CHAPTER-V

ENVIRONMENTAL IMPACT ASSESSMENT

5.0 Introduction

Coal mining and allied activities have impacts on environmental parameters including biotic, abiotic and socio-economic parameters. The magnitude of impacts depend on a number of factors including scale of mining, technology employed, meteorological conditions, geology and topography of the area etc.

The mining area of the Vijay West Project lies within the forest area and inclines along with necessary infrastructures have to be developed in the forest area. About 4.25 Sq km area in dip side of Vijay West geological block has been considered for underground mining under this project.

5.1 Identification of impact

Identification of impact is an important task in any EIA study. This helps in focusing attention upon relevant environmental parameters and relating them with the activities involved. As far as mining projects are concerned, the following parameters are important in the Environmental Impact Assessment.

1. Socio-economic Impact

2. Impact of Subsidence

2. Impact on land use

3. Environmental & ecological factors

- { Ambient air quality
- { Water quality
- { Noise
- { Soil quality
- { Flora & Fauna

4. Hydro-geological aspects

5. Risk assessment

5.1.1 Socio Economic Impact

i) The houses/ hutments are located in scattered. No depillaring operation has been proposed beneath the village area. So, no provision for rehabilitation is envisaged in PR.

ii) The project will enhance better amenities in area like development of road, electricity, education and other developmental works. This project will bring primary and secondary employment opportunities to local people.

iii) Chattisgarh Govt will be benefited through financial revenues by way of royalty, sales tax etc. from the direct and indirect operations in the project area.

5.1.2 Impact of Subsidence

Maximum subsidence, subsidence contours and profile:

The anticipated maximum possible subsidence likely to occur over the mining area due to extraction of seam III, seam II (Top) and seam I individually are 1.548, 1.530 and 1.372m respectively. The anticipated maximum possible subsidence likely to occur after 10, 15 and 20 years of mining is 1.548, 1.548 and 3.429m respectively. The estimated maximum possible subsidence at the end of mine life (after 25 years of mining) is 3.567m which is likely to take place over the panels T7, M7 and L6. In the forest area the anticipated maximum possible subsidence likely to take place is 3.567m, i.e. over the same panels T7, M7 and L6. From the estimated subsidence at each grid point, subsidence contours are drawn at every 5 year stage of depillaring and shown in Plates 6, 8, 10 and 12. In Plates 6 and 8 subsidence contours are shown at 0.3m intervals and in Plates 10 and 12 at 0.5m intervals. Subsidence contours are shown alternately in violet and green colours.

Effect of subsidence on surface topography and surface features along with mitigative measures :

For the terrain of the area, the maximum anticipated subsidence of 3.567m is unlikely to extensively affect the drainage pattern in the area. However, subsidence may result in the formation of pools over the centre of the panels and cracks at the zones of high tensile strain such as along the boundary and barriers. These pools of water may be retained wherever possible for the benefit of vegetation in the forest land or filled up / drained out (by cutting drains) depending on safety of the underground workings. The surface cracks developed due to subsidence need to be filled up regularly with clay and stone chips to achieve original drainage pattern of the area and to prevent ingress of air and water into the goaf. It will minimise the chances of underground inundation and spontaneous heating.

Impact of subsidence on villages:

Kandai, Bijadand and Putipa Khana villages existing over the mining area are unlikely to be affected by subsidence because depillaring in panels is not proposed to be carried out vertically below and within 60m from the villages, i.e. a sufficient area of solid coal pillars will be left underneath the villages.

Impact of subsidence on nallas:

Except at three places, all the nallas flowing over the mining area are unlikely to be affected by subsidence because sufficient solid coal pillars are proposed to be left below the nallas. A nalla commencing near the panel M5 of seam II (Top) is likely to be affected by a maximum amount of 0.447m subsidence and 10.64 mm/m tensile strain. Another nalla commencing near the panel T11 is likely to be affected by a maximum amount of 0.964m subsidence and 21.42 mm/m tensile strain at its beginning. The nalla flowing over the panel T17A is also likely to be affected by a maximum amount of 0.308m subsidence and 8.8 mm/m tensile strain. The above said three subsidence affected nallas need to be protected by leaving coal pillars un-extracted vertically below and within the subsidence influence area, i.e. coal pillars are to be left un-extracted in the panel M5 of seam II (Top) and in the panels T11 and T17A of seam III.

Impact of subsidence on roads:

A PWD road passing through the centre of the mining area is unlikely to be affected by subsidence because sufficient coal pillars are proposed to be left un-extracted vertically below and within the subsidence influence area. The forest roads running over the property are also unlikely to be affected by subsidence because sufficient solid coal pillars have been left vertically below and within the subsidence influence area.

Impact of subsidence on proposed area for infrastructure:

The area left for proposed infrastructure is likely to be affected by a maximum amount of 1.420m subsidence and 21.85 mm/m tensile strain. Thus, this area needs to be kept free from subsidence influence area by leaving sufficient coal pillars un-extracted in the panels around it in all the three seams.

Impact of subsidence on tenancy land / agriculture land:

The tenancy land / agriculture land not yet demarcated on the surface plan is likely to be affected by subsidence, thus requiring crop compensation to the land owners and subsequent reclamation by filling and consolidation of the land. Payment of crop compensation to the tenancy land owner has also been recommended in the project report during the year when depillaring operation will be carried out in the panels below the tenancy land.

Effect of subsidence on forest with mitigative measures:

The values of tensile strain due to extraction of seams III and II (Top) individually and after extraction of all the three seams are exceeding the limit prescribed by MOEF, i.e. 20 mm/m. Such amount of tensile strain is likely to develop surface cracks more than 300mm wide. Thus, some mitigative and management measures are suggested to limit the tensile strain and width of surface cracks within the permissible limit, i.e. by restricting the thickness of extraction in each seam and there should be a lapse of a few years, about 5 years, between extraction of successive panels in superimposition. This will allow the strata to settle. Since time plays an important role in multiple seam extraction, the super-incumbent strata will tend to consolidate with rains and become stable for lower seam workings. The slope and strain will be reduced if sufficient time, about 5 years, is allowed between the upper and lower seam extraction. The surface cracks may also reduce with the subsequent travelling profile of subsidence. Wherever, due to deployment of SDLs / continuous miner, it is not possible to restrict the thickness of extraction, manual depillaring or partial extraction or development as a final operation may be planned. To limit the tensile strain within permissible limit of 20 mm/m, the mitigative measures to be adopted for the various panels of seams III and II (Top) are shown in Tables 4 and 5 respectively. Due to extraction of bottom most seam I, the anticipated maximum possible tensile strain likely to occur in the forest area is below the permissible limit of 20 mm/m. Thus, for the panels of seam I restriction in thickness of extraction is not required, only a time lag of about 5 years is required to be implemented after extraction of the panels of seam II (Top) in superimposition.

Considering the above suggested mitigative measures (control measures), the maximum possible tensile strain likely to occur in the forest area is within the permissible limit of 20 mm/m as prescribed by MOEF. For such amount of tensile strain the surface cracks likely to occur over the forest area will not exceed 300mm width. The surface cracks likely to develop after extraction of each seam

need to be filled up properly and regularly with clay and stone chips. The tensile strain caused (not exceeding 20 mm/m) due to extraction of lower seam will open up the filled cracks and some new cracks may also develop. Thus, it will be necessary to refill these cracks. Since extraction of the three seams will be done in descending order and there will be a lag of 5 years in their extraction, depressions will form on the surface and deepen in steps. Considering the mitigative measures, the anticipated maximum possible subsidence likely to occur after extraction of all the three seams is 2.978m. Similarly the magnitude of cumulative slope/tilt is not likely to cause falling of trees as it will take place in three steps. The anticipated maximum possible slope likely to occur after extraction of each seam is 39.96 mm/m, i.e. a tilt of 2.3^0, which is not likely to cause falling of trees. The presence of soil up to 6.0m thick at the surface will act as cushioning cover for stepping or opening of cracks. Strain will be absorbed to some extent by the soil and cracks will be reduced. Moreover, soil even under strain may not cause dislocation of most of the plants.

Thus, it is anticipated that with mitigative measures (control measures) the forest may not be considerably affected by subsidence. Only a limited a number of trees falling on the edges of subsidence trough and surface cracks may get tilted or dislodged. However, provision has to be made for compensatory afforestation and strengthening of forest cover to take care of losses, if any. Provision of compensatory afforestation has also been suggested in the project report. Surface cracks developed in the forest area should be filled up with clay and stone chips and thereafter with a 0.3m high clay heap over the cracks. It will prevent the ingress of air and water into the goaf and avoid the chances of spontaneous heating and inundation. It will also minimise the erosion of top soil and improve the water retention capacity of soil.

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Table 1 : Anticipated maximum possible subsidence, slope and tensile strain over mining area after extraction of seam III, without control measures.

Panel No.	Av. Width	Av. Depth	Extraction Thickness	Maximum subsidence	Maximum slope	Maximum Tensile strain	Likely width of surface cracks
	(m)	(m)	(m)	(mm)	(mm/m)	(mm/m)	(mm)
T1	82.8	30	3.2	1376	91.73	45.87	>300
T2	82.8	30	3.5	1505	100.33	50.17	>300
T3	82.8	30	3.5	1505	100.33	50.17	>300
T5	82.8	39	3.6	1548	79.38	39.69	>300
T6	82.8	40	3.6	1548	77.40	38.70	>300
T7	82.8	45	3.6	1548	68.80	34.40	>300
T8A	64.0	35	3.6	1355	77.43	38.71	>300
T8B	82.8	50	3.6	1548	61.92	30.96	>300
T9	82.8	55	3.6	1548	56.29	28.15	>300
T10	82.8	35	3.6	1548	88.46	44.23	>300
T11	82.8	45	3.6	1548	68.80	34.40	>300
T13A	88.8	35	3.6	1548	88.46	44.23	>300
T13B	88.8	70	3.6	1348	38.51	19.26	<300
T14	88.8	60	3.6	1548	51.60	25.80	>300
T15A	88.8	55	3.6	1548	56.29	28.15	>300
T15B	88.8	80	3.6	1273	31.83	15.91	<200
T17A	60.0	25	3.0	1290	103.20	51.60	>300
T17B	82.8	35	3.0	1290	73.71	36.86	>300
T22	88.8	78	3.6	1458	37.38	18.69	<300
T29	82.8	44	3.6	1548	70.36	35.18	>300
T30	82.8	42	3.6	1548	73.71	36.86	>300
T31	82.8	40	3.6	1548	77.40	38.70	>300
TMD1 R	106.8	80	3.0	1213	30.33	15.16	<200

Note: To limit the tensile strain below 20 mm/m in the forest land, mitigative measures required to be undertaken are given in Table 5.

Table 2 : Anticipated maximum possible subsidence, slope and tensile strain over mining area after extraction of seam II (Top) only, without control measures

Panel No.	Av. Width	Av. Depth	Extraction Thickness	Maximum subsidence	Maximum slope	Maximum Tensile strain	Likely width of surface cracks
	(m)	(m)	(m)	(mm)	(mm/m)	(mm/m)	(mm)
M2	82.8	50	2.2	1122	44.88	22.44	>300
M5	82.8	42	2.2	946	45.05	22.52	>300
M6A	109.8	30	1.8	774	51.60	25.80	>300
M6B	109.8	57	2.0	1020	35.79	17.89	<200
M7	109.8	62	2.0	1020	32.90	16.45	<200
M8A	109.8	43	1.8	774	36.00	18.00	<200
M8B	109.8	68	2.0	1020	30.00	15.00	<150
M10	109.8	50	1.9	969	38.76	19.38	<300
M12	106.8	72	2.8	1428	39.67	19.83	<300
M13	106.8	80	3.0	1530	38.25	19.13	<300
M14	106.8	70	3.0	1530	43.71	21.86	>300
M21	106.8	100	2.8	1323	26.46	13.23	<150
MMD 3	106.8	40	2.2	946	47.30	23.65	>300
MMD 1R	106.8	100	2.8	1323	26.46	13.23	<150

Note: To limit the tensile strain below 20 mm/m in the forest land, mitigative measures required to be undertaken are given in Table 6.

Table 3: Anticipated maximum possible subsidence, slope and tensile strain over mining area after extraction of seam I only, without control measures

Panel No.	Av. Width	Av. Depth	Extraction Thickness	Maximum subsidence	Maximum slope	Maximum Tensile strain	Likely width of surface cracks
	(m)	(m)	(m)	(mm)	(mm/m)	(mm/m)	(mm)
L2	109.8	65	1.8	918	28.25	14.12	<150
L3	109.8	72	1.8	918	25.50	12.75	<100
L4	109.8	67	2.0	1020	30.45	15.22	<200
L5A	88.8	62	2.1	1071	34.55	17.27	<200
L5B	88.8	83	2.1	972	23.42	11.71	<100
L6	88.8	86	2.3	1002	23.30	11.65	<100
L7	106.8	45	1.9	817	36.31	18.16	<300
L9A	132.3	50	1.7	867	34.68	17.34	<200
L9B	80.0	67	1.7	768	22.93	11.46	<100
L9C	132.3	93	2.0	1020	21.94	10.97	<100
L11A	106.8	95	2.3	910	19.16	9.58	<100
L12A	106.8	100	2.5	1158	23.16	11.58	<100
L12B	106.8	125	2.5	860	13.76	6.88	<50
L14	106.8	75	2.5	1012	26.99	13.49	<150
L20	106.8	122	2.5	959	15.72	7.86	<50
L31	109.8	85	2.0	1020	24.00	12.00	<100
LMD1R	106.8	125	2.3	959	15.34	7.67	<50
LMD3	106.8	75	2.7	1372	36.58	18.29	<300

Note : To limit the tensile strain below 20 mm/m in the forest land, restriction in thickness of extraction is not required, only a time lag of about 5 years is required to be implemented after extraction of the panels of seam II (Top) in superimposition.

Table 4 : Anticipated maximum possible subsidence, slope and tensile strain over mining area after extraction of seams III, II (Top) and I, without control measures.

Panel No.	Av. Depth	Maximum subsidence	Maximum slope	Maximum Tensile strain	Likely width of surface cracks
	(m)	(mm)	(mm/m)	(mm/m)	(mm)
T1, M2	50	1791	71.64	35.82	>300
T2, M2, L2	65	3191	98.18	49.09	>300
T3, L3	72	2033	56.47	28.24	>300
T5, M5	42	2042	97.24	48.62	>300
M5, L4	67	1900	56.72	28.36	>300
M6A, L5A	62	1759	56.74	28.37	>300
T6, M6B, L5B	83	3499	84.31	42.16	>300
T7, M7, L6	86	3567	82.95	41.48	>300
T8A, M8A	43	1482	68.93	34.47	>300
T8B, T9, M8B	68	2512	73.88	36.94	>300
L7	45	817	36.31	18.16	<300
T10	35	1548	88.46	44.23	>300
T11, M10, L9C	93	3534	76.00	38.00	>300
M10, L9A, L9B	67	1891	56.45	28.22	>300
T13A, T13B, M12	72	2937	81.58	40.79	>300
T14, M12, M13, L11	95	3118	65.64	32.82	>300
T15, M13, L12	125	3429	54.86	27.43	>300
T17AB	35	1290	73.71	36.85	>300
T15A, M14, L12A	100	2096	41.92	20.96	>300
T22, M21, L20	122	3405	55.82	27.91	>300
T29	44	1548	70.36	35.18	>300
T30, L31	85	2458	57.83	28.92	>300
T31	40	1352	67.60	33.80	>300
TMD1R, MMD1R, LMD1R	125	3495	55.92	27.96	>300
MMD3, LMD3	75	2318	61.81	30.91	>300
L14	75	1012	26.99	13.49	<150

Note: To limit the tensile strain below 20 mm/m in the forest land, mitigative measures required to be undertaken are suggested in the Tables 3, 5 and 6.

Table 5 : Anticipated maximum possible subsidence, slope and tensile strain over mining area after extraction of seam III, with control measures as indicated in mitigative measures column

Panel No.	Extraction Thickness	Max. subsidence	Max. slope	Max. Tensile strain	Likely width of surface cracks	Mitigative measures for panels in forest area
	(m)	(mm)	(mm /m)	(mm /m)	(mm)	**Extraction thickness to be reduced from :**
T1	1.35	585	39.00	19.50	<300	3.2 to 1.35m/partial extraction/ only development/manual depillaring
T2	1.35	585	39.00	19.50	<300	3.5 to 1.35m/partial extraction/ only development/manual depillaring
T3	1.35	585	39.00	19.50	<300	3.5 to 1.35m/ partial extraction/ only development/manual depillaring
T5	1.80	774	39.70	19.85	<300	3.6 to 1.8m
T6	1.85	796	39.80	19.90	<300	3.6 to 1.85m
T7	2.05	882	39.20	19.60	<300	3.6 to 2.05m
T8A	1.60	688	39.32	19.66	<300	3.6 to 1.6m
T8B	2.30	989	39.56	19.78	<300	3.6 to 2.3m
T9	2.55	1097	39.90	19.95	<300	3.6 to 2.55m
T10	1.60	688	39.32	19.66	<300	3.6 to 1.6m
T11	2.05	882	39.20	19.60	<300	3.6 to 2.05m
T13A	1.60	688	39.32	19.66	<300	3.6 to 1.6m
T13B	3.60	1348	38.52	19.26	<300	Not required
T14	2.75	1183	39.44	19.72	<300	3.6 to 2.75m
T15A	2.55	1097	39.90	19.95	<300	3.6 to 2.55m
T15B	3.60	1273	31.82	15.91	<200	Not required
T17A	1.15	495	39.60	19.80	<300	3.0 to 1.15 m /partial extraction / only development
T17B	1.60	688	39.32	19.66	<300	3.0 to 1.6m
T22	3.60	1458	37.38	18.69	<300	Not required
T29	2.00	860	39.10	19.55	<300	3.6 to 2.0m
T30	1.95	839	39.96	19.98	<300	3.6 to 1.95m
T31	1.85	796	39.80	19.90	<300	3.6 to 1.85m
TMD1R	3.00	1213	30.33	15.16	<200	Not required

Table 6 : Anticipated maximum possible subsidence, slope and tensile strain over mining area after extraction of seam II (Top), with control measures as indicated in mitigative measures column

Panel No.	Extraction Thickness	Max. subsidence	Max. slope	Max. Tensile strain	Likely width of surface cracks	Mitigative measures for panels in forest area
	(m)	(mm)	(mm/m)	(mm/m)	(mm)	**Extraction thickness to be reduced from :**
M2	1.95	995	39.80	19.90	<300	2.2 to 1.95m
M5	1.95	839	39.95	19.98	<300	2.2 to 1.95m
M6A	1.35	581	38.73	19.37	<300	1.8 to 1.35m/partial extraction/ only development/manual depillaring
M6B	2.0	1020	35.79	17.89	<200	Not required
M7	2.0	1020	32.90	16.45	<200	Not required
M8A	1.8	774	36.00	18.00	<200	Not required
M8B	2.0	1020	30.00	15.00	<150	Not required
M10	1.9	969	38.76	19.38	<300	Not required
M12	2.8	1428	39.67	19.83	<300	Not required
M13	3.0	1530	38.25	19.13	<300	Not required
M14	2.7	1377	39.34	19.67	<300	3.0 to 2.7m
M21	2.8	1323	26.46	13.23	<150	Not required
MMD3	1.85	796	39.80	19.90	<300	2.2 to 1.85m
MMD1R	2.8	1323	26.46	13.23	<150	Not required

Note: A time lag of about 5 years is required to be implemented after extraction of the panels of seam III in superimposition.

5.1.3 Impact on land use

The mining right of Vijay West underground project is 475.268 Ha. Within mining right, the surface right would be 9.00 Ha, and outside mining area, the land for the colony, that is contemplated about 17 km from the project, would be 13.10 Ha; however the site thereof is not identified yet.

Under CBA

Sl. No.	Particulars	Land under CBA in Ha.	Remarks
1	Mining Right	475.268	
2	Surface Right	9.000	Situated within the Mining Right
	SUB-TOTAL	**475.268**	
3	Land for Colony	13.10	Site not identified yet; however, the colony is 17 km from the project.
4	Land Use		
Forest-CJJ* & BJJ* (Ha)	**Tenancy (Ha)**	**Government (Ha)**	**Total (Ha)**
360.660	76.405+38.203	-	**475.268**
360.660	**114.608.**	**-**	**475.268**

* CJJ-Chhote Jhar ka Jungle, BJJ- Bade Jhar ka Jungle.

The surface area have PWD road, Forest Road, Nallas, Forest area and villages (part). The houses/ hutments are in scattered and below this area, no depillaring operation have been proposed. In the PR , it has been considered that the crop compensation would be paid for the tenancy land within mining area which would be affected by subsidence due to depillaring operation over panels and therefore land not to be purchased. Crop compensation would be paid during the year when respective panels would be worked.

The major area of Project mining is under forest land. Surface features below the road and villages, depillaring of panels have not been proposed to prevent subsidence impact on the surface. The method of mining is depillaring by caving under moderate depth of cover. It is expected that degradation of land will be minimum. If any cracks/voids are created due to underground mining activities, it will be restored to original profile by filling up cracks/ voids. It is suggested that the site restoration is progressive so that restoration is more or less similar to the rate of mining.

For planning purpose approximate distance of 60.00 m barrier from edge of major surfaces like village, PWD Road, nallas etc.has been considered.

The objective of restoration of post mining area will be determined in consultation with local community and the govt. authority so that the potential end use of mined out land is determined .The existing land use pattern will not be affected by this underground mining.

The quality of solid waste, due to excavation of inclines and air shaft would be utilised for making the haulage embankment and belt conveyor gantry. So there will be no adverse impact on environment on account of this.

5.1.4 Environmental quality

5.1.4.1 Impact on air quality

The mining operation will be confined to underground operations. The work-zone air quality will be maintained as per DGMS standards. Proper ventilation arrangements have been provided to make the work-zone ambient quality within limit. However, the following activities will be located at surface which may affect the air quality.

- Transportation of coal to loading point.
- Sizing and crushing of coal at crusher point of CHP.
- Material handling operation.

Fugitive emission will be generated due to operation of above activities.There will be only a small CHP for sizing and crushing of coal at the mine site and the generation of fugitive dust will be of small quantity. The operation of the underground mine may affect the ambient air quality if proper mitigation arrangements will not be adopted.

5.1.4.2 Impact on Water Quality

The mine effluent will be generated due to the following activities:

A) Underground mine seepage water will be pumped out to the surface after initial settlement in the mine sump. The mine discharge is mainly seepage water contaminated with coal dust. If not treated before discharge, this effluent may affect the surface water quality.

B) The existing small workshop will generate effluent which will contain suspended solids and small amount of oil and grease. The quantity of effluent generated is very small and the same will be treated in sedimentation cum oil and grease trap. The discharge of treated effluent will not affect the quality of the existing surface water.

C) Effluent generated from CHP will contain high TSS (mainly coal dust) due to water spraying arrangements. This will pollute existing water source if discharged without treatment.

5.1.4.3 Effect on Ground Water Quality

The mine effluent, CHP and workshop effluent will contain only suspended solids (mainly fine coals) and small amount of oil & grease. The effluent will not contain any toxic metals, therefore the seepage or leakage of effluent will not affect the ground water quality.

5.1.4.4 Effect on Surface Water Quality

The following mining activities may alter the surface water quality if discharged to natural water resource without treatment.

- Mine water discharge
- Workshop and CHP effluent discharge
- Domestic waste water discharge.

The mine discharge if not treated before mixing to surface water resource may increase the suspended solid load in the surface water quality. The CHP and workshop effluent may also increase the TSS and oil and grease level to receiving water body. Similarly the domestic sewage may increase the TSS and BOD level of water quality.

5.1.5 Impact on Noise

Noise is defined as undesirable sound. The Director General Of Mines Safety (DGMS) has prescribed the limits for noise level for workers in an 8 hour shift with unprotected ear, as 85 dB(A). DGMS has recommended 115 dB(A) as the noise level above which an unprotected ear may run a risk of hearing impairment and appropriate ear protective devices should be used and 140 dB(A) as the noise level where no worker should enter without ear protection. The noise level at the transfer points of coal in the underground workings as well as at the face and on surface would be kept within the permissible limit.

The existing noise levels at different locations in core and buffer zone are within the prescribed limits. There is no report of noise induced occupational health hazards among the workers in the area.

The operation of small CHP and transportation of materials will not cross the noise level limit suggested for industrial area.

5.1.6 Impact on Soil Quality

The main sources for affecting the soil are spillage of coal dust on approach roads, spillage and erosion effects near the mine entry, CHP and loading points. Soil erosion is a natural process and starts with surface run off of the water during rainy season. Where soil surface is covered under grasses and plants, the erosion rate is nominal and only small quantity of loose soil enters the drainage system. In

the underground mine, this is not going to create a major problem as a minimum space on surface are used for mining activities.

Quality of soil collected from three different locations in the core zone within the leasehold area shows that pH is within 6.83 to 7.23. Nitrogen, Phosphorous and potassium are in the range of 110-243 kg/ha, 9.6 to 41.3 kg/ha and 82-141 kg/ha respectively. Texture class is clay loam and it is going to support vegetation. The existing land use of the proposed project will not be changed except 24.1 Ha required for infrastructure and colony area.

5.1.7 Impact on flora and fauna

The flora and fauna in the underground mine is not going to be affected much. However, the general ecology comprising flora, fauna & general environment is going to be protected and improved.

5.1.8 Risk assessment

5.1.8.1 Blasting

For proper blasting and minimising the adverse side effects due to blasting viz noise, ground vibration, air blast, fly rocks etc. the following precautions would be followed to avoid dangerous situation :

- The optimal blast design parameters will be used.
- All necessary precautions will be taken while blasting so that the underground workings of seam below present workings and in close proximity will remain safe.
- Instruments like vibration meter etc. will be used to monitor vibration and necessary precautions will be taken while blasting.
- Before blasting is done, warning sound will be given so that people can move to safe places.
- Arrangement will be made to alert the people working underground for sudden inrush of water by accidental development of fracture connecting the working place to the water bodies/acquifer.

5.1.8.2 Explosive Handling

Vijay West UG is proposed mine. All the safety measures to counter danger from explosives will be taken. Adherence to relevant statutory safety provisions as stipulated by DGMS, Chief Controller of Explosives and others will be made.

5.1.8.3 Mine inundation

Numerous small streams/nallas flowing radially from the plateau constitute the main drainage pattern. These streams join with the two main streams "Bamni Nadi & Teti Nadi" which in turn flow into the Hasdeo river in the north-east. The seasonal nallas are the main source of irrigation in the area and all these are rain fed only. Number of shallow dug wells has been constructed in the soil and in the weathered mentle in which the occurrence of ground water is limited to weathered fractured zones. Except these nallas, no major river falls within the proposed mining area. As precautionary measures, a barrier of about 60m from the edge of the nalla is left.

It is also proposed that below nalla (part of which is within working property) and around 60m from the edges, only development work has been proposed to protect the surface cracks from inundation point of view. In addition, all exploratory boreholes drilled in mining area should be plugged so that water from surface should not find its way to the underground workings through these boreholes. In lower cover area, developed cracks (if any) should be filled up and compacted as soon as possible.

5.1.8.4 Fire

Accidental fires are causes of large scale loss of property and life. Keeping this in view, adequate fire fighting arrangement has been made. Adequate number of fire extinguisher has been provided for store and other service buildings. While calculating total water demand for the project, provision for fire fighting has also been made.

5.1.8.5 Road Accidents

Sufficient arrangements for illumination of roads have also been made. Road crossings have been properly planned and designed to prevent vehicular accidents.

5.1.8.6 Safety Rules

Mining operation is required to follow statutory mine safety rules administered by the Directorate General of Mine Safety (DGMS), Chief Controller of Explosives and others. During planning an underground project, sufficient care have been taken to comply with these rules. Planning and design of electrical installation have taken into account the existing provisions of Indian Electricity Rules 1956 to obviate the hazards due to use of electricity. All enumerated Safety rules in above said legislations will be diligently followed.

To create safety awareness and impart education on safe practices, the following steps are being taken.

- Holding annual safety weeks

- Imparting basic and refresher training to new and old employees respectively.

5.1.9 Impact on Hydro-geology

Probable Impact of Mining on Groundwater System

(a) Impact on Topography & Drainage

Subsidence due to total extraction of coal causes changes in topography and drainage by developing micro basins, subsidence fractures, ridges, pot holes etc. This alters the drainage of the area in micro level. Care is taken during mining activity to leave enough pillars in underground as barriers below main drainage/water body to avoid any damage to surface water bodies and main rivers / nalas are diverted. In deeper underground mines, the subsidence is barely noticeable on the surface.

(b) Impact on Aquifer System

Various methods of U/G mining activities may cause changes in aquifer geometry, water level in the vicinity of the mine and disturb ground water flow direction. This can also create secondary fractures and higher permeability zones within the aquifer. After the mining activity, the aquifer restores its original water level and mined out area acts as a good reservoir.

In the present case, as the proposed Vijay West U/G project is deeper U/G mine, the impact of mining activity on unconfined aquifer will be marginal to negligible in the deep dip.

(c) Impact of Water Levels

When an impervious bed such as clay (shale) coal seams is present above the working seam the water level in the phreatic aquifer is not affected due to Bord and Pillar mining activity. In case of total extraction of coal (depillaring) and resultant subsidence cracks, the water may drain into the mine causing lowering of water table at the vicinity of the mine.

Drawdown thus created may be limited to lesser area since the mine pumped out water is re-circulated into the pheratic aquifer by natural recharge. It is observed that after mining activity is over the water level restores to its original level. The radius of probable impact on water level under caving conditions is predicted using

Sichardt formula (Table 4) for various hydraulic conductivity (k) values by the area and considering that the entire unconfined aquifer is de-saturated.

During mining, the formation near to the mine mouth only get disturbed and marginally dewatered. However, due to non-homogenic and non-isotropic nature of the aquifers, the radius of influence will be limited to a very small distance.

Table No.4 - Probable Impact of Mining on Groundwater Levels

Sl. No.	Project	Area	Avgerage Mine Depth(m)	Avg. Unconfined Aquifer thickness (m)	Radius of Influence (m) based on assumed `K' values	
					K=0.25 m/d	K=5.0 m/d
1	Vijay West UG(Prop)	Chirimiri	78	23.18	115	515
2	Rani Atari UG	- do -	70	23.25	118	529

(Radius of Influence is from the periphery of the mine)

With variation in aquifer/ mine geometry, return flow for mine discharge, abundant recharge potential and improved subsidence management, the zone of disturbance will be reduced further.

(d) Impact on Ground Water Quality

The groundwater chemistry indicates that the groundwater in the area is potable and does not contain any toxic elements. The underground mining activity does not induce any unwanted chemical or elements into the groundwater affecting the water chemistry except for total suspended solids (TSS), no serious pollutant has been observed in the mine water discharge. The discharge water of adjacent Rani Atari UG mine conforms to the MOEF standards.

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