CHAPTER – 7
ENVIRONMENT IMPACT ASSESSMENT

Environment Impact Assessment of any project is done to evaluate the changes in air, noise, water, land, biological and socio-economic environment. In the present study, the details for air, noise and biological environment are taken from records of G.M.D.C Ltd. Author has been fortunate to be associated with Shri D.A. Pancholi of Environment Research Group (ERG) of G.M.D.C, Ltd. for carrying out such studies at Rajpardi mine site during 2001 and 2002 field campaigns. For the want of proper equipments and logistical support, there was no way author could have done these studies on his own. However, the water and land environments have been studied by the author in detail independently.

7.1 Air Environment

The baseline data on ambient air quality of the project area is essential for evaluating the changes in air quality due to mining operation. Ambient air quality is strongly influenced by seasonal changes, therefore, it is desirable to carryout these studies during winter, summer and post monsoon seasons. The impact zone is considered 10 km radial area from the centre of the mine site (Figure 7.1a, b).

7.1.1 Ambient air quality monitoring station network

For the purpose of monitoring the quality of air, the monitoring network had been set up. The network of air quality surveillance unit is based on following criteria:

- Core area, the zone of highest pollutant concentration within the region. In our case the mine site itself is such a location.
- Topography and terrain characteristics.
- Population density in the impact zone.
- Residential and other sensitive areas.
- Other industrial pockets, if any.

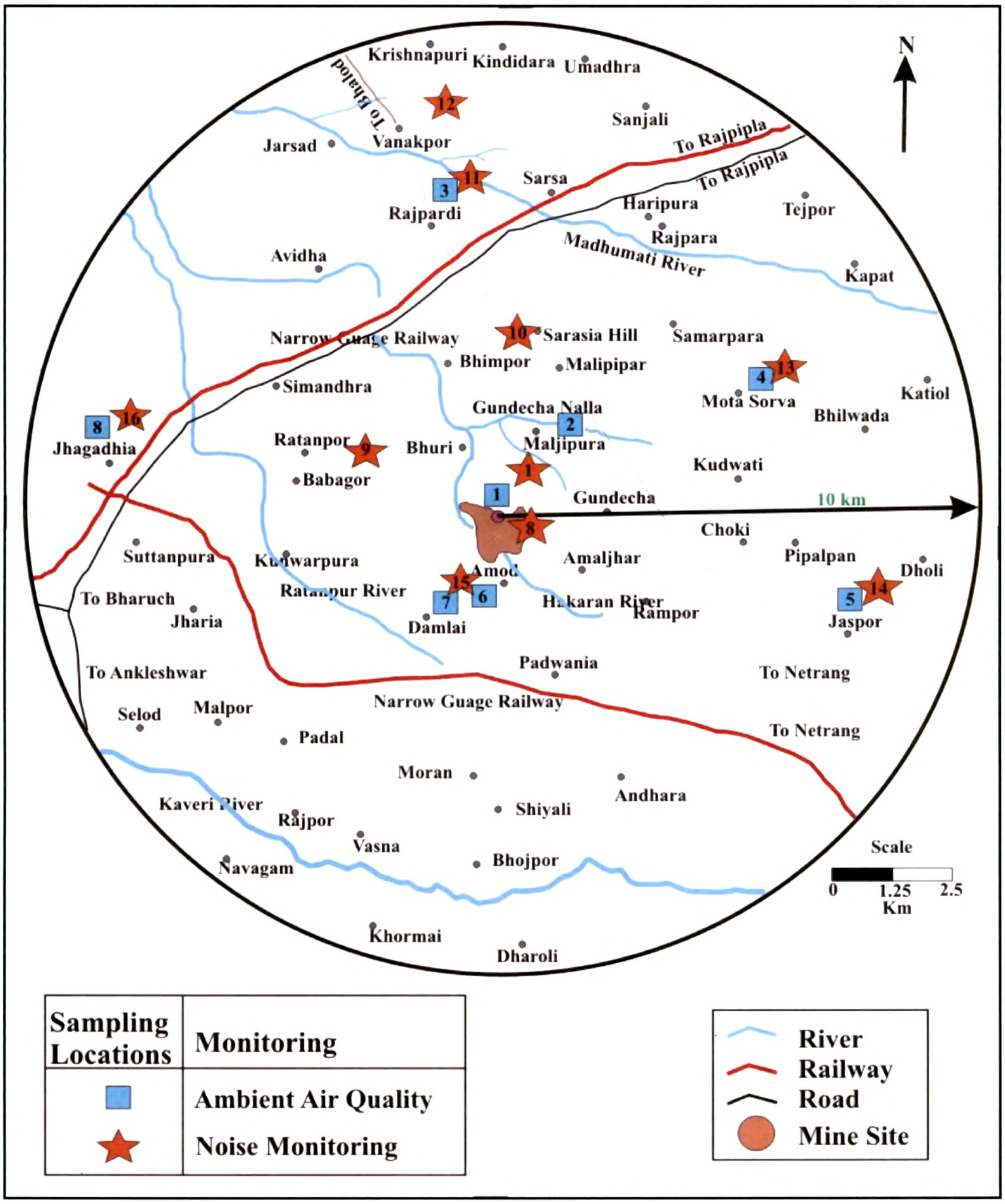

Figure 7.1a: Various locations for air and noise monitoring considered in the 10 km radius

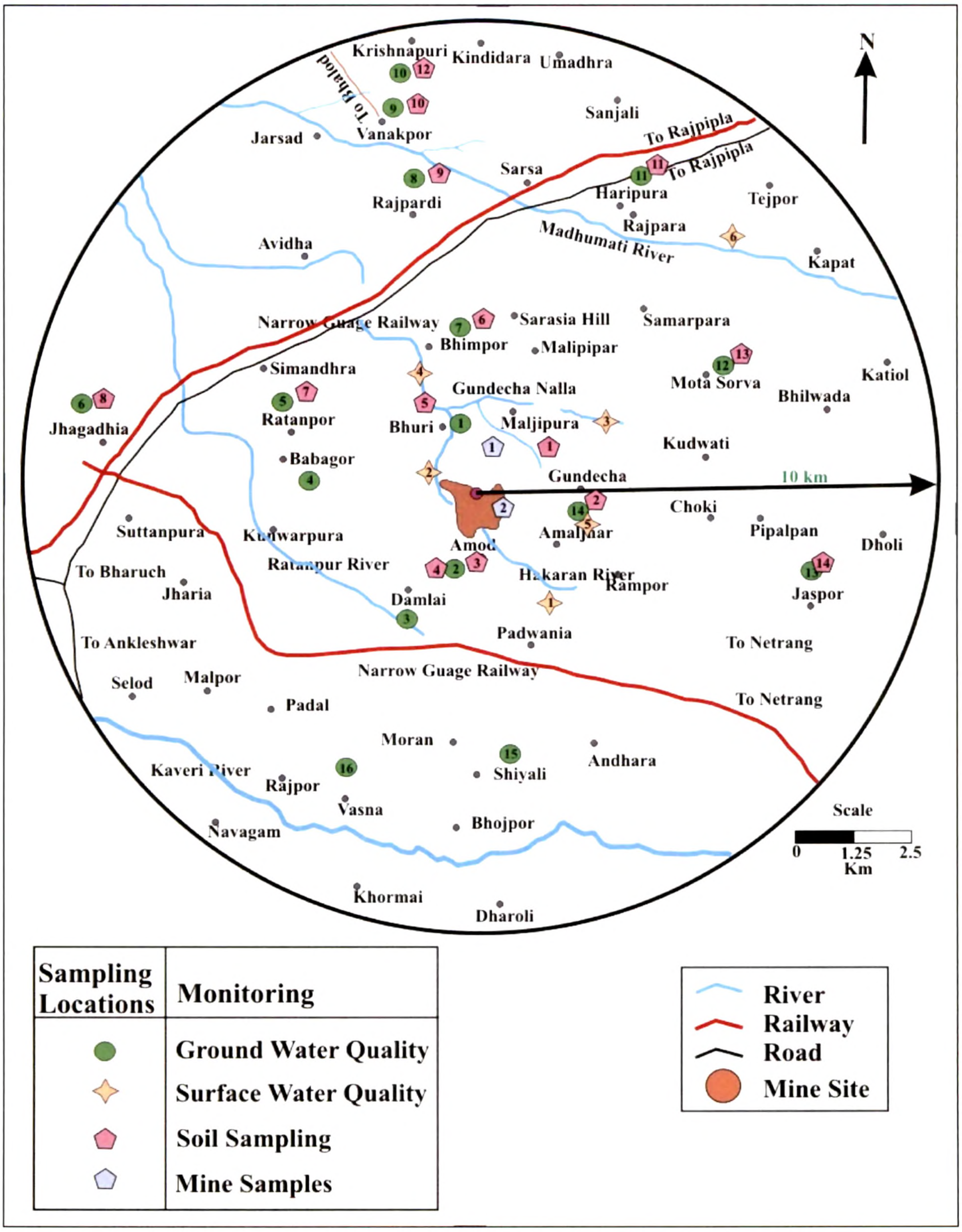

Figure 7.1b: Various sampling locations for surface water, ground water and soil considered in the 10 km radius

Based on these criteria, eight ambient air quality stations were finalized for the year 2001 – 2002 (Table 7.1a); the stations are at mine office, GMDC colony, Rajpardi, Mota Sorva, Jasper, Amod, Damial and Jhagadia. These stations are in different direction and at different distances from the impact zone.

The envisaged air pollutants are suspended particular matter (SPM), SO_2 and NO_X, among these the SPM is expected to be the major pollutant around the mine project. As the distribution of air pollutants are greatly influenced by the weather change, it is imperative to install weather monitoring stations to record continuous micrometeorological parameters like wind speed, direction and ambient temperature at mine site for a sufficiently long period of time during different season.

7.1.1.1 Micro-Meteorology

The data obtained from round the clock monitoring of eight weather stations during every survey season were used to plot wind rose diagrams to understand the dominant wind direction and wind velocity, etc. These diagrams were prepared for all three seasons to take into account the seasonal influence on the wind patterns (Figure 7.2a, b, c). SO_2 and NO_2 was also measured using spectrophotometer on the samples collected from HVS (Table 7.1a, b, c).

Table 7.1a: Location of ambient air quality stations for winter, summer and post monsoon seasons

Sr. No.	Sampling Station	Direction	Aerial Dist. (Km)
1	Mine Office	N	1.8
2	GMDC colony	N	1.2
3	Rajpardi	NNW	5.8
4	Mota sorva	ENE	5.4
5	Jaspor	ESE	7.8
6	Amod	--Reference--	
7	Damial	SSW	2.8
8	Jhagadia	WNW	8

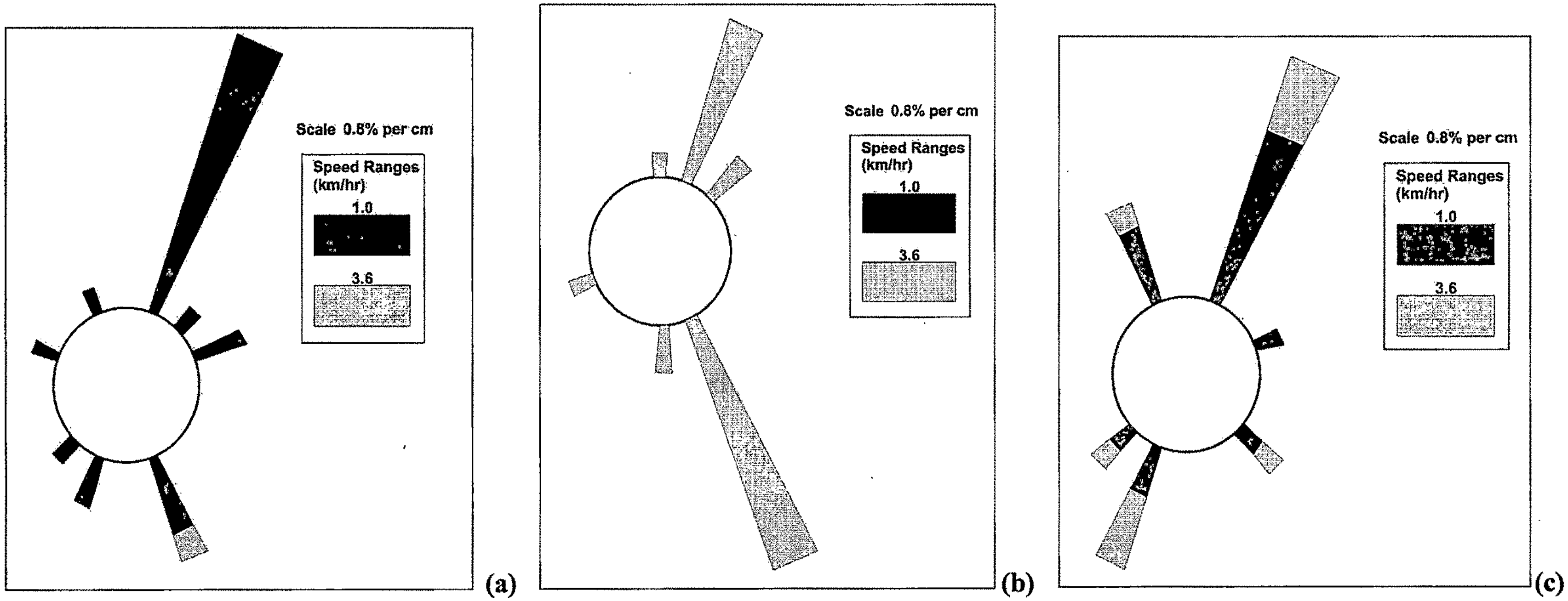

Figure 7.2: (a) Wind rose diagram for winter season (b) Wind rose diagram for summer season (c) Wind rose diagram for post monsoon season (after Bhatt, 2002)

Table 7.1b: SPM, SO_2 and NO_2 data from the eight locations within the impact zone

Station	SPM µg/m³									NO_X µg/m³								
	Minimum			Maximum			Arithmetic Mean			Minimum			Maximum			Arithmetic Mean		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	175	206	123	286	240	142	258	228	133	10.2	9.5	3	31.6	33.7	38	25.1	21	17.6
2	228	210	180	265	265	323	254	245	249	28.7	20.3	8	35.7	28.7	27	31.8	25.6	16.9
3	178	245	119	416	262	156	308	254	135	14.4	12.4	3	29.2	14.4	28	22.4	13.4	16
4	211	156	211	302	194	302	276	177	251	11.4	7.2	12	18.2	11.5	20	15	9.8	15.9
5	195	124	105	271	163	269	249	146	174	5	7.5	5	16.3	9.3	14	12.1	8.6	8.9
6	133	107	69	238	133	94	177	122	82	5.8	8.1	3	22.7	12.5	29.5	16.4	12	18.4
7	132	155	94.5	268	188	102	204	170	97.3	10.8	8.4	3	27.2	12.2	16.4	20.1	10	11.2
8	178	206	94.5	332	255	102	277	235	97.3	16.9	10.4	8	34.4	25.9	20	27.6	19.1	14.2

Table 7.1c: SPM, SO_2 and NO_2 data from the eight locations within the impact zone

Station	SO_2 µg/m³								
	Minimum			Maximum			Arithmetic Mean		
	W	S	P M	W	S	P M	W	S	P M
1	6	7.2	6	31.7	32.4	24	21.7	17.6	13.8
2	6	8.2	6	27.6	15.4	32	19.7	13.9	18.5
3	6	8.1	23	27.8	11.3	25	19.9	9.9	24
4	6	6	9	19.4	8.4	17	12.4	7.6	13.6
5	6	6	8	18.7	6	26	11.6	6	16.9
6	6	6	6	12.7	6	24	9.6	6	17.9
7	6	6	6	16.2	7.7	27.6	12.4	6.8	19
8	6	6	6	36.3	18.1	32	28.7	13.7	20.8

The data shows SPM variation at every location; however, unexpectedly the mine site SPM is on the lower side compared to other sample site like Jhagadia, GMDC colony, etc. This suggests good management of dust at the mine site. In the peripheral areas the vehicular movement has contributed to the higher SPM values. Similarly SO_2 values are also high at mine office, GMDC, colony and Jhagadia location; this is purely on account of higher vehicular density at these places. The NO_2 variation in the area is very low. The value of SPM, SO_2 and NO_2 are all within the prescribed values of CPCB (Annexure –5).

7.2 Noise environment

The noise environment studies were carried out at 16 locations (Figure 7.1). The study encompasses the following aspects:

- Reconnaissance survey
- Equivalent noise level measurements
- Source identification
- Impact of noise exposure

There is variation in the equivalent noise levels at each location on seasonal basis (Table 7.2), except for the mine site, the noise levels were well within the prescribed limits of CPCB (Annexure – 6).

The variation in the noise levels in the impact zone is between 53.3 to 81.0 db (A), 52.9 to 82.1 db (A) and 53.4 to 85.6 db (A) for winter, summer and post monsoon periods respectively. The sources of noise are mainly the machinery operation and vehicular movement at the mine site for overburden and lignite haulage.

Table 7.2: Noise levels for three seasons around study area

Sr. No.	Location	Equivalent Noise levels, Leq [dB(A)]		
		W	S	P M
1	Administrative office	62.3	68.9	60.4
2	Mine office	65.3	70.6	66.4
3	Pump house generator near mines	81	78.5	82
4	Near mining operation	76.2	78	74.23
5	Water pump near mine	78.5	80.6	76.14
6	Near excavator	80.3	82.1	85.6
7	GMDC colony near dispensary	55.3	52.9	53.4
8	Truck yard	67.3	66.4	66.4
9	Babagor hill	70.3	72.5	70.7
10	Bhimpor village	58.8	55.69	55.87
11	Rajpardi market	62.9	63.5	69.54
12	Vanakpor	65.6	66.4	70.6
13	Mota sorva	64.7	62.58	55.4
14	Jaspor village	64.8	69.4	64.7
15	Damlai village	62.3	67.4	63.4
16	Jhagadia market	75.4	70.2	67.3

7.3 Water environment

The average rainfall of the region from 1996 – 2005 is 695 mm. The area lacks perennial rivers, the main source of water for drinking purpose are bore, open wells, hand pumps and the pipe line water supply created by G.M.D.C, Ltd. Karjan canal is providing round the year irrigation in the region and thus contribute to the groundwater recharge. The hydrogeology of the area has already been discussed in the Chapter - 6. In order to understand seasonal variation at each sample site, three season samples were collected and analyzed for the physical, chemical, inorganic and organic nutrients and heavy metal levels in these samples. Following is the assessment of water environment in the impact zone, based on the data of groundwater, surface water and the acid mine pond samples.

7.3.1 Groundwater

The groundwater collected during three seasons has given a consistent data on physico-chemical, inorganic, organic and heavy metal value ranges. Seasonally, the values (Table 6.2a – e) have remained within the prescribed limits of potable water (Annexure 5). The physical and chemical quality of groundwater has remained unaffected due to mining because of the favorable hydro-geological conditions. The aquifer is above the lignite seams; hence leaching of heavy metals from lignite into the groundwater system is ruled out. The quality of water from the impact zone is not different from the surrounding areas. All the variation in the physical and chemical parameters is on account of rock - water interaction, climatic conditions and recharge in the region.

The sulphate and heavy metal content in the ground water, is comparable to the base level values. Thus natural conditions of groundwater aquifer have prevented pollution. The seasonal variation is narrow and compares well with the surrounding groundwater locations of the region.

7.3.2 Surface water

The surface water as such is not available as the streams are not perennial. In the region and in the vicinity of mining area canal irrigation is in practice. All the samples of different season have shown normal variation in physico-chemical, inorganic, heavy metal and biological parameters (Table 7.3a – g). All the samples have agreed well with the CPCB standards.

7.3.3 Waste water

At six different locations (Table 7.4a) waste water sampling was done. The physio-chemical parameters vary widely (Table 7.4b – g). The septic tank inlet, outlet and oxidation pond samples have shown pH from 6.5 to 8.1, turbidity is high for inlet sample (39 NTU) and the outlet sample has shown considerably lower value of turbidity (6.1 NTU). Similar variation is seen in the conductivity values in these samples, showing reduction progressively from inlet to outlet and finally to the oxidation pond sample. The mine water at the pumping location and within mine pit has pH range of 7.7 to 7.8; whereas the stagnant acid mine water has registered pH value of 2.5. There is wide fluctuation in the turbidity and conductivity values of these samples. Inorganic and heavy metal data has also registered wide range for these samples. The seasonal variations are mainly influenced by the increase/decrease in the volume of these water bodies.

7.4 Land environment

The impacts on the land environment due to lignite mining are enumerated by Acharya (2000), Bhatt (2002), Canter (1996), Saxena (1995), Singh (2005) and Bell (1988). The general impact of mining on the environment is highlighted by Valdiya (1988).The area is rocky in patches and the rest of the area has good soil cover. However, there are some additional features such as dumping sites and the mine pits. There is a conspicuous change in the landscape of the area within the mining lease. The moderate climate, fertile soils and good availability of water has ensured good agricultural output in the region.

Table 7.3a: Surface water sampling locations

Sr. No.	Locations
1	Upstream of Hakaran Nallah
2	Downstream of Hakaran Nallah
3	Gundecha Nallah
4	Confluence of Hakaran & Gundecha Nallah
5	Karjan canal
6	Madhumati Nallah

Table 7.3b: Physical parameters of the surface water in the study area

Station	pH			Turbidity (NTU)			Conductivity (mS/cm)			T.D.S. (mg/l)			S.S. mg/l			T.S. mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	7.9	8	7.2	2.6	8.3	3	0.58	0.15	0.68	322	75	396	27	84	30	349	159	426
2	8.2	8.3	8.5	17.5	13.5	33.5	1.23	0.25	1.47	762	118	922	180	112	100	942	230	1022
3	7.9	8.2	8.3	2.7	8.6	7.5	0.7	0.43	0.98	392	212	610	19	85	20	411	297	630
4	8	8	8.3	19.5	14.5	74.5	1.33	1.37	1.63	782	800	1042	120	132	144	902	932	1186
5	7.9	8.2	8.4	1.8	1.4	1.6	0.32	0.14	0.33	162	52	172	16	ND	18	178	52	190
6	8.3	7.9	8.5	1.6	34.5	3.5	0.46	1.36	0.53	252	723	303	12	324	32	264	1047	335

Table 7.3c: Inorganic parameters of the surface water in the study area

Station	Alkalinity as $CaCO_3$ mg/l			Hardness as $CaCO_3$ mg/l								
				T			Ca			Mg		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	210	189	207	220	122	108	85	54	67	135	68	41
2	165	189	127	377	142	287	193	70	186	184	72	101
3	187	203	197	220	142	136	66	62	54	154	80	82
4	195	175	127	465	298	615	203	183	186	262	115	429
5	120	147	117	161	141	116	85	85	63	76	56	53
6	187	147	197	200	131	127	105	50	56	95	81	71

Table 7.3d: Inorganic parameters of the surface water in the study area

Station	SO_4^{-} mg/l			Cl^- mg/l			K^+ mg/l			F^- mg/l			Na^+ mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	19	27	27	52	40	61	2.3	2.4	2.8	1.22	1.83	1.51	64	61	41
2	229	28	359	180	44	159	2.7	2.2	2.1	1.16	2.46	1.46	141	81	109
3	22	32	32	74	65	118	2.5	2.3	2.6	0.99	0.72	1.31	176	64	74
4	239	79	404	180	176	190	3.2	2.8	3.3	1.15	1.35	1.26	141	169	196
5	26	16	15	31	35	40	2.2	1.8	2.1	0.81	ND	0.67	16	16	12
6	19	20	22	35	39	45	2.4	2.2	2.3	0.96	1.08	1.03	43	36	37

Table 7.3e: Organic and nutrient parameters of the surface water in the study area

Station	DO mg/l			BOD mg/l			COD mg/l			PO_4^{3-} mg/l			NH_3-N mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	5.7	5.3	4.8	5.3	<5	8.6	12.3	9.3	15.3	0.76	0.82	0.43	0.43	0.45	0.34
2	4.7	4.7	4.3	<5	5.8	7.1	18.3	13.3	14.3	0.81	0.85	0.49	0.73	0.58	0.29
3	6.4	5.9	6.1	5.2	<5	9.7	11.3	9.3	17.3	0.65	0.72	0.4	0.25	0.32	0.39
4	6.5	6.3	6.4	<5	<5	<5	17.3	16.3	11.3	0.87	0.89	0.55	0.4	0.43	0.39
5	6.1	4.6	4.7	<5	<5	<5	6.3	6.3	8.3	0.63	0.66	0.31	0.25	0.28	0.31
6	5.1	4.7	4.3	6.1	<5	5.6	6.3	15.3	7.3	0.86	0.88	0.55	0.4	0.45	0.44

Table 7.3f: Heavy metals in the surface water in the study area

Station	Fe mg/l			Ni mg/l			Zn mg/l			Cu mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	0.16	0.18	0.13	ND	ND	ND	0.03	ND	ND	ND	ND	ND
2	0.47	0.47	0.47	0.05	0.05	0.06	ND	ND	ND	ND	ND	ND
3	0.12	0.13	0.09	ND	ND	ND	ND	ND	ND	ND	ND	ND
4	0.47	0.74	0.74	ND	ND	ND	0.02	ND	ND	ND	ND	ND
5	0.34	0.46	0.29	0.05	0.08	0.05	ND	ND	ND	ND	ND	ND
6	0.08	0.08	0.08	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 7.3g: Heavy metals in the surface water in the study area

Station	Co mg/l			Mn mg/l			Cr mg/l			Cd mg/l			Pb mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	0.1	0.11	0.08	ND	ND	ND	0.04	ND	ND	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	0.08	0.09	0.07	ND	ND	ND	ND	ND	ND	0.05	0.06	0.03
3	0.11	0.11	0.09	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.05	0.05	ND
4	0.07	0.07	0.07	0.06	0.06	0.06	ND	ND	ND	ND	ND	ND	0.05	0.06	0.02
5	0.09	0.1	0.07	0.06	0.08	0.05	ND	ND	ND	ND	ND	ND	0.05	0.05	ND
6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.05	0.06	ND

Table 7.4a: Wastewater sampling locations

Sr. No.	Locations
1	Septic tank - inlet
2	Septic tank - outlet
3	Oxidation pond - outlet
4	Pumped Acid mine water
5	Acid mine water - inside the mine
6	Acid mine water - old stock (Stagnant)

Table 7.4b: Physical parameters of the wastewater in the study area

Station	pH			Turbidity (NTU)			Conductivity (mS/cm)			T.D.S. (mg/l)			S.S. mg/l			T.S. mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	6.5	7.2	7.7	26	39	38	2.32	2.03	2.74	1356	1612	1741	244	344	140	1600	1956	1881
2	7.2	6.8	7.9	3.2	6.1	31	2.36	1.52	2.61	1300	956	1681	24	56	80	1324	1012	1761
3	7.3	7.6	8.1	1.6	0.9	18	2	1.31	2.53	1230	774	1630	24	8	20	1254	782	1650
4	7.6	7.8	8	8.4	6.8	18	1.36	2.26	1.4	840	1478	840	111	72	64	951	1550	904
5	7.2	7.7	7.4	13	8.1	17	1.34	0.34	1.34	820	206	849	110	84	128	930	290	977
6	2.6	2.5	2.8	2.1	21	1	3.5	1.1	4.31	2190	576	2743	ND	244	28	2035	820	2771

Table 7.4c: Inorganic parameters of the wastewater in the study area

Station	Alkalinity as $CaCO_3$ mg/l			Hardness as $CaCO_3$ mg/l								
				T			Ca			Mg		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	759	630	640	261	255	197	125	167	122	136	88	75
2	726	588	625	243	254	161	118	127	86	125	127	75
3	565	140	620	224	245	132	106	127	47	118	118	85
4	150	700	100	342	274	591	195	137	169	147	137	422
5	140	168	168	346	147	364	178	78	179	168	69	185
6	0	0	0	1166	421	160	610	176	103	556	245	57

Table 7.4d: Inorganic parameters of the wastewater in the study area

Station	SO_4^{--} mg/l			Cl^- mg/l			K^+ mg/l			F^- mg/l			Na^+ mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	54	133	50	254	242	321	45	12	13	0.54	1.63	1.03	362	365	360
2	35	52	38	208	225	301	23	8.5	9	0.45	1.03	1.00	270	275	314
3	15	44	26	196	183	259	15	2.1	5	0.26	0.51	0.64	57	155	285
4	74	43	18	145	264	140	2.3	7.5	1.6	0.6	0.34	0.64	250	410	95
5	253	52	269	172	85	168	2.4	1	2.6	0.48	2.2	0.58	236	83	241
6	1050	615	1820	125	30	207	3	1.8	2.1	0.84	ND	0.72	125	143	135

Table 7.4e: Organic and nutrient parameters of the wastewater in the study area

Station	DO mg/l			BOD mg/l			COD mg/l			PO_4^{3-} mg/l			NH_3-N mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	1.1	1.2	1.3	92	17	47	90	58	145	4.25	4.49	4.21	6	ND	5.59
2	3	3.3	3.2	23	15	22	81	52	88	1.63	4.26	1.55	5.3	ND	5.6
3	4.3	4.1	4	14	13	10	12	24	24	1.6	1.68	1.55	0.2	0.06	0.15
4	--	--	--	--	--	--	20	22	18	0.32	0.41	0.29	0.12	0.05	0.11
5	--	--	--	--	--	--	25	29	27	0.29	0.32	0.27	0.35	ND	0.38
6	--	--	--	--	--	--	21	18	24	0.35	0.33	0.33	1.5	1.5	1.77

Table 7.4f: Heavy metals in the wastewater in the study area

Station	Fe mg/l			Ni mg/l			Zn mg/l			Cu mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	0.15	0.17	0.11	0.06	0.07	0.06	ND	ND	ND	0.01	0.01	0.01
2	0.05	0.05	0.04	ND	ND	ND	ND	ND	ND	ND	ND	ND
3	ND	ND	ND	0.04	0.04	0.03	ND	ND	ND	ND	ND	ND
4	0.65	0.69	0.63	0.04	0.04	0.04	0.03	0.03	0.03	ND	ND	ND
5	6.6	6.6	6.6	0.07	0.07	0.05	0.03	0.04	0.02	0.01	0.04	0.01
6	7.3	7.33	7.21	1.7	1.7	1.68	6	6	5.8	0.99	0.99	0.85

Table 7.4g: Heavy metals in the wastewater in the study area

Station	Co mg/l			Mn mg/l			Cr mg/l			Cd mg/l			Pb mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	ND	ND	ND	0.08	0.08	0.08	ND	ND	ND	ND	ND	ND	0.03	0.03	0.03
2	ND	ND	ND	0.03	0.05	0.02	ND	ND	ND	ND	ND	ND	0.03	0.04	0.01
3	0.07	0.07	0.06	0.03	0.03	0.03	ND	ND	ND	ND	ND	ND	0.03	0.03	0.03
4	0.03	0.05	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.03	0.04	0.02
5	0.09	0.09	0.08	0.14	0.14	0.13	ND	ND	ND	0.01	0.01	ND	0.04	0.05	0.03
6	3.8	3.8	3.3	1.75	1.75	1.71	ND	ND	ND	0.02	0.02	0.02	0.06	0.07	0.04

The soil and dump samples were taken (Table 7.5a) to study the physical and chemical properties (Table 7.5b – f) and to see deviations in these parameters compared with the soils in the agricultural areas, due to mining influence.

The bulk densities of soils range between 1.08 to 2.71 gm/cc and the porosity of these soils ranges between 38.75% and 50.9% for all the seasons.

The variations in the pH, EC, Ca^{++}, Mg^{++}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-}, HCO_3^{-} and PO_4^{3-} in these soils are not much influenced by the climatic conditions. Similar is the case of cation exchange capacity of these soils. The organic matter carbon and water holding capacities of these soils are also unchanged throughout the year. The textural characteristics of these soils based on gravel, sand, silt and clay proportion puts them in loamy sand, sand silty loam soil categories.

Table 7.5a: Soil sampling locations

Sr. No.	Sampling Locations
	Village Samples
1	Maljipura
2	Amaljhar
3	Amod
4	Damlai
5	Bhuri
6	Bhimpor
7	Ratanpor
8	Jhagadia
9	Rajpardi
10	Vanakpor
11	Haripura
12	Krishnapuri
13	Mota sorva
14	Jaspor
	Mine Samples
15	Over burden Silica dump
16	Mine soil

Table 7.5b: Physical properties of the soil in the study area

Station	Density (gm/cc)						Porosity Percent		
	Bulk (b)			Particle (p)			(p-b/p)x100		
	W	S	P M	W	S	P M	W	S	P M
1	1.17	1.15	1.25	2.2	2.2	2.37	46.8	47.73	47.2
2	1.23	1.25	1.29	2.31	2.31	2.43	46.7	45.89	46.9
3	1.32	1.26	1.3	2.2	2.16	2.21	40	41.67	41.1
4	1.28	1.29	1.13	2.31	2.28	2.1	44.5	43.42	46.2
5	1.08	1.13	1.22	2.21	2.23	2.43	50.9	49.33	49.8
6	1.18	1.27	1.27	2.23	2.38	2.26	47	46.64	43.8
7	1.26	1.24	1.24	2.21	2.11	2.46	42.9	41.23	49.6
8	1.16	1.23	1.26	2.32	2.41	2.18	50	48.96	42.2
9	1.17	1.25	1.37	2.05	2.17	2.35	42.8	42.40	41.7
10	1.3	1.3	1.36	2.18	2.16	2.61	40.3	39.81	47.8
11	1.2	1.26	1.35	2.37	2.43	2.27	49.3	48.15	40.5
12	1.19	1.48	1.16	2.1	2.44	2.2	43.3	39.34	47.2
13	1.45	1.27	1.31	2.41	2.38	2.27	39.8	46.64	42.2
14	1.14	1.2	1.36	2.15	2.16	2.31	46.9	44.44	41.1
15	1.64	1.66	1.62	2.7	2.71	2.71	39.2	38.75	40.2
16	1.31	1.35	1.27	2.58	2.65	2.52	49.2	49.06	49.6

Table 7.5c: Organic carbon and water holding capacity of the soil in the study area

Station	Organic Carbon (%)			Water Holding Capacity (%)		
	W	S	P M	W	S	P M
1	0.98	0.68	0.53	47.3	46.7	45.6
2	0.33	0.35	0.48	41.5	42.3	41.2
3	0.3	0.39	0.65	45.4	46.2	46.3
4	0.89	0.65	0.64	43.1	44.6	43.8
5	0.49	0.16	0.41	44.8	45.3	42.3
6	0.53	0.61	0.85	42.5	43.5	44.2
7	0.63	0.45	0.87	45	46.5	46.5
8	0.93	0.78	0.82	46.1	47.5	47.1
9	0.83	0.56	0.95	47.5	47.6	45.3
10	0.4	0.52	0.75	45.3	45.6	41.3
11	0.77	0.35	0.65	41	43.2	42.1
12	0.21	0.2	0.61	47.4	41.2	47.5
13	0.1	0.44	0.51	40.7	46.2	43.1
14	0.61	0.81	0.62	46.5	47.3	43.6
15	0.18	0.22	0.32	34.7	35.1	36.2
16	0.6	0.65	0.51	37.2	38.6	36.4

Table 7.5d: Cation exchange properties of the soil in the study area

Station	Ca^{++} meq/100gm			Mg^{++} meq/100gm			Na^{+} meq/100gm			K^{+} meq/100gm			ESP		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	10	11.18	10.6	83.3	82.31	78.41	15.2	16.31	4.48	6.53	7.43	6.43	13.2	13.91	13.17
2	33	31.12	29.08	41.6	45.7	40.11	11.2	10.14	9.06	2.43	1.89	1.72	12.7	11.41	11.32
3	22	24.2	18.08	33.4	35.51	28.52	6.95	7.52	5.18	3.84	3.41	2.97	10.5	10.79	9.46
4	10.7	11.82	10.35	40	41.23	38.15	8.69	7.46	6.71	2.69	2.73	1.34	13.9	11.79	11.86
5	4.75	3.78	3.14	33.3	32.4	28.24	6.52	6.18	5.11	5.12	4.97	4.42	13.12	13.05	12.49
6	5	6.08	12.8	36.6	35.2	60.14	8.69	8.26	9.65	12.1	10.87	24.18	13.9	13.67	9.03
7	14	13.7	19.61	63.3	67.72	46.31	10.4	11.14	10.21	31.7	29.47	4.18	8.73	9.13	12.71
8	22.5	21.43	23.16	50	48.26	81.22	10.8	11.12	16.02	4.35	4.46	5.13	12.32	13.04	12.7
9	27.5	26.61	10.46	96.6	95.26	92.04	16.4	18.73	15.61	6.15	5.31	11.21	11.18	12.92	12.07
10	10.5	11.24	16.77	90	92.38	81.7	19.6	19.21	9.12	26.1	16.13	3.07	13.4	13.82	8.24
11	19	17.98	4.12	86.6	84.7	68.02	10.8	10.18	9.1	3.46	4.27	8.12	9	8.69	10.18
12	20	5.72	21.2	66.6	72.48	86.23	15.1	9.93	14.08	6.79	8.96	7.12	13.91	10.22	10.94
13	5.4	24.61	20.12	70	95.67	41.23	10.8	15.78	10.12	9.1	7.74	8.2	11.33	10.97	12.7
14	22	18.91	19.14	90	65.8	39.12	15.2	15.02	10.23	7.82	7.21	8.26	11.25	14.04	13.32
15	0.5	1.06	1.01	26.6	27.6	26.67	6.34	6.27	5.98	0.16	0.21	0.19	18.86	17.84	17.66
16	1.37	1.42	1.2	28.7	28.2	27.4	8.71	8.11	7.81	1.28	1.21	1.21	21.74	20.82	20.81

Table 7.5e: Chemical properties of soil in 1:2 soil water extract

Station	pH			EC mS/cm			Ca^{++} meq/100gm			Mg^{++} meq/100gm			Na^{+} meq/100gm			K^{+} meq/100gm		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	7.1	7	7.0	0.07	0.09	0.14	1.26	1.94	1.02	2.37	2.67	2.1	0.3	0.36	1.08	0.09	0.07	0.46
2	7	7.2	7.1	0.13	0.14	0.15	3.78	2.11	1.12	0.22	0.93	0.18	2.71	2.16	2.04	0.1	0.07	0.05
3	7.2	7.1	7.2	0.09	0.13	0.16	1.68	1.93	1.08	1.54	2.35	1.23	1.95	2.21	1.9	0.02	0.02	0.01
4	6.7	6.5	6.9	0.23	0.24	0.48	2.94	2.97	2.47	1.48	1.65	1.32	1.08	1.06	1.01	0.08	0.1	0.08
5	7	7	7.1	0.32	0.14	0.25	3.36	2.68	2.63	1.05	1.13	0.87	0.86	0.84	0.66	0.35	0.36	0.31
6	7.1	7	7.4	0.14	0.14	0.28	2.52	2.25	1.42	1.5	1.5	0.88	3.26	3.31	1.47	0.33	0.12	0.34
7	7.7	7.3	7.2	0.21	0.38	0.59	1.26	1.68	1.22	1.97	1.76	0.87	1.52	1.68	0.13	0.35	0.57	0.03
8	6.7	7.1	7.2	0.08	0.19	0.26	1.68	1.88	2.12	1.13	1.11	0.39	0.21	0.25	5.11	0.05	0.06	0.31
9	7.3	7.1	7.5	0.29	0.29	0.48	2.94	2.26	1.83	0.67	0.72	0.82	6.52	6.45	3.81	0.11	0.1	0.44
10	7.4	7.6	7.1	0.23	0.4	0.47	2.1	2.78	0.85	0.71	1.64	0.76	4.34	4.41	0.27	0.33	0.58	0.04
11	6.8	7.1	6.7	0.02	0.25	0.13	0.84	1.08	0.82	1.58	1.95	0.71	0.26	0.31	2.07	0.04	0.08	0.71
12	7.2	6.3	6.9	0.13	0.17	0.46	1.26	1.69	1.26	1.56	1.95	0.84	3.26	2.08	2.01	0.05	0.18	0.12
13	6.8	6.4	7.2	0.1	0.25	0.34	1.68	1.94	0.84	1.54	0.97	0.36	2.17	2.18	0.97	0.18	0.14	0.19
14	6.8	7	7.8	0.06	0.24	0.39	1.68	1.58	0.84	0.24	1.83	0.16	2.17	3.16	0.97	0.1	0.08	0.12
15	6.2	6	6.3	0.08	0.08	0.75	2.52	1.26	2.94	1.09	1.97	0.26	3.26	3.42	1.41	0.028	0.02	1.7
16	5.6	5.2	5.7	0.16	0.28	0.14	2.94	3.41	2.15	2.29	2.03	2.01	3.04	3.02	2.84	0.084	0.04	0.02

Table 7.5f: Chemical properties of soil in 1:2 soil water extract

Station	Cl^- meq/100gm			SO_4^- meq/100gm			NO_3^- meq/100gm			HCO_3^- meq/100gm			PO_4^{3-} meq/100gm		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	0.52	0.6	0.58	0.72	0.68	0.28	0.04	0.05	0.03	0.98	1.37	1.27	0.01	0.013	0.018
2	1.04	1.07	0.57	0.29	0.34	0.21	0.08	0.12	0.09	1.47	1.6	0.91	0.014	0.01	0.032
3	0.52	0.94	0.43	0.5	0.52	0.41	0.1	0.15	0.05	1.22	1.31	1.14	0.027	0.033	0.028
4	1.56	1.08	0.82	0.52	0.56	0.38	0.32	0.14	0.11	0.98	1.14	1.91	0.013	0.014	0.015
5	1.3	0.83	0.96	0.97	0.87	0.96	0.08	0.07	0.04	1.72	1.83	1.37	0.01	0.015	0.021
6	0.39	0.48	0.43	0.37	0.42	0.12	0.15	0.13	0.1	1.47	1.6	1.6	0.084	0.072	0.071
7	0.52	0.96	0.07	1.04	1.1	0.13	0.14	0.17	0.01	2.45	2.41	1.84	0.07	0.068	0.005
8	0.02	0.09	0.98	0.16	0.14	0.11	0.03	0.02	0.07	1.22	2.06	0.91	0.003	0.006	0.011
9	2.08	1.88	1.16	0.31	0.27	0.35	0.02	0.04	0.14	1.72	2.29	1.83	0.038	0.036	0.024
10	1.56	2.88	1.15	0.6	0.53	0.61	0.02	0.06	0.25	1.96	2.52	2.29	0.1	0.115	0.031
11	1.82	1.6	0.12	0.33	0.28	0.27	0.31	0.28	0.11	1.22	1.83	1.14	0.03	0.028	0.053
12	0.02	0.09	0.98	0.22	0.28	0.41	0.02	0.12	0.08	1.96	1.06	0.98	0.017	0.035	0.018
13	0.02	1.02	0.43	0.2	0.66	0.01	0.11	0.02	0.35	0.98	1.97	1.13	0.029	0.048	0.088
14	1.3	0.08	0.42	0.64	0.31	0.09	0.03	0.04	0.21	0.73	2.01	1.14	0.056	0.012	0.014
15	1.04	1.05	0.09	1.14	1.06	0.08	0.07	0.05	0.37	0.73	0.91	0.61	0.014	0.013	0.089
16	2.04	1.81	1.72	0.58	0.62	0.47	0.08	0.09	0.05	0.49	0.68	0.32	0.012	0.016	0.008

Photo 7.1: Generation of suspended particulate matter due to vehicular haulage near the mine area. Also plantation on the dump is seen.

Photo 7.2: Closure view of the dump showing rill erosion and slope failure.

In the case of dump soils the textural attributes are lost. The leachate analysis (Table 7.6a, b) was carried out on the soil and dump samples to understand heavy metal dispersion due to rain water in the region. The leachate heavy metal levels are similar to the data obtained for the water samples and are below the toxicity levels.

Table 7.6a: Locations of samples for leachate analysis

Sample no.	Location
1	Avitha village farm
2	Between Vamkapar & Piadra
3	Between Pipadra & Sanjali
4	Between Samollia & Rajpardi
5	Near Kapat
6	Farm in Kadwani village
7	Between Kadvali to Amod
8	West of Sarasia hill
9	North of Sarasia hill
10	Sarsia hill
11	Gundecha
12	Gundecha
13	Near Mine (Base of Dump on south side)
14	Near Mine (Base of Dump on east side)
15	Near Mine (Base of Dump on north side)
16	Dump at Amod
17	Between Maljipur & Bhuri (Base of Dump)
18	Between Maljipur & Bhuri (Middle of Dump)
19	Between Maljipur & Bhuri (Top of Dump)
20	From the open face in mine

Table 7.6b: Leachate analysis of soil, dump and lignite samples from the study area

No.	Sample Nature	Cr	Cd	Ni	Zn	Mn	Fe	Cu	Pb	Co	Mo
1	Sandy loam	0.857	0.136	N.D.	N.D.	0.904	17.165	N.D.	1.872	1.237	9.12
2	Silty loam	N.D.	0.279	N.D.	0.868	0.399	19.506	0.677	0.035	N.D.	21.89
3	Sand	N.D.	0.449	N.D.	0.098	1.097	29.169	N.D.	1.345	1.046	9.61
4	Loamy sand	N.D.	0.392	N.D.	N.D.	0.246	13.686	N.D.	N.D.	2.038	6.21
5	Sandy soil	N.D.	0.395	N.D.	N.D.	2.638	9.351	N.D.	N.D.	2.154	3.71
6	Silty loam	N.D.	0.519	N.D.	0.225	3.547	7.869	0.570	N.D.	2.981	9.88
7	Sand	N.D.	0.267	N.D.	1.364	2.033	14.978	N.D.	N.D.	2.884	30.65
8	Silty loam	N.D.	0.295	N.D.	N.D.	1.887	14.510	0.492	N.D.	N.D.	38.09
9	Silty loam	N.D.	N.D.	N.D.	0.941	3.614	2.673	0.651	2.162	1.287	10.64
10	Loamy sand	N.D.	0.431	N.D.	0.451	1.531	9.673	0.080	6.048	1.996	7.47
11	Silty loam	0.224	0.296	N.D.	0.091	1.757	12.810	0.362	N.D.	0.004	17.24
12	Loamy sand	N.D.	0.192	N.D.	1.684	1.236	3.136	0.844	2.675	0.478	27.87
13	Dump	N.D.	0.640	N.D.	0.340	1.862	40.381	N.D.	N.D.	N.D.	7.61
14	Dump	0.100	0.223	N.D.	0.164	0.992	14.964	0.156	N.D.	1.184	N.D.
15	Dump	N.D.	0.199	N.D.	4.738	0.400	10.624	0.953	0.623	N.D.	N.D.
16	Dump	N.D.	0.433	N.D.	2.422	2.033	24.245	0.708	N.D.	0.544	19.09
17	Dump	0.299	0.277	N.D.	N.D.	0.299	8.912	N.D.	N.D.	N.D.	N.D.
18	Dump	0.797	N.D.	N.D.	N.D.	1.965	8.252	0.247	N.D.	1.931	N.D.
19	Dump	N.D.	0.110	N.D.	N.D.	0.342	31.971	0.130	N.D.	2.981	34.71
20	Lignite	N.D.	0.371	N.D.	0.330	0.422	14.529	N.D.	N.D.	N.D.	8.29

The surface soils are less cohesive, as a result are prone to rill and gully erosion. The failure of mining face at times is also because of poor grain to grain bonding in soils around mine site. The Tertiary rocks are also having very low to medium uniaxial compressive strength, these soils fail owing to their own weight along the free faces of mining pits. The porosity of these rocks is over 30%, the water saturated condition induces mine face failures. This is mine pit specific problem requiring additional safety measures for the mining personals. During monsoon the dumps undergo rill erosion

(Photo 7.2). To stabilize the dumps G.M.D.C., Ltd. has taken up vigorous forestation programme, as well as mating of the dump surfaces. These measures have minimized the erosion and windblown dust problem from these locations.

To win the lignite from the nearby upstream areas of Hakran stream, the stream course has been diverted further southwest nearer to the southern dump. It was observed that the sediment load due to rills erosion has increased primarily in response to the stream diversion. This problem is in the initial stage and needs proper monitoring and mitigatory measures for land conservation. All the dumps except the southwest dump are widely covered by plantation; these measures have stabilized the dumps (Figure 5.3).

The mine pit towards the northern end has been reclaimed by dumping back the overburden sand in a progressive manner.

7.5 Biological environment

The mining block is a small area and apparently has not endangered the local ecosystem; on the contrary plantations have increased the available biomass and have imparted stability to the overburden dumps. Various plant species used for the purpose of reclamation of dumps are listed in Annexure 2. The list of flora and fauna in the study are appended in Annexure 1, 7. Various microorganisms are also recorded in the study area (Annexure 8, 9).

7.6 Socio - economic environment

Environment as a whole is a complex of physical, social, economic, cultural and aesthetic dimensions which affects individual, communities and ultimately determines their forms, characters, relationships and survivals. As such it becomes imperative to integrate the components of socio-economic environment in impact assessment study related to environmental conservation, protection and management.

The social environment refers to demographic structure of the area incorporating population dynamics, infrastructure resource base and health status of the community, while economic environment refers to land utilization pattern, land values, employment generation, industrial development and sustainability of the project in financial term. The aesthetic environment refers to scenic value of the area, tourist attraction, forest and wildlife, historic and cultural monuments. The details on socio – economic environment are largely taken from the GMDC, Ltd. records.

The proposed G-19 extension includes the Amod village, which is having an area of about 642 hectare and 183 houses. There are total 16 villages under the study area, with 4050 households. Village Bhuri registered lowest number of 37 households while Rajpardi registered maximum number of 1545 households followed by Avidha having 707 households. Low population density villages are Bhuri and Bhimpor, whereas, Rajpardi is moderately populated town.

7.6.1 Infrastructure resource base

Due to obligatory developmental and welfare activities undertaken by GMDC, good infrastructure development has taken place in the area. All villages are well connected by approach roads. Drinking water is supplied through tanker by G.M.D.C. Ltd., in some villages like Maljipura, Amod, Bhuri, Bhimpor etc. Electricity is made available for domestic and irrigation purposes. Education facility up to primary level is available in most of the villages. Medical facility is provided to the community by primary health centers.

7.6.2 Economy, employment and welfare

Mining being a labor intensive industry, involves large number of people in various activities like loading, unloading, transportation, construction etc. Mining project is a major employment provider to the local population of the nearby villages and the economy of the area is dependent on mining and agriculture related activities. Over two hundred fifty persons from the surrounding villages are given employment by G.M.D.C. Ltd. Mining project has created opportunities for trade, commerce and automobile business in the area.

- GMDC has provided utensils to Amod Village Primary School for "Mid day meal" scheme run by Government.
- Provided ambulance to charitable trust for hospital services which is available round the clock.
- Provision of school bus for children of employees who are studying at village Rajpardi, Talvadi and Khond.
- Provided shelter and distributed grains, food utensils, cloths etc in flood affected areas during cyclonic rain in year 1994.
- Arrange film shows for local villagers as a part of entertainment programme.
- Donated Rs. 5 lakhs to Shramik Vikas Sansthan for settlement and upliftment of surrounding villages like Bhuri and Amod.
- Provided computer to school at Rajpardi along with donation of Rs. 60,000/- for construction of computer centre.
- Drinking water is supplied through tanker to the villages like Amod, Maljipura Bhuri, Navi Tarsali etc. through out the year.
- Regular health camps and blood donation camps are organized.
- Holidays are adjusted to accommodate the local tribal festivals.

7.7 Summary of the overall EIA for the study area:

The following table summarizes the overall Environmental Impact Assessment for Air, Noise, Land, Water, Biological and Socio-economic domains of the study area.

Table: 7.7 Summary of overall Environmental Impact Assessment for Rajpardi Lignite Mine.

Sr. No.	Environment	Parameters	Impact Level	Overall Impact	Assessment
1.	Air	**A). Air Quality:** 1. SPM 2. NO_2 3. SO_2 **B). Micro Meteorology:** 1. Wind Speed 2. Wind Direction	 M N N X X	Negligible	No Impact
2.	Noise	1. Within Mine (Core zone) 2. Outside Mine (Buffer zone)	I N	Moderate	No Impact
3.	Land	1. Soil 2. Landuse 3. Dumps 4. Aesthetic looks	M M I I	Moderate to Intense	Negative Impact
4.	Water	1. Ground Water 2. Surface Water 3. Waste Water	M M I	Moderate to Intense	Negative Impact
5.	Biological	**1. Fauna** **2. Flora** a). Land b). Aquatic	N P N	Negligible	No Impact
6.	Socio-Economic	1. Rehabilitation and Resettlement 2. Infrastructure 3. Economy, Employment & Welfare 4. Help	N P P P	Positive	Positive Impact

* code used: S- Severe, I – Intense, M – Moderate, N – Negligible, X – No effect, P – Positive.