-XII
LANDUSE PATTERN

58		Kheri	0.00	62.00	195.00	117.00	106.00	480.00
		Sub Total	**0.00**	**4849.20**	**10730.03**	**7207.04**	**6254.71**	**29040.98**
0-10 Km		**Grand Total**	**266.74**	**8208.35**	**17019.18**	**13988.43**	**10973.39**	**50456.09**

ANNEXURE-XIII
DEMOGRAPHIC DETAILS

v																					
Sl.No.	**Name of the Village**	**DWF**	**Tp**	**W**	**T**	**TW**	**HP**	**R**	**C**	**L**	**S**	**O**	**P O**	**TO**	**PT**	**P**	**B**	**RS**	**NW**	**CB**	**COB**
0-3 Km																					
1	Agoocha	1	1	1	1	2	1	2	2	2	2	2	1	0	0	90	1	0	0	1	0
2	Bhairoon Khera	1	2	1	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0
3	Amartiya	1	2	1	2	2	1	2	2	2	2	2	0	0	0	1	0	0	0	0	0
4	Balapura	1	2	1	2	2	1	2	2	2	2	2	0	0	0	1	0	0	0	0	0
5	Bhagwanpura	1	2	1	2	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
6	Deopura	1	2	1	2	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
7	Gajsinghpura	1	2	1	2	2	1	2	2	2	2	2	0	0	0	1	0	0	0	0	0
8	Khera Palola	1	2	1	2	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
9	Kothiya	1	1	1	2	2	1	2	2	2	2	2	1	0	0	20	1	0	0	1	0
10	Kalyanpura	1	2	1	1	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
11	Purani Rajyas	1	2	1	1	2	1	1	2	2	2	2	0	0	0	0	0	0	0	0	0
	Sub Total	**11**	**20**	**11**	**19**	**22**	**12**	**21**	**22**	**22**	**22**	**22**	**2**	**0**	**0**	**113**	**2**	**0**	**0**	**2**	**0**
3-7 Km																					
12	Hurda Magra	1	1	1	1	2	1	2	2	2	2	2	1	0	0	55	1	0	0	1	1
13	Anandipura	1	2	1	2	2	1	2	2	2	2	2	0	0	0	1	0	0	0	0	0
14	Lachhmipura	1	1	1	2	2	1	2	2	2	2	2	0	0	0	1	1	0	0	0	0
15	Kotri	1	1	1	1	2	1	2	2	2	2	2	1	0	0	1	1	0	0	0	1
16	Barantiya	1	2	1	2	2	1	2	2	2	2	2	1	0	0	1	1	0	0	0	0
17	Jaisinghpura	1	2	1	2	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
18	Sultanpura	1	2	1	2	2	1	2	2	2	2	2	0	0	0	1	0	0	0	0	0
19	Chainpuriya	1	2	1	1	2	1	2	2	2	2	2	0	0	0	1	0	0	0	0	0
20	Araniya Chauhan	1	1	1	2	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
21	Daulatpura	1	1	1	2	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
22	Ranjeetpura	1	1	2	2	2	1	2	2	2	2	2	0	0	0	0	1	0	0	0	0
23	Bagthala	1	1	1	2	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
24	Kayampura	1	1	1	2	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
25	Itariya	1	2	1	1	2	1	2	2	2	2	2	1	0	0	0	1	0	0	0	0
26	Purani Arwar	1	2	1	2	2	1	2	2	2	2	2	1	0	0	1	1	0	0	0	0
27	Nai Arwar	1	2	1	2	2	1	2	2	2	2	2	0	0	0	1	1	0	0	0	0
28	Sardarpura	1	1	1	2	1	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
29	Beh Ka Khera	1	2	1	2	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
	Sub Total	**18**	**27**	**19**	**32**	**35**	**18**	**36**	**36**	**36**	**36**	**36**	**5**	**0**	**0**	**63**	**8**	**0**	**0**	**1**	**2**
7-10 Km																					
30	Gulabpura (Rural)	1	2	1	2	2	1	2	2	2	2	2	0	0	0	0	1	0	0	0	0
31	Hurda Seja	1	1	1	1	2	1	2	2	2	2	2	1	0	0	55	1	0	0	1	0
32	Barla	1	2	1	2	2	1	2	2	2	2	2	1	0	0	0	1	0	0	0	0
33	Chatarpura	1	2	1	2	2	1	2	2	2	2	2	0	0	0	1	0	0	0	0	0
34	Balwantpura	1	2	1	2	2	1	2	2	2	2	2	0	0	0	1	0	0	0	0	0
35	Bhojras	1	2	1	1	1	1	2	1	2	2	2	1	0	0	4	1	0	0	0	0
36	Lachhmanpura	1	2	1	2	2	1	2	2	2	2	2	0	0	0	1	0	0	0	0	0
37	Apaliyas	1	2	1	2	2	1	2	2	2	2	2	0	0	0	3	0	0	0	0	0
38	Roopaheli	1	1	1	1	1	1	2	2	2	2	2	1	0	0	50	1	1	0	1	0
39	Haripura	1	2	1	2	2	1	2	2	2	2	2	0	0	0	1	1	0	0	0	0
40	Baori	1	2	1	2	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
41	Barla (Arwar Ka)	1	2	1	2	2	1	2	2	2	2	2	0	0	0	1	1	0	0	0	0
42	Sangariya	1	1	1	1	2	1	2	1	2	2	2	1	0	0	1	1	0	0	0	0
43	Khera Rajpura	1	2	1	2	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
44	Panotiya	1	2	1	2	2	1	2	2	2	2	2	0	0	0	1	1	0	0	0	0
45	Nathriyas	1	2	1	2	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
46	Diyas	1	2	1	2	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
47	Rampura	1	2	1	1	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
48	Khamor	1	1	1	1	2	1	2	2	2	2	2	1	0	0	1	1	0	0	0	0

ANNEXURE-XIII
DEMOGRAPHIC DETAILS

Sl.No.	Name of the Village	DWF	Tp	W	T	TW	HP	R	C	L	S	O	P O	TO	PT	P	B	RS	NW	CB	COB
49	Jasoriya	1	2	1	1	2	1	2	2	2	2	2	0	0	0	1	0	0	0	0	0
50	Dabla	1	1	1	2	2	1	2	2	2	2	2	1	0	0	20	1	0	0	1	0
51	Gharta	1	1	1	1	2	1	2	2	2	2	2	1	0	0	3	1	0	0	0	0
52	Mokhampura	1	2	1	1	2	1	2	2	2	2	2	0	0	0	0	1	1	0	0	0
53	Nagar	1	1	1	1	2	1	1	2	2	2	2	0	0	0	5	0	0	0	0	0
54	Ganahera	1	2	1	1	2	1	2	2	2	2	2	0	0	0	1	1	0	0	0	0
55	Barli	1	1	1	2	2	1	2	2	2	2	2	1	0	0	3	1	0	0	0	0
56	Mataji Ka Khera	1	2	1	2	2	1	2	2	2	2	2	0	0	0	0	1	0	0	0	0
57	Deoliya Kalan	1	1	1	1	1	1	2	2	2	2	2	1	0	0	0	1	0	0	1	0
58	Kheri	1	2	1	1	2	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
	Sub Total	**29**	**49**	**29**	**45**	**55**	**29**	**57**	**56**	**58**	**58**	**58**	**10**	**0**	**0**	**153**	**17**	**2**	**0**	**4**	**0**
0-10 Km	**Grand Total**	**58.00**	**96.00**	**59.00**	**96.00**	**112.00**	**59.00**	**114.00**	**114.00**	**116.00**	**116.00**	**116.00**	**17.00**	**0.00**	**0.00**	**329.00**	**27.00**	**2.00**	**0.00**	**7.00**	**2.00**

Note :

DWF ng Water Facility
Tp : Tap
W : Well
T : Tank
TW Tube Well
HP Hand Pump
R : River
C : Canal
L : Lake
S : Spring
O : Others
PO Post Office
TO egraph Office
PT Telegraph Offices
P : Phone
B : Bus
RS ailway Service
NW gable Waterways
CB mmercial Bank
CoB operative Bank