GUJARAT MINERAL DEVELOPMENT CORPORATION LIMITED
(A Government of Gujarat Enterprise)
Lignite Project, Umarsar, P.O: Ghaduli Pin- 370627
Tal: Lakhapat, Dist: Kutch (GUJ) **E mail:** umarsar@gmdcltd.com
PHONE: + (02839) 294414 FAX: + (02839) 294428 CIN:L14100GJ1963SFC001206

GMDC/Umarsar/ENV/699 /2021-22 Date : 29/10/2021.

To,
Deputy Director General of Forests (C)
Integrated Regional Office,
Gandhi Nagar, (IRO Bhopal)
E mail : iro.ganhingr-mefcc@govt.in
Copy : **Email:** rowz.bpl-mef@nic.in

Subject : Submission Of compliance status Of Environmental Clearance

Respected sir,
Here with we are submitting Present status of Overall Environmental Performance vide EC No. J.11015/575/2017-IA.II(N) , dated 25th June 2009. For, Umarsar Open Cast Lignite Mine Project(1 MTPA).

Name of project: Umarsar Open Cast Lignite Mine Project(1 MTPA). at Village Umarsar, Taluka Lakhpat, District Kutch, Gujarat By Gujarat Mineral Development Corporation Ltd.
MoEF Clearance No. & Date : Environmental Clearance (EC) No. J.11015/575/2017-IA.II(N) , dated June 25th 2009.
Period Of Status : 01-04-2021 to 30-09-2021.

For, GMDC Ltd,

29/10/2021

General Manager(P)
Umarsar

Copy to.
1. The APCCF (c) , Regional Office (WZ), Bhopal
2. Zonal Office, CPCB , Baroda
3. Regional Office , Gujarat pollution Control board. Bhuj
4. General Manager (Env.), Corporate office GMDC Ltd.

Encl:
1. Report and Annexure
2. Land use study report with time series Map.

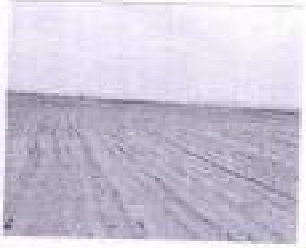
Compliance status of Environmental clearance of Umarsar Mines of Gujarat Mineral Development Corporation

Time Period: April 2021 to September 2021

A. Specific conditions

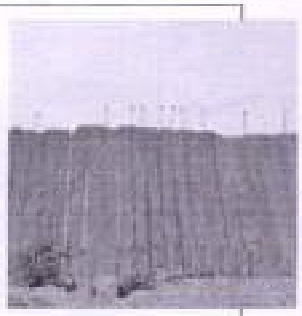
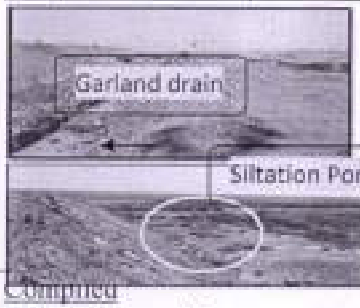
Sr.no	Conditions	Compliance Status
1	The project proponent shall obtain the prior approval of the national wildlife board of India before start mining operations	Complied Permission has been obtained from The chief wild life warden, Gandhinagar vide letter no. WLP/32/B/7820-25/2012-13 dated 16/03/2013 Attached letter
2	No mineral Transportation shall be undertaken through the sanctuary of area falling within the mine and the sanctuary, which is buffer to the mine along the sanctuary	Complied No route for Mineral transportation has been within sanctuary area.
3	The wild life conservation plan prepared for conservation of wildlife in the Narayan Sarovar sanctuary shall be implemented in consultation with chief wildlife warden, govt. of Gujarat the funds for the plan shall be maintained in a separate fund of Rs. 129.50 Lacs towards capital costs and 33 Lacs as revenue expenditure. The status of implementation of the various activities there under such as fencing, development of plantation, construction of van talavadis , and other water recharge measures , water holes and ponds, eco-awareness programmes for local villagers , shall be regularly submitted to the regional office of the MoEF, Bhopal as a part of compliance report.	Complied We have carried out the plantation activity in mine lease area and surrounding also we have time to time contribute to Forest Department towards NSSL conservation. Eco awareness programme conducted two times in this time periods for local people and employee under the World Environment day & Van Mahotsav celebration. GMDC have allocated 341.33 Lacs funds earlier for Development of Green belt, making biological task force, Barbed wire fencing construction of hawada, check dams, van talavadi and interpretation center for conservation & Development of Narayan sarovar Sanctuary.
4	A mine drainage plan with surface drainage design of the mine resulting from surface run off and diversion of rivers Moti, seasonal nalahs and ponds found within the active mining area and for the mine discharge water based on a peak rain fall data shall be prepared and implemented.	Complied The plan has been prepared and incorporated in progressive mine closure plan. Mine closure plan for Umarsar Lignite Block was approved on 17/10/2006 by the Government of India, Ministry of Coal (MOC), vide letter no. 34011/13-2011 – CPAM dated 25th October 2013.

<table>
<tr>
<td>5</td>
<td>The plan for diversion and realignment of the nala and modification of the natural surface drainage and design of the diversion canal shall be done in consultation and approval of the concerned state flood and and irrigation department. dimension and depth of the nala should be used for reclamation and development of green belt.</td>
<td>Complied
The plan for diversion of nala has been prepared and incorporated in progressive mine closure plan.
The approval of Nala diversion will be taken before the actual implementation.</td>
</tr>
<tr>
<td>6</td>
<td>Top soil shall be stacked properly with proper slope at earmarked site(s) and shall not be kept active and shall be used for reclamation and development of green belt.</td>
<td>Complied
Top soil has been stacked at earmarked placed.
<table>
<tr><th>Sl no</th><th>Location</th><th>Storage Area (in Ha)</th><th>Volume (in Lac m³)</th><th>Slope</th></tr>
<tr><td>1</td><td>West side</td><td>2.77</td><td>2.896</td><td>28</td></tr>
</table>
Top Soil is then utilized in Green belt development and reclamation of mined out area. 10.82 lac m³ top soil has already been used for physical reclamation of area

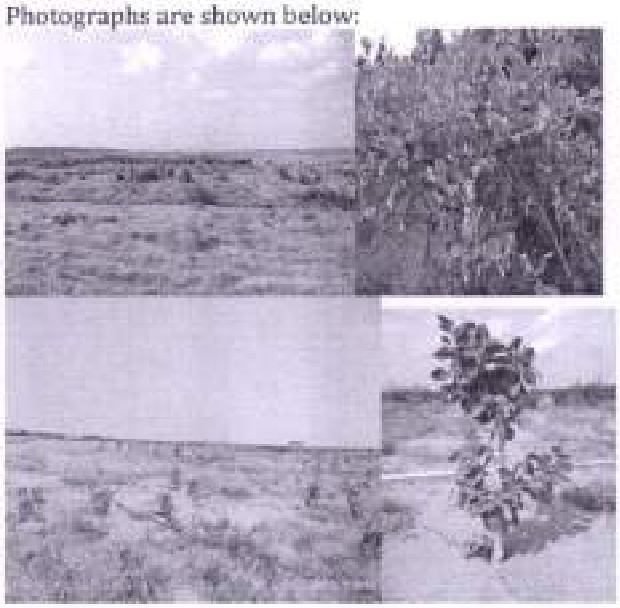
 </td>
</tr>
<tr>
<td>7</td>
<td>OB shall be stacked at earmarked external OB dump site within ML area and shall be a maximum height of 50m only each. The ultimate slope of the dump shall not exceed 28*
Monitoring and management of existing reclaimed dump sites shall continue until the vegetation becomes self. compliance status shall be submitted to the ministry of environment & forests and its regional office located at Bhopal on yearly basis.</td>
<td>Complied
There are 01 external dumps in the present scenario, the details of which is furnished below
<table>
<tr><th>Sl no</th><th>Dump</th><th>Height</th><th>Slope</th></tr>
<tr><td>1</td><td>West side of mines</td><td>15</td><td>25°</td></tr>
</table>
Height of each deck of the dump does not exceed 10m & total height is 30 m & Over all slope of dump does not exceed 25° as shown in table above.

Backfilling has started in April 2016 and still the Dumping is in progress.

Monitoring and management of existing reclaimed dumpsites is being continued until the vegetation becomes self sustained.</td>
</tr>
</table>

<table>
<tr><td></td><td></td><td>   </td></tr>
<tr><td>8</td><td>Catch drains and siltation ponds of appropriate size shall be constructed to arrest silt and sediment flows from soil, OB and mineral dumps .The water so collected shall be utilized for watering the mine area ,roads, green belt development etc. the drains shall be regularly de-silted and maintained properly. Garland drains (size, gradient and length)and sump capacity shall be designed keeping 50% safety over and above the peak sudden rainfall and maximum discharge in the area adjoining the mine site sump capacity shall also provided adequate retention period to allow proper setting of silt material.</td><td><u>Complied</u>
We have developed Garland drains and connected all garland drains into pond, the water from pond is utilized for sprinkling in mining area to control dust particle in air and green belt development.
<table>
<tr><th>S.n</th><th>Garland Drain</th><th>Length(in m)</th><th>Breadth (in m)</th><th>Depth (in m)</th></tr>
<tr><td>1</td><td>Garland Drain no.1</td><td>3500</td><td>2</td><td>2</td></tr>
<tr><td>2</td><td>Garland Drain no.2</td><td>3000</td><td>1.5</td><td>1.5</td></tr>
<tr><td>3</td><td>Garland Drain no.3</td><td>4200</td><td>1.5</td><td>1.5</td></tr>
<tr><td>4</td><td>Siltation Pond</td><td>250</td><td>132</td><td>2</td></tr>
</table>


 </td></tr>
<tr><td>9</td><td>Dimension of the retaining wall at the toe of the dumps and OB benches within the mine to catch run off and siltation shall be based on the rainfall data.</td><td><u>Complied</u>
As mining activity was started from march 2015 and only little area of earmarked for OB dump site was utilized. Further company is agreed to construct retaining wall when it will be necessary.</td></tr>
<tr><td>10</td><td>Water sprinkling system shall be provided to check fugitive emissions, haulage roads transfer points.</td><td><u>Complied</u>
We have 05 Nos. dedicated sprinkler for sprinkling water round the clock to control the fugitive emission.</td></tr>
<tr><td>11</td><td>All approach roads, major haul roads and roads to village umarser being diverted shall be black topped.</td><td><u>Complied</u>
We have provided Metal with suitable clay on the Road in mining area. Water is also provided by sprinkler system. Road leading to village Umarsar was carpeted with asphalt.</td></tr>
<tr><td>12</td><td>No drilling and blasting shall be carried out.</td><td><u>Complied</u>
The mine is with soft strata. Hence no drilling and blasting activity was carried out.</td></tr>
<tr><td>13</td><td>A 50 m wide green belt shall be created along the lease boundary using native species. In addition grassland shall be developed within the core zone in un distributed areas, using</td><td><u>Complied</u>
The plantation activity is being carried out in phase manner. In reporting periods 02 Ha area with 3400 Sapling planted. And 700 kg seeds spread by making seedballs Total Plantation 39 Ha as Green belt & 23 Ha. area reclaimed as biological in Backfilled area with</td></tr>
</table>

	native grass species. Area brought under Afforestation shall not be less than 1067 ha which includes reclaimed external OB dump(107 ha),backfilled area(849.45 ha) ,along ML boundary ,along roads, green belts,in undistributed area by planting native species in consultation with the local DFO/Agriculture department .The density of the trees shall be around 2500 plants per ha.	150900 Nos. Of Plants , Photographs are shown below: 
14	A progressive closure plan shall be implemented by reclamation of quarry area of which 849.45 ha shall be backfilled and afforested by planting, native plant species in consultation with the local DFO/Agriculture Department. The density of the tree shall be around 2500 plant per ha. The balance 23.47 has of de-coaled area being converted into a water reservoir shall gently sloped along the upper benches and stabilized and reclaimed with plantation.	Complied The backfilled area is 240 ha. Out of it Physical reclaimed 240Ha. & Biological reclaimed 39 Ha. area under plantation. 
15	No mining shall be carried out below 50m depth below ground level . No ground water shall be used for mining operations. Additional water required, if any shall be met by recycling/reuse of the water from the existing activities and from rainwater harvesting measure.	**Noted and complied** The mining was not carried out below 50 m depth. Company is not using any ground water for mining activity.
16	Mine pit water which is high in TDS shall be treated in an RO plant to prescribed limits before discharge into natural	Complied We have installed ETP Plant for Mine pit water, after treatment water is being used for sprinkling purposes. And not discharged in natural water body / course.

	water/land. The brine concentrate from the RO plant shall be stored in a concrete lined pit.	
17	Regular monitoring of ground water level and quality shall be carried out by establishing a network of existing wells and construction of new peizometers. The monitoring for quality shall be done four times a year in pre-monsoon (May), monsoon (August), post monsoon (November) and winter (January) seasons and for quality (including TDS and add mine water) in May. Date links collected shall be submitted to the Ministry of Environment & Forests and to the Central Pollution Control Board quarterly within one month of monitoring.	Complied Recently we have 03 ground water monitoring station. in surrounding Mines Lease and Results of the Ground water monitoring is attached here with **Annexure-II**
18	The company shall put up artificial ground water recharge measures such as check dams within and adjoining the lease for augmentation of ground water resource in case monitoring indicates decline in water table. The project authorities shall meet water requirement of nearby village(s) in case line village wells go dry due to dewatering of mine.	Complied We are doing the work of conservation of water with the help of irrigation & agriculture department and self on the demand of villagers. The work of deepening of ponds and construction of check dams in area is being carried out by GMDC under CSR activity. This reporting periods we have developed 01 Pond/check dam in lease area for water harvesting and our use purpose.
19	ETP shall also be provided for workshop, and CHP, effluents shall be treated to conform to prescribed standards, particularly for PH and TDS in case of discharge in to any water course outside the lease.	Complied Waste water generated from work shop is being discharge through septic tank after the removal of oil & grease. Water is not being discharged in to any water course outside the lease.
20	Land ousts shall be compensated as per norms not below that laid out under the National R& R policy. Activities under CSR for the ten villages in the buffer zone shall be not less than a capital outlay of Rs. 2.0 crores.	Complied GMDC has Implemented National R&R policy for rehabilitation of Umarsar village in buffer zone. The periods CSR Expenses around 12 Lacs and Some works are under progress.
21	For monitoring land use pattern	Complied

	and for post mining land use, a time series of land use maps, based on satellite imagery (on a scale of 1:5000) of the core zone and buffer zone, from the start of the project and end of mine life shall be prepared once in 3 years (for any one particular season which is consistent in the time series) and the report submitted to MoEF and its Regional office at Bhopal.	We have Attached herewith report for monitoring land use pattern and for post mining land use, a time series of land use maps, based on satellite imagery (on a scale of 1:5000) of the core zone and buffer zone. As annexure-III
22	A final mine closure plan along with details of corpus fund shall be submitted to the ministry of Environment & Forests for approval 5 years in advance of final mine closure for approval. The habitat Restoration plan shall include plan for development of 622 ha for agro- pastoral land use using/reintroducing a mix of native grass and shrub special from the original ecosystem, which are conserved by insitu and ex-situ method of conservation.	Complied Presently mine is in progressive stage.

B. GENERAL CONDITIONS

Sr. no.	Conditions	Remarks
1	No change in mining technology and scope of working shall be made without prior approval of the Ministry of Environment and Forest	Complied We have already submitted the process plan to MOEF and Gujarat pollution control Board at the time of CC&A.
2	No change in the calendar plan including excavation quantum of mineral lignite and waste shall be made.	To cater the demand of nearby power plants along with small scale industries of Gujarat, revised mine plan preparation is under active consideration & process.
3	Four ambient air quality monitoring stations shall be established in the core zone as well in the buffer zone for monitoring SPM, RPM, SO2, NOx. Location of the stations shall be decided based on the meteorological data, topographical features and environmentally and	Complied We are monitoring ambient air quality at Six stations The results of same is

	ecologically sensitive targets in consultation with the State Pollution Control Board. In addition heavy metals such as Hg, As, Pb, Cd etc shall also be monitored twice in a year.	attached as **annexure-I**
4	Fugitive dust emissions (SPM and RSPM and heavy metals such as HG, Pb, Cr, As etc.) from all the sources shall be controlled regularly monitored and data recorded properly. Water spraying arrangement on haul roads, wagon, loading, dump trucks (loading and unloading) points shall be provided and properly maintained.	Complied We have 05 nos. dedicated sprinkler tanker for spraying water.
5	Data on ambient air quality (SPM, RSPM, SO2, NOx and heavy metals such as Hg,Pb,Cr,As etc) shall be regularly submitted to the Ministry including its Regional Office at Bhopal and to the State Pollution Control Board and the Central Pollution Control Board once in six months	Complied Data has been Regularly sent with EC compliance and state pollution control board on regular basis. – **Attached As Annexure-I**
6	Adequate measures shall be taken for control of noise levels below 85 dBA in the work environment. Workers engaged in blasting and drilling operations, operation of HEMM, etc shall be provided with ear plugs/muffs.	Complied Noise is within limit and AC cabin is provided in mining machineries.
7	Industrial wastewater (workshop and waste water from the mine) shall 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 before discharge. Oil and grease trap shall be installed before discharge of workshop effluents	Complied Waste water generated from work shop is being discharge through septic tank after the removal of oil & grease.
8	Vehicular emissions shall be kept under control and regularly monitored. Vehicles used for transporting the mineral shall be covered with tarpaulins and optimally loaded.	Complied We have already developed system for covering the every trucks before dispatched and check at out gate. No truck is allowed to pass without it.
9	Environmental laboratory shall be established with adequate number and type of pollution monitoring and analysis equipment in Consultation with the State Pollution Control Board.	Complied All the sampling and analysis of air and noise is being carried out through consultant.
10	Personnel working in dusty areas shall wear protective respiratory devices and they shall also be provided with adequate training and information on safety and health aspects. Occupational health surveillance programme of the workers shall be undertaken periodically to observe any contraction due to dust and to take corrective measures, if needed.	Complied Workers used PPE. And awareness has been Provided on job & VTC center. Health surveillance has been carried out time to time.
11	A separate environmental management cell with suitable qualified personnel shall be set up under the control of a Senior Executive, who will report directly to the Head of the company	Complied Separate Environmental cell is established and which is report to head of the projects. Further there is Environmental Cell at corporate level.
12	The funds earmarked for environmental protection measures shall be kept in separate account and shall not be	Complied We have kept separate

	diverted for other purpose. Year-wise expenditure shall be reported to this Ministry and its Regional Office at Bhopal	budget provision for environment protection measure every year. The provision for year 2020-21 is 299.25 lacs.
13	The Regional Office of this Ministry located at Bhopal shall monitor compliance of the stipulated conditions. The project authorities shall extend full co-operation to the officer(s) of the Regional Office by furnishing the requisite data/information/monitoring reports.	Noted with esteem
14	A copy of the EC will be marked to concerned Panchayat /local NGO, if any, from whom any suggestion/representation has been received while processing the proposal	Complied
15	State Pollution Control Board shall display a copy of the clearance letter at the Regional Office, District Industry Centre and Collector's Office/Tehsildar's Office for 30 days.	Complied
16	The project authorities shall 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 seven days 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 may also be seen at the website of the ministry of Environment & Forests at http://envfor.nic.in. The compliance status shall also be uploaded by the project authorities in their website and regularly updated at least once in six months so as to bring the same in the public domain. The monitoring data of Env. Quality (air, water, noise and soil) shall also be displayed at the entrance of the project premises and mines office and in corporate office and also on the company's website.	Complied.

For, GMDC LTD,

Prepared By

Authorized Signature.

27/10/2021

General Manager (P)

Umarsar Lignite Mine

Annexure-I - Ambient Air Monitoring Umarsar lignite mines project.

APR-2021 to SEP -2021			Parameter				
Sr. No	Location	Month	PM10 ($\mu g/m^3$)	PM2.5 ($\mu g/m^3$)	SO2 ($\mu g/m^3$)	NO2 ($\mu g/m^3$)	co mg/m3
1	Nr. Adm Office	APR	64.9	29.1	13.4	16.2	
2	Nr. Dispatch Weight Bridge	APR	75.9	39.1	18.3	23.7	
3	Nr. Wadh Ghat Weight Bridge	APR	70.9	36.4	21.7	18.2	
4	Nr. Umarsar School	APR	64.2	30.9	16.5	22.7	
5	Nr. Time Office	APR	77.9	40.1	15.8	22.5	
6	Nr. Flura Gate	APR	69.8	37.5	14.8	22.5	
1	Nr. Admin Office	MAY	57.4	33.7	18.4	21.1	0.2
2	Nr. Dispatch Weight Bridge	MAY	86.3	47.1	13.4	19.4	0.4
3	Nr. Wadh Ghat Weight Bridge	MAY	88.4	41.2	15	22.1	0.3
4	Nr. Umarsar School	MAY	58.1	25.8	10.9	16.4	0.3
5	Nr. Time Office	MAY	69.8	45	16.5	19.8	0.2
6	Nr. Flura Gate	MAY	76.3	47.5	16.9	19.6	0.2
1	Nr. Admin Office	JUN	69.3	31.7	16.2	20.5	
2	Nr. Dispatch Weight Bridge	JUN	78.8	42.1	16.4	20.2	
3	Nr. Wadh Ghat Weight Bridge	JUN	77.7	37.1	15.2	20.2	
4	Nr. Umarsar school	JUN	78.4	40.4	19.6	21.8	
5	Nr. Time Office	JUN	71.2	37.1	11.9	17.9	
6	Nr. Flura Gate	JUN	71.6	32.5	15.8	23.3	
1	Nr. Admin Office	JULY	65.6	22.9	15	17.5	
2	Nr. Dispatch Weight Bridge	JULY	69.4	28.3	16.1	19.8	
3	Nr. Wadh Ghat Weight Bridge	JULY	64.5	24.2	16.6	19.8	
4	Nr. Umarsar school	JULY	61.9	22.9	12.3	18.8	
5	Nr. Time Office	JULY	68.7	29.2	12.1	15.9	
6	Nr. Flura Gate	JULY	60.5	30.4	15	22.9	
1	Nr. Admin Office	AUG	63.9	26.2	13.7	16.7	
2	Nr. Dispatch Weight Bridge	AUG	73.7	31.7	14.1	21.6	
3	Nr. Wadh Ghat Weight Bridge	AUG	72.1	27.9	15.6	20.8	
4	Nr. Umarsar school	AUG	60.5	23.3	14.1	20.5	
5	Nr. Time Office	AUG	63.7	27.9	14.5	17.9	
6	Nr. Flura Gate	AUG	72.9	29.6	13.4	20.8	
1	Nr. Adm Office	SEP	67.4	32.5	17.4	20.6	0.3
2	Nr. Dispatch Weight Bridge	SEP	75.7	37.5	17.3	23.6	0.4
3	Nr. Wadh Ghat Weight Bridge	SEP	71.4	33.3	16.0	21.3	0.5
4	Nr. Umarsar school	SEP	64.6	29.2	15.8	21	0.4
5	Nr. Time Office	SEP	65.7	31.2	14.3	20.2	0.4
6	Nr. Flura Gate	SEP	74.7	36.2	15.7	24.8	0.2
	Six monthly Hevay metal		Hg (Ng/m3)	Pb (ug/m3)	Cr (ug/m3)	As (ug/m3)	
1	Nr. Adm Office	SEP	BQL	BQL	BQL	BQL	
2	Nr. Dispatch Weight Bridge	SEP	BQL	BQL	BQL	BQL	
3	Nr. Wadh Ghat Weight Bridge	SEP	BQL	BQL	BQL	BQL	
4	Nr. Umarsar school	SEP	BQL	BQL	BQL	BQL	
5	Nr. Time Office	SEP	BQL	BQL	BQL	BQL	
6	Nr. Flura Gate	SEP	BQL	BQL	BQL	BQL	

AM-Environment

27/10/2021

General Manager(P)

Annexure-II -Ground Water Analysis Results of Umarsar From APR-21 to SEP-21								
Parameter		Unit	May-21			Sep-21		
			GW well - 01 chhuger	GW Pizometer-01	GW Pizometer-02	Ground Water-Well 01	GW Pizometer-01	GW Pizometer-02
Location			near Chhuger Village	Near Umarsar Gate Road	GCC Camp	near Chhuger Village	Near Umarsar Gate Road	GCC Camp
Sr.No	water level	Mtr	5	17	20	4	18	20
1	pH at 25 °C	-	7.1	7.1	6.8	7.23	6.9	7.31
2	Total Dissolved Solids(TDS)	mg/L	9242	16278	10330	9290.0	10150	15926
3	Total Suspended Solids(TSS)	mg/L	73	67	58	80.0	52	72
4	Acidity	mg/L	82	76	66	84.0	82	78
5	Alkalinity	mg/L	86	107	92	88.0	98	88
6	Chloride	mg/L	4699	3749	2899	4649.0	3149	3799
7	Calcium as Ca.	mg/L	248.5	519	780	240.5	332.7	509
8	Magnesium as Mg	mg/L	77.76	192	87.48	68.0	97.2	250.29
9	Sulphate	mg/L	721.84	501	452.16	753.6	482.3	552.64
10	Nitrate	mg/L	1.3	6.4	6.2	1.4	6	6.5
11	iron	mg/L	0.21	3.8	2.8	0.3	3.1	4.2
12	floride	mg/L	bql	bql	bql	BQL	BQL	BQL
13	phosphate	mg/L	0.52	0.45	0.46	0.63	0.59	0.68
14	Total Hardness as CaCo3	mg/L	1170	1850	1140	1130	1180	1880
15	Cadmium (As Cd)	mg/L	BQL	BQL	BQL	BQL	BQL	BQL
16	Arsenic (As As)	mg/L	BQL	BQL	BQL	BQL	BQL	BQL
17	Zinc (As Zn)	mg/L	0.05	BQL	BQL	BQL	BQL	BQL
18	Lead (As Pb)	mg/L	BQL	BQL	BQL	BQL	BQL	BQL
19	Nickle (As Ni)	mg/L	BQL	BQL	BQL	BQL	BQL	BQL
20	Total Chromium (As Cr)	mg/L	BQL	BQL	BQL	BQL	BQL	BQL
21	Mercury (As Hg)	mg/L	BQL	BQL	BQL	BQL	BQL	BQL
22	Manganese (As Mn)	mg/L	BQL	BQL	BQL	BQL	BQL	BQL
23	Berylium (As Be)*	mg/L	BQL	BQL	BQL	BQL	BQL	BQL
24	Selenium (As Se)*	mg/L	BQL	BQL	BQL	BQL	BQL	BQL
25	Cobalt (As Co)*	mg/L	BQL	BQL	BQL	BQL	BQL	BQL
26	Barium (As Ba)*	mg/L	BQL	BQL	BQL	BQL	BQL	BQL

AM-Environment

29/10/2021
General Manager(P)

Study of Change in Land Use Pattern

by using Remote Sensing and Geographical Information System (RS/GIS) technique for mining lease area of GMDC

Umarsar Opencast Lignite Mine, Kutch

(Core Area)

Submitted By

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CHAPTER : 1

PROJECT BRIEF

I. Preamble

In an effort to map and monitor the changes in land use pattern of Umarsar Lignit mine in the State of Gujarat as a part of the compliance of Environment Clearance, a workorder was awarded to M/s Nirzar Lakhia for study of Land use changes by using remote sensing and GIS technique.

II. About GMDC

GMDC was incorporated on 15th May, 1963 to develop major Mineral Resources in the State and started with a Silica Sand quarrying Plant near Surajdeval (Dist. Surendranagar) for crushing and screening of Silica Sand required for Glass Industry. From this humble starting, GMDC today boasts of a vast array of Mineral Portfolio in its mineral rich basket. Hence, the journey of GMDC begins for Mining Sector of Gujarat.

Rapid Industrial Development, requires Fuel and Energy resources. The motive inspired the state to incorporate a Public Sector Company that would target exclusive development of Mineral Resources endowed on the state. Thus, began a historical journey which has today reached a milestone of Glorious fifty-five years.

CHAPTER : 2

OBJECTIVE AND SCOPE

The objective of the present study is to perform Digital processing of entire lease area using remote sensing and GIS technique (Pre- and during mining operations) regularly once in 3 years for monitoring land use pattern and assess the impact of mining and restoration of land post closure or completion of the excavation of a particular mine pit area.

For this purpose change in land cover area, change in forest area and expansion of mining over the period of time, infrastructure, roads, water bodies, dump areas etc. should be mapped.

The current report brings out the changes in land use pattern in the core zone and 10 km buffer zone of the Umarsar Lignite Mine in Kutch by comparing land use pattern during 2009, 2012, 2015 and 2018 using Remote sensing techniques for the purpose of monitoring change in the Land use pattern and for determining post mining use of the area.

I. Study Areas

Umarsar mining site lies between 23°47'33.37"N to 23°42'50.09"N latitude and 68°47'24.42"E to 68°50'52.70"E. The study area is situated in Umarsar village of Lakhpat taluka of Kutch District. Total 28 villages are present within 10 kms radius of GMDC Umarsar mining lease boundary.

Village map of the study area is shown as below:

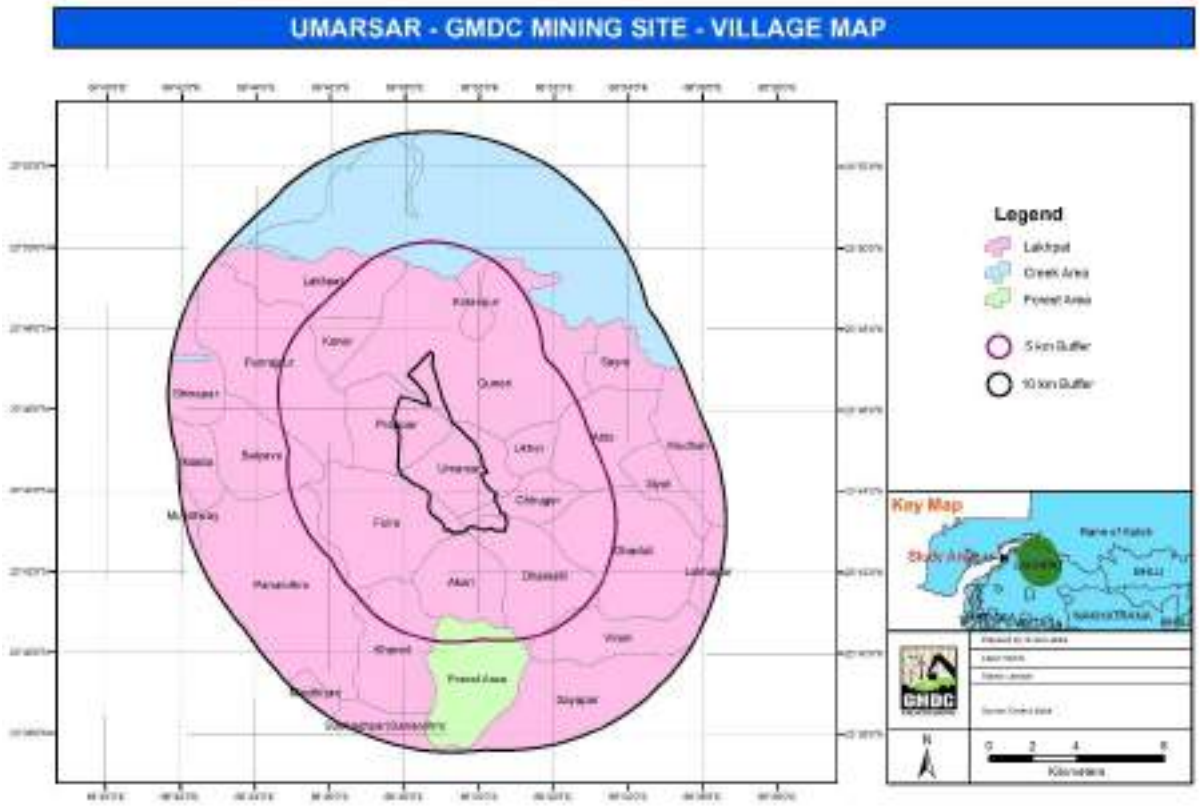

Fig. 2.1 Village Map of Umarsar GMDC Lignite lease boundary

II. Location and description of the site:

Project Name & Address	Area of Mine (in Ha.)	Detail of Project wise corresponding years for land Use Study.
Umarsar Lignite Project, village Umarsar, Taluka Lakhpat, Dist. Kutch (Gujarat).	2186.76	2009, 2012, 2015 and 2018

Table. 2.1 Location and Description of the site

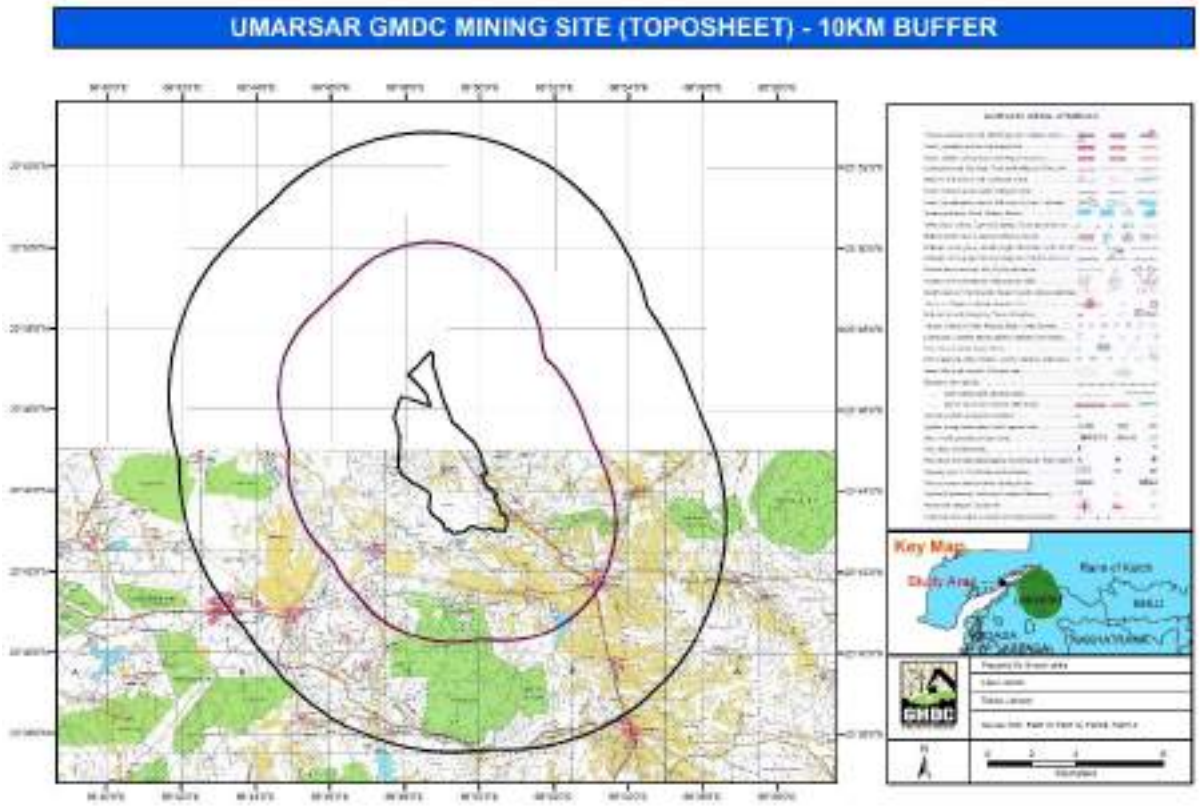

Fig. 2.2 Toposheet of study area (Upper half of is not available at SOI)

III. Data-set used

Satellite	Sensor	Number	Date Of Pass	Band	Resolution
Year – 2009					
Cartosat-1	PAN_ AFT	Path=0487 Row=0288 SceneSequence Number=57	2009	PAN_ AFT	2.5
Cartosat-1	PAN_ AFT	Path=0487 Row=0287 SceneSequence Number=56	2009	PAN_ AFT	2.5
Cartosat-1	PAN_ AFT	Path=0488 Row=0287 SceneSequence Number=57	2009	PAN_ AFT	2.5

IRS-P6	L4MX	StripNumber= 202 SceneNumber= 69	2008	234	5.8
IRS-P6	L3MX	Path= 089 Row= 055	2009	234	23
Year – 2012					
Cartosat-1	PAN_ FORE	Path=0488 Row=0287 SceneNumber= 54	2012	PAN_ FORE	2.5
Cartosat-1	PAN_ FORE	Path=0487 Row=0287 SceneNumber= 54	2012	PAN_ FORE	2.5
IRS-R2	L4FX	Path= 089 Row= 055	2012	234	5.8
Year – 2015					
IRS-R2	L4FX	Path= 089 Row= 055	2015	234	5.8
Cartosat-1	PAN_ AFT	Path=0487 Row=0287 SceneSequence Number=52	2015	PAN_ AFT	2.5
IRS-R2	L4FX	Path= 089 Row= 055	2015	234	5.8
Year – 2018					
IRS-R2	L4FX	Path= 089 Row= 055	2018	234	5.8
Cartosat-1	PAN_ AFT	Path=0487 Row=0288 SceneSequence Number=48	2018	PAN_ AFT	2.5
Cartosat-1	PAN_ AFT	Path=0487 Row=0287 SceneSequence Number=47	2018	PAN_ AFT	2.5
Cartosat-1	PAN_ AFT	Path=0488	2018	PAN_ AFT	2.5

		Row=0287 SceneSequence Number=29			
IRS-R2A	L4FX	Path= 089 Row= 055	2018	234	5.8

Table. 2.2 Satellite Images of Umarsar, Kutch

Other Supporting datasets

The following ancillary data have also been used during the course of the study.

1. Surface plan maps of GMDC
2. Primary data collection through field visits
3. Villages map of Kutch district
4. Survey of India Toposheet
5. DGPS Survey
6. Drone Images

IV. Approach and Methodology:

Steps:	**Description of Approach and Methodology (Considering all 6 Mine locations)**
Step 1:	Procurement of Village Maps with Plots and Survey of India Topo sheet, DILR Maps.
Step 2:	Procurement of Satellite Image as per Mine Project wise Detail for Years required in Land Use Pattern Study.
Step 3:	Pre-Processing, Geo-rectification and Mosaicing of Satellite Image.
Step 4:	Digitization of Mines boundary / surface area / Topographic Map for the study area.
Step 5:	Scan, Geo-referencing and Digitization of Plot Level Village Map.
Step 6:	Topographic Survey: Field Visit and Photography, Survey through DGPS/Total Station, Land Use verification and demarcation of Mine Boundary (First Visit).
Step 7:	Preparation of Base Map of study area.
Step 8:	Preparation of Land Use Maps as per Mine Project wise Detail for respective Years of particular mine required in Land Use Pattern Study (Core + 10 Km Buffer).

Step 9:	Overlay Analysis of Village Map on Land Use as per Mine Project wise Detail for respective Years of particular mine required in Land use Pattern Study.
Step 10:	Field Visit for Group discussion with the locals and verification of any anomalies or queries
Step 11:	Preparation of Final Land use Maps.
Step 12:	Change Detection Analysis for various years as tabulated at table given under clause no. 3 (every 3 Years) for Land use of core mining area and its Buffer area.
Step 13:	Layout Designing of the Maps.
Step 14:	Draft Reports and Presentation.
Step 15:	Staff Training Program (Free/Open source software will be provided to GMDC for visualization of the Maps) to understand the project methodologies and outcome of the land use study.
Step 16:	Feedback from GMDC authorities.
Step 17:	Final Reports (5 Copies in Hard Form with colour Pictures, Photos and Maps etc.) AND 2 Copies in Soft Form in Pen Drive) including Original Satellite Images and other Maps / Reports etc.).
Step 18:	Final Outputs: Prints of Maps (A2 or A3 size) and Reports (A4 size)

Table. 2.3 Approach and Methodology

Description of Task/Steps:

This task focused on the preparation of change detection model and mapping for monitoring land use pattern and for post mining land use condition, a time series of land use maps based on satellite imagery (on a scale of 1:5000) of the core zone and buffer zone, from the start of the project until end of mine life were prepared once in 3 years (for pre-monsoon season which was consistent in the time series), and the report submitted to MoEFCC and its Regional Office at Bhopal.

The detailed activities carried out under this scope of work are as follows:

Step 1:

Procurement of Mines boundary / surface area map / Topographic Map:

Initially Mines boundary / surface area map / Topographic Map, other related details were collected from the GMDC. Mines boundary / surface area map at times also contain village and plot level boundary as well, which has been

taken into consideration.
The format for mines related maps that were collected from GMDC were in AutoCAD, JPG and/or PDF format which were then be digitized and converted into soft copy in the required GIS format.

Step 2:

Procurement of Village Maps with Plots & type of Ownership (Census 2011, Revenue data etc.) and Survey of India Topo sheet, DILR Maps

Village boundary were extracted from the census book 2011 and available village maps from GMDC offices. Plot level maps or DILR / Cadastral maps has been collected from District land Record office and GMDC offices of respective area where it was available.

Survey of India topo sheet were procured from Survey of India website as well as their office at Gandhinagar, Gujarat. They were later processed and Geo referenced with its required co-ordinate system.

Step 3:

Procurement of Satellite Image as per Mine Project wise Detail for Years required in Land Use Pattern Study asked by GMDC:

Satellite images were procured from NRSC, Hyderabad based on the co-ordinates of mine boundaries identified from the Mines boundary map/ surface area map / Topographic Map of the respective mines provided by the GMDC and boundaries verified and identified through field survey.

Cartosat series and LISS IV series of satellite images of same time period/ seasons of pre-monsoon period were procured from NRSC, Hyderabad. These were mostly from January to July months.

LISS IV is important as it has the highest available Multispectral resolution of 5 mtr. Cartosat series of images was also required as it has the highest Pancromatic (black & White or Grey scale) resolution available (2.5 mtrs).
1. The Layer stacking the MSS image of LISS IV was done before any kind of analysis.
2. Pre-processing like radiometric correction, haze reduction removal of any bad line etc was done before using it for any kind of analysis.

3. Ortho-rectification was done based on available DEM and field DGPS survey prior to any other processes for achieving better accuracy.

4. Both these images were fused for getting best of both the images in terms of spectral and spatial resolution for generation of the Land use maps at the scale of 1:5000.

Step 4:

Pre-Processing, Geo-rectification and Mosaicing of Satellite Image

Survey of India topo sheet was Geo referenced with its required co-ordinate system and was used as a base for initial level geo referencing of the other map and satellite data.

The co-ordinate system used were in accordance with the NRSC standards. In these study Global UTM WGS84 zone 42 and 43 N (as per the location of the mines within the Gujarat state) were used.

Geo-referencing was done for the available Mines boundary / surface area map / Topographic Map and village maps so that they can be superimposed with each other.

Plot level village maps and/or DILR maps were also superimposed on them so that all the available data are appropriately scaled and in the precise locations with respect to ground.

Step 5:
Digitization of Mines boundary / surface area / Topographic Map for the study area

Mines boundary / surface area map / Topographic Map and other related spatial and spatial data collected from the GMDC office were digitized to bring it into GIS format.

Maps available in AutoCAD format were directly converted to GIS format after the required treatment to remove all the existing as well as conversion related errors. Maps available in JPG and PDF format were converted to GIS format after Georeferencing through appropriate application of Projection system (UTM

WGS84 Zone 42 or 43) and later on digitizing them in ArcGIS Pro and Desktop software.

Step 6:

Scan, Geo referencing and Digitization of Plot Level Village Map

Village map extracted from the Census 2011 book were scanned, Geo referenced with appropriate projection system and digitized in GIS format. DILR map with Plot boundaries collected from District land records were also geo referenced with appropriate projection system. For precision mapping geo referencing was done by superimposing them on the satellite images in such a way that the actual plots visible on the satellite images fall precisely on village plot boundaries. Maps were then be digitized in GIS Environment.

Step 7:
Topographic Survey: Field Visit and Photography, Survey through DGPS/Total Station, Land Use verification and demarcation of Mine Boundary.

List of locations were identified (which needed verification) for the field survey before going to the field. These locations were carefully selected after proper visual analysis of satellite images and collected maps.

These helped in process of identification and demarcation of mine boundaries and village/plot boundaries and verification of areas unidentified from satellite images for preparation of Base map.

Appropriate grid sampling technique for the topographic survey were planned based on the latest satellite images and Mines boundary / surface area map / Topographic Map available through GMDC. Grid size varied based on the actual field conditions. In general it ranged from 10 ft x 10 ft to 100 ft x 100 ft depending on the actual field conditions.

A benchmark was identified for proper superimpositions with satellite images and govt. provided maps. Photographs of all the location of the mine boundary Pillars were collected along with the photographs of the land use features. These all the photographs were Geo-tagged for better visual presentation on the GIS software.

After marking of the final mine boundaries (after field verification) on GIS base map, digital code to each photograph was given this helped in integration of socio-economic data and GIS at local level.

Step 8:

Preparation of Geo-referenced Base Map

The preparation of Geo-referenced base map to an appropriate scale of 1:5000 which is prerequisite for the Change detection analysis was generated for superimposition of all other maps over it. The digital base map would provide a common spatial framework that should be used by all participating departments within GMDC for any kind of mapping and the development of detailed GIS based maps in future.

ArcGIS Pro 2.7 and ArcGIS Desktop 10.8 which is its latest version and is a global leader in GIS mapping software was used to analyze, manipulate and display the appropriate mining data.

The preparation of geo-referenced base map was based on high-resolution satellite imageries and DGPS field survey. To facilitate sharing of information between various sections, it is critical that GIS base mapping be compatible with standard data base formats.

National Remote Sensing Centre, Hyderabad has already standardized a format for representing a Land use map with its respective coding. This system was adopted for representation of the features in a Land use map which will make it possible for other agencies to incorporate them in their respective studies when required. (The same format will be adopted for preparation of Land use map as well.)

The base map contains major surface features with reference names, such as National Highway, State Highway, main roads, railways, airport, important landmarks, water bodies, rivers, mine boundaries, administrative boundaries, structures etc.

The base map provides the background upon which other data layers (such as Mines boundary / surface area map / Topographic Map/ contours, surface and social infrastructure etc.) are superimposed and analyzed in GIS.

Step 9:

Preparation of Land Use Maps as per Mine Project wise Detail for Years required in Land Use

Pattern Study (Core + 10 km Buffer) Land use map has been also prepared based on the visual interpretation to get the best results. Field verifications was done for the required areas for better demarcation of the features.

Same co -ordinate system was used as in the geo referencing of the Satellite images (UTM WGS84 Zone 42 or 43 N as per the location of the mines within the Gujarat state).

File type used for the preparation of the GIS Maps are in the format of "Personal Geo database" and "file Geo database".

The classification system that was adopted for Land use map generation is based on standardized format from NRSC (National Remote Sensing Centre, Hyderabad) However since all the categories are not covered in that system required updation was done to cover other categories.

There are various levels of classification systems adopted by NRSC, we had successfully reached to the level I and II of the classification with additional level III information included in the maps for more important features like National Highway, State Highway, Railways tracks etc. where ever felt necessary.

Step 10:

Overlay Analysis of Village Map on Land Use as per Mine Project wise Detail for Years required in Land Use Pattern Study

After the completion of all the maps an attempt was made to superimpose the plot level village maps over the land use maps generated for various years. These becomes useful for change analysis at village level. Based on this a village wise change detection maps can be generated. This may also help in any future development works or any socio-economic studies.

Step 11:

Field Visit for Group discussion with the locals and verification of any anomalies or queries

Field visit has been done for final verification of the features of the land use as well as cross - verification of the features presented in the village and plot level maps. Drone survey was also conducted for any minute level anomalies or queries which were left after the final preparation of the Land use map.

During this visit a group discussion was also done with the locals and authorities. The focus of this discussion was to understand the terrain and land use of the past and the changes that have occurred after the operation of the mines and study the impact of any positive or negative nature on the land use and environment in their perspective. Such focus group discussion helped to better understand the environment and changes that have occurred over a period of time.

Step 12:

Preparation of Final Land use Maps

Land use maps were finalized by resolving all the remaining queries after the final field verifications and Drone survey.

Step 13:

Change Detection Analysis for various years (every 3 Years) for Land use of core mining area and its Buffer zone area

Change detection analysis is important for understanding of the pattern of change in a given area over the period of time, this is useful for planning of any future development works. Change detection analysis would be done for every 3 years as per the requirement of the project.

Software like ArcGIS were used for the change detection analysis. It has special modules of spatial analysis tool for such analysis, which were taken into consideration.

Change detection was based on a simple over analysis, however special codes were developed for getting the final desired output for the change analysis. These were then used in categorizing the change in terms of increase in area, no change or decrease in the same category or got converted into different category.

The new features that may have developed in the later years or which were not present in the earlier years were also considered and highlighted separately.

Step 14:

Layout Designing of the Maps

Layout has be designed in such a way that all the necessary details can be displayed in the map at various scales and sizes appropriately. This was done after a discussion with the authorities of GMDC to meet their requirements.

Step 15:

Draft Reports and Presentation (Mid Review - for required modification)

A set of Draft Reports were prepared for the reviewing purpose for the GMDC authorities prior to submission of the final reports. These were then modified where ever felt necessary as per the specifications of the authorities and a presentation was given to update the authorities with the results and the output of the final reports.

Step 16:

Staff Training Program (Free/Open source software will be provided to GMDC for visualization of the Maps)

GMDC has planned to incorporate training program for GMDC's Staff as a part of the project so that they can be well equipped to learn and understand the intricacies of the project methodologies and results

Step 17:
Feedback from GMDC authorities
This was helpful in understanding overall quality management during the execution of the project.

Step 18:

Final Reports

Maps and reports were finalized after a careful review and discussions with GMDC authorities as per their requirements. Maps were provided separately as well for quick references with necessary details.

Step 19:

Final Outputs: Softcopies and Prints of Maps and Reports

- Softcopies and Hardcopies of Satellite images in A3 and/or A1 Size or other size as desired by GMDC.
- Final output will be submitted to the GMDC authorities as per their requirements.
- Maps will also be submitted separately in a larger size as per the requirement of GMDC.
- Reports will be printed in A4 size.
- All the maps and report are in colour.
- Reports and Maps of Core and Buffer Zone areas would be provided separately

CHAPTER 3

STATUS OF LAND USE LAND COVER

Land use is the description of how people utilize the land for the socio-economic activities. Land use maps play a significant role in planning, management and monitoring programs at local, regional and national levels. For ensuring sustainable development, it is necessary to monitor the ongoing process on land use/land cover pattern and any upcoming changes within the surrounding area.

Three Level Classification System from NNRMS:

Level -1	Level -II	Level -III
Built Up	Urban	Residential
		Mixed builtup
		Recreational
		Public / Semi Public
		Communication
		Public utilities / facility
		Commercial
		Reclaimed
		Transportation
	Rural	Rural
	Mining / Industrial Area	Industrial
		Mine / Quarry
		Industrial / Mine dump
		Ash / Cooling pond
		Abandoned Mine Pit
		Land fillarea
Agricultural land	Crop Land	Kharif
		Rabi
		Zaid
		Two cropped
		More than two cropped
	Fallow Land	Current
		Long
	Plantation	Agricultural
		Horticultural
		Agro Horticultural
	Aqua / Pisciculture	Aqua / Pisciculture
Forest	Evergreen / Semi evergreen	Dense / Closed
		Open

	Deciduous (Dry / Moist / Thorn)	Dense / Closed
		Open
	Forest Plantation	Forest Plantation
	Scrub Forest	Scrub Forest
	Forest Blank	Forest Blank
	Littoral/Swamp Forest (Mangrove/Forest Water Swamp)	Dense
		Open
Grass/ Grazing	Alpine / Sub-Alpine	Alpine / Sub-Alpine
	Temperate / Sub Tropical	Temperate / Sub Tropical
	Tropical / Desertic	Tropical / Desertic
	Manmade	Manmade
Wastelands	Salt Affected Land	Slight
		Moderate
		Strong
	Gullied / RavinousLand	Gullied
		Shallow ravine
		Deep ravine
	Scrub land	Dense / Closed
		Open
	Sandy area	Desertic
		Coastal
		Riverine
	Barren rocky	Barren rocky
Wetlands	Inland Natural	Inland Natural
	Inland Manmade	Inland Manmade
	Coastal Natural	Coastal Natural
	Coastal Manmade	Coastal Manmade
Waterbodies	River / Stream	Perennial
		Dry
	Canal / Drain	Lined
		Unlined
	Lake / Ponds	Perennial
		Dry
	Reservoir / Tanks	Perennial
		Dry
Others	Shifting cultivation	Current
		Abandoned
	Tree Clad Area	Dense
		Open

Table. 3.1 NNRMS Classification system

Definitions:

Green Areas:

1. **Agriculture/Cropland:** These are the areas with standing crop as on the date of Satellite overpass. Cropped areas appear in bright red to red in color with varying shape and size in a contiguous to non- contiguous pattern. They are widely distributed indifferent terrains; prominently appear in the irrigated areas irrespective of the source of irrigation. It includes kharif, rabi and zaid crop lands along with areas under double or triple crops.

2. **Fallowland:** Fallow land is all arable land either included in the crop rotation system or maintained in good agricultural and environmental condition (GAEC), whether worked or not, but which will not be harvested for the duration of a crop year. The essential characteristic of fallow land is that it is left to recover, normally for the whole of a crop year.

   On land lying fallow there shall be no agricultural production. Land lying fallow for more than 5 years for the purpose of fulfilling the ecological focus area shall remain arable land.

   Fallow land may be:

- bare land with no crops at all
- land with spontaneous natural growth which may be used as feed or ploughed in
- land sown exclusively for the production of green manure (green fallow)

Fallow land may be: bare land with no crops at all.

3. **Barren Land:** A barren landscape is dry and bare, and has very few plants and no trees. Those ecosystems in which less than one third of the area has vegetation or other cover.
4. **Plantation:** These are the areas under agricultural tree crops planted adopting agricultural management techniques. Depending on the location, they are exhibit a dispersed or contiguous pattern. Use of multi-season data will enable their separation in a better way. It includes agricultural plantation (like tea, coffee, rubber etc.) horticultural plantation (like coconut, arecanut, citrus fruits, orchards, fruits, ornamental shrubs and trees, vegetable gardens etc.) and agro-horticultural plantation

5. **Shrubs:** A shrub is a small- to medium-sized perennial woody plant. Unlike herbaceous plants, shrubs have persistent woody stems above the ground. Shrubs can be deciduous or evergreen. They are distinguished from trees by their multiple stems and shorter height, less than 6–10 m (20–33 ft) tall.
6. **Medium Shrubs:** It is a growth of bushes which has foliage more than 30% and less than Dense shrubs i.e. 70% or more.
7. **Dense Shrubs:** A thicket or Dense Shrubs is a growth of trees, bushes, or shrubbery that is very close together with more than 70% of the area covered with foliage.
8. **Tree clad area:** A large area of land covered by trees and other plants growing close together outside forest boundary.
9. **Forest:** The term forest is used to refer to land with a tree canopy cover of more than 10 percent and area of more than 0.5 ha. Forests are determined both by the presence of trees and the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 m (MOEF, 2011).

Open Area:

10. **Open Plot:** The plots that are a vacant place without any scrubs or other vegetations.
11. **Rocky Outcrop:** These are rock exposures of varying lithology often barren and devoid of soil and vegetation cover.

Wastelands:

Described as degraded lands which can be brought under vegetative cover with reasonable effort and which is currently underutilized and land which is deteriorating for lack of appropriate water and soil management or on account of natural causes. It consists of:

12. **Salt affected Land:** Generally characterized as land that has excess salt in the soils with patchy growth of grasses
13. **Scrub Land:** These areas possess shallow and skeletal soils, at times chemically degraded extremes of slopes, severely eroded or subjected to excessive aridity with scrubs dominating the landscape
14. **Mudflats:** Mudflats or mud flats, also known as tidal flats, are coastal wetlands that form in intertidal areas where sediments have been deposited by tides or rivers

Water Regime:

15. **Drainage:** The system of water or waste liquids flowing away from somewhere into the ground or pipes or drainage channels /ditches/ systems. The ability of soil to allow water to flow away:
16. **River /Stream / Canals:** Rivers/streams are natural course of water flowing on the land surface along a definite channel/slope regularly or intermittently towards a sea in most cases or in to a lake or an inland basin in desert areas or a marsh or another river. Canals are artificial water course constructed for irrigation, navigation or to drain out excess water from agricultural lands.
17. **Floodplains:** An area of low-lying ground adjacent to a river, formed mainly of river sediments and subject to flooding.
18. **Water Body:** This category comprises areas with surface water in the form of ponds, lakes, tanks and reservoirs.

Built-up Spaces / Human Interventions:

19. **Built-up:** "Built-up area" is defined as the presence of buildings (roofed structures). This definition largely excludes other parts of urban environments or human footprint such as paved surfaces (roads, parking lots), commercial and industrial sites (ports, landfills, quarries, runways) and urban green spaces (parks, gardens).
20. **Industries:** An area outside of a town or city that is designed especially for factories or offices/business.
21. **Weigh Bridge:** A truck scale, weighbridge or railroad scale is a large set of scales, usually mounted permanently on a concrete foundation, that is used to weigh entire rail or road vehicles and their contents. By weighing the vehicle both empty and when loaded, the load carried by the vehicle can be calculated.
22. **Public Utility/Spaces:** A public space refers to an area or place that is open and accessible to all peoples, regardless of gender, race, ethnicity, age or socio-economic level. These are public gathering spaces such as public parking, parks/gardens etc. Connecting spaces, such as sidewalks and streets, are also public spaces.

Mining:

23. **Mine Pit:** This is a current surface mining area of extracting rock or minerals from the earth by their removal from an open-air pit. This space is current dug-up area which is not backfilled or covered by waste dump or overburden. Here it refers to the mine pit of GMDC lease area.
24. **Quarry**: A place, typically a large, deep pit, from which stone or other materials are or have been extracted.
25. **Waste Dump:** A site for the disposal of solid waste or unrequired materials.
26. **Benches:** In mining, a bench is a narrow, strip of land cut into the side of an open-pit mine. These step-like zones are created along the walls of an open-pit mine for access and mining.

Transportation Network:

27. **Metalled Road:** A metalled road has a level surface made of small pieces of stone; used especially of country roads and tracks.
28. **Unmetalled Road:** Roads made up of mud and gravel which are generally found in the rural areas is unmetalled roads.
29. **Material Transport Route:** This are the temporary route or road constructed specially for the transport of materials / minerals or rocks.
30. **National HW:** The National highways in India are a network of trunk roads owned by the Ministry of Road Transport and Highways.
31. **State HW:** A state highway, state road, or state route is usually a road that is either numbered or maintained by a sub-national state. A road numbered by a state falls below numbered national highways
32. **Major Road:** A main road is an important road that leads from one town or city to another or road that is used by majority of the traffic.
33. **Minor Road:** These are the internal roads connecting the rural or local areas.

I. Land use of Core Area of Umarsar Opencast Lignite Mine

Year 2009

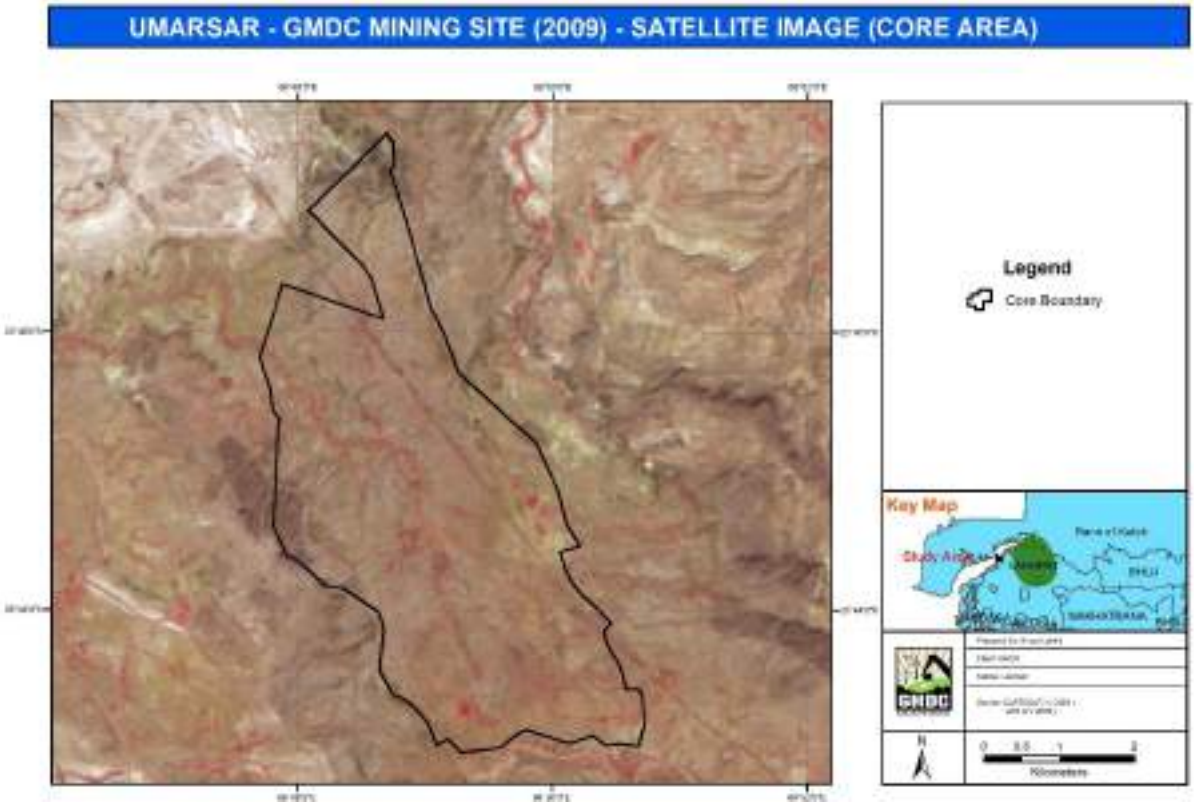

Fig 3.1.1 Satellite image of GMDC Umarsar core mine area (2009)

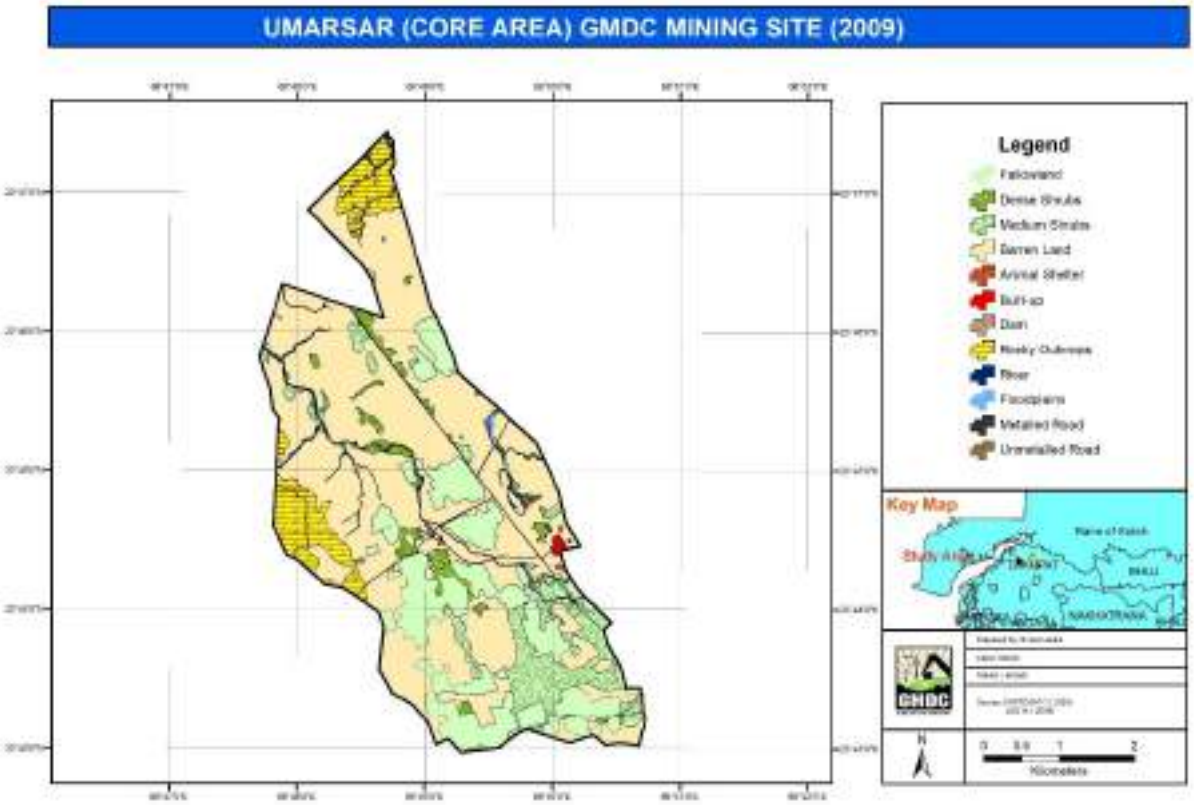

Fig 3.1.2 Land use map of GMDC Umarsar core mine area (2009)

Legends	Area (Hectare)	Percentage
Animal Shelter	4.376	0.200%
Barren Land	1304.595	59.659%
Built-up	4.005	0.183%
Dam	0.911	0.042%
Dense Shrubs	75.329	3.445%
Fallowland	398.267	18.212%
Floodplains	2.759	0.126%
Medium Shrubs	195.287	8.930%
Metalled Road	4.506	0.206%
River	30.926	1.414%
Rocky Outcrops	157.650	7.209%
Unmetalled Road	8.150	0.372%
Grand Total	**2186.760**	**100.00%**

Table. 3.2 Area table of Land use of GMDC Core mine site (2009)

Observations:

The total mine area of 2186.76 hectare is classified in 12 different classes as shown in the table above . Table 3.2 showing status of Land use/Land cover in in Hectare and in percentage of total for the year 2009. Fig. 3.1.1 and Fig. 3.1.2 shows satellite image and Land use map of mine area resp.

Built-up

The built-up area in 2009 is 3.76 hectare or 0.17% of the total lease area. There is no industrial activities going on within the lease boundary in 2009. These Umarsar village is present in Eastern side of the lease boundary. These local set-up of residential colony with closely built structures including all buildings, school, commercial building, trees and other open spaces present within this setup is considered as one unit. There is also a presence of animal shelters with the lease boundary.

Agriculture area

The majority of the area within the lease in 2009 is barren land with area covering 59.65 % and other majority of the areas is an (uncultivated land) Fallow land with 18.21 % of the total lease area.

Water Regime

There is no major river passing within the lease boundary however there is one small tributary passing from south-east to north-west direction within the lease boundary. Total area covered is 30.92 hectare or 1.41 % of total mining lease area.

Water bodies in terms of lakes or ponds are not present within the lease boundary in 2009.

Mining Area

Mine pit area mentioned here are the excavated areas with significant surface expressions. There are other areas of mining activities present within the lease boundary like waste dump, benches etc.

There are no mining activities present in 2009 based on satellite image.

Rock Outcrops are found to be present within the core lease area in northern and western side. Area covered is 157.65 hectare or 7.2 % of total mining lease area.

Shrubs:

There is also a presence of cluster of Dense and Medium shrubs other than that present in the reclaimed areas or waste dump area. There is nearly 12.37 % of shrub land area within the core mine boundary.

Plantation:

There is no Plantation during this year as there are no mining activities started in 2009

Transportation Network

State Highway or Lakhpat-Gaduli road categorized here as metalled road is passing through the lease boundary from South-east to North-west direction. There are few unmetalled roads or Kaccha road present within the lease boundary. Total are covered by metalled and unmetalled roads is 12.6 hectare or 0.57 %.

Year 2012

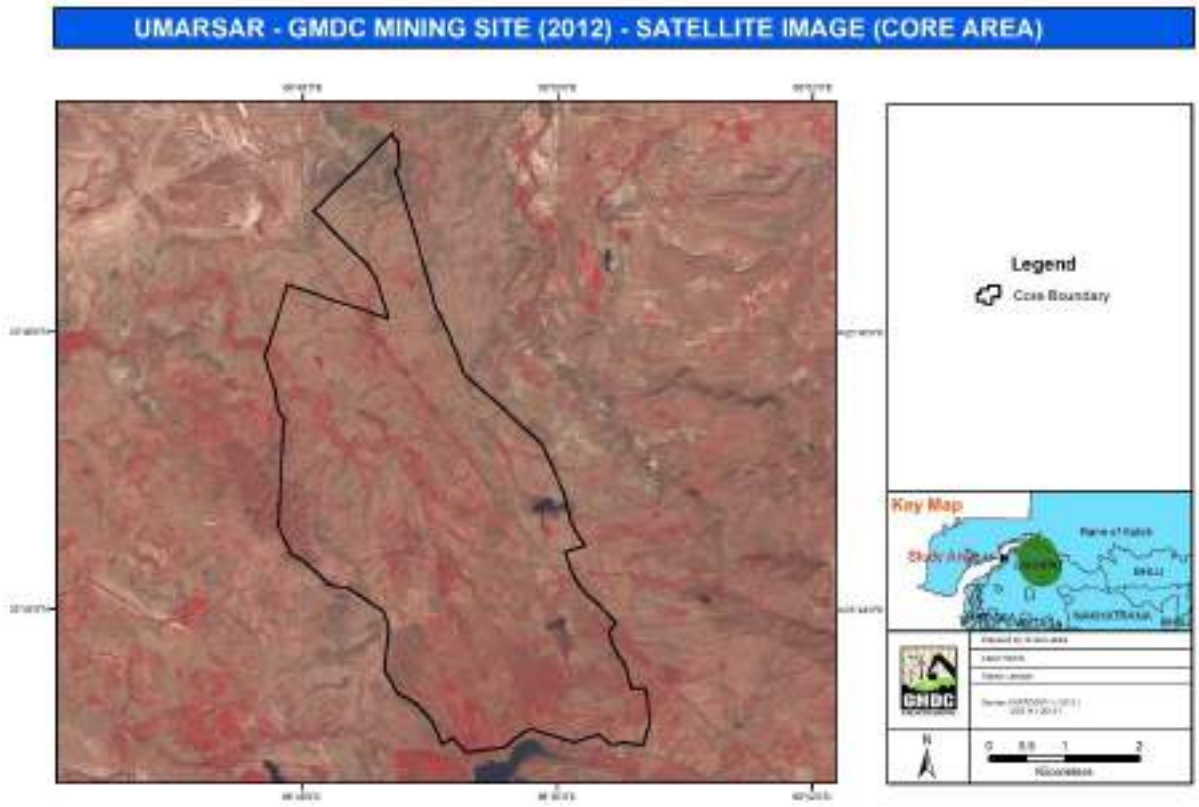

Fig 3.1.3 Satellite image of GMDC Umarsar core mine area (2012)

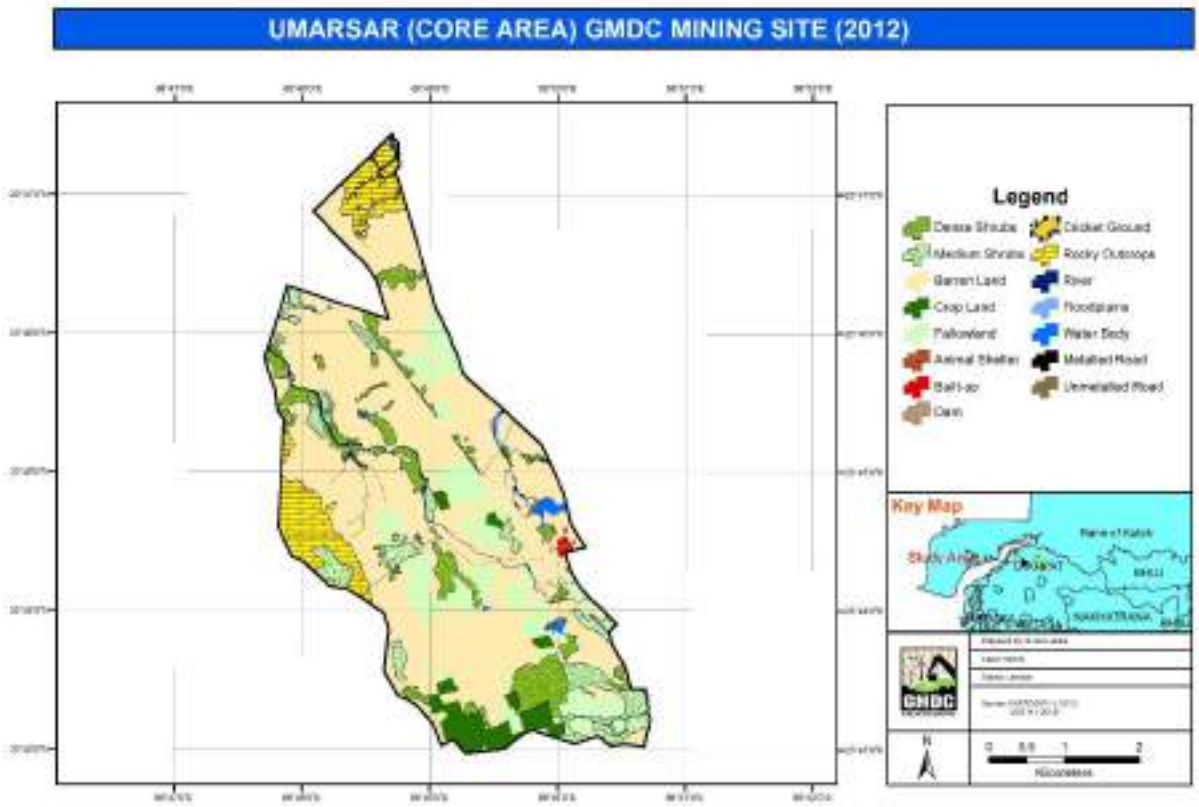

Fig 3.1.4 Land use map of GMDC Umarsar core mine area (2012)

Legends	Area (Hectare)	Percentage
Animal Shelter	2.627	0.12%
Barren Land	1296.274	59.28%
Built-up	4.295	0.20%
Cricket Ground	1.099	0.05%
Crop Land	83.410	3.81%
Dam	0.917	0.04%
Dense Shrubs	190.590	8.72%
Fallowland	250.774	11.47%
Floodplains	3.338	0.15%
Medium Shrubs	143.327	6.55%
Metalled Road	5.606	0.26%
River	27.702	1.27%
Rocky Outcrops	158.413	7.24%
Unmetalled Road	5.878	0.27%
Water Body	12.512	0.57%
Grand Total	**2186.760**	**100.00%**

Table. 3.3 Area table of Land use of GMDC Core mine site (2012)

Observations:

The total mine area of 2186.76 hectare is classified in 15 different classes as shown in the table above . Table 3.3 showing status of Land use/Land cover in in Hectare and in percentage of total for the year 2012. Fig. 3.1.3 and Fig. 3.1.4 shows satellite image and Land use map of mine area resp.

Built-up

The built-up area in 2012 is 4.02 hectare or 0.18% of the total lease area. There is no industrial activities going on within the lease boundary in 2012. These Umarsar village is present in Eastern side of the lease boundary. These local set-up of residential colony with closely built structures including all buildings, school, commercial building, trees and other open spaces present within this setup is considered as one unit. There is also a presence of animal shelters with the lease boundary. Cricket playground seem to have be built or present during 2012.

Agriculture area

The majority of the area within the lease in 2012 is barren land with area covering 59.28 % . Other major areas is Agricultural land, (cultivated area) Crop land is 3.81% and (uncultivated land) Fallow land is 11.47 % of the total lease area. Total agriculture land including cultivate and uncultivated is 15.28 %.

Water Regime

There is no major river passing within the lease boundary however there is one small tributary passing from south-east to north-west direction within the lease boundary.

Water bodies in terms of lakes or ponds occupy around 0.57% of total lease area in 2012. While river occupies around 1.27%. In total they cover approx. 1.84%.

Mining Area

Mine pit area or quarry area mentioned here are the excavated areas with significant surface expressions. There are other areas of quarry or mining activities present within the lease boundary like waste dump, benches etc.

There is no mining activities present in 2012 based on satellite image.

Rock Outcrops are found to be present within the core lease area in northern and western side. Total area covered is 158.41 or 7.24 %.

Shrubs:

There is nearly 15.27 % of shrub land in terms of dense and medium clusters within the core mine boundary.

Plantation:

There is no Plantation during this year as there are no mining activities started in 2012

Transportation Network

State Highway or Lakhpat-Gaduli road categorized here as metalled road is passing through the lease boundary from South-east to North-west direction. There are few unmetalled roads or Kaccha road present within the lease boundary. Total are covered by metalled and unmetalled roads is 11.47 hectare or 0.53 %.

Year 2015

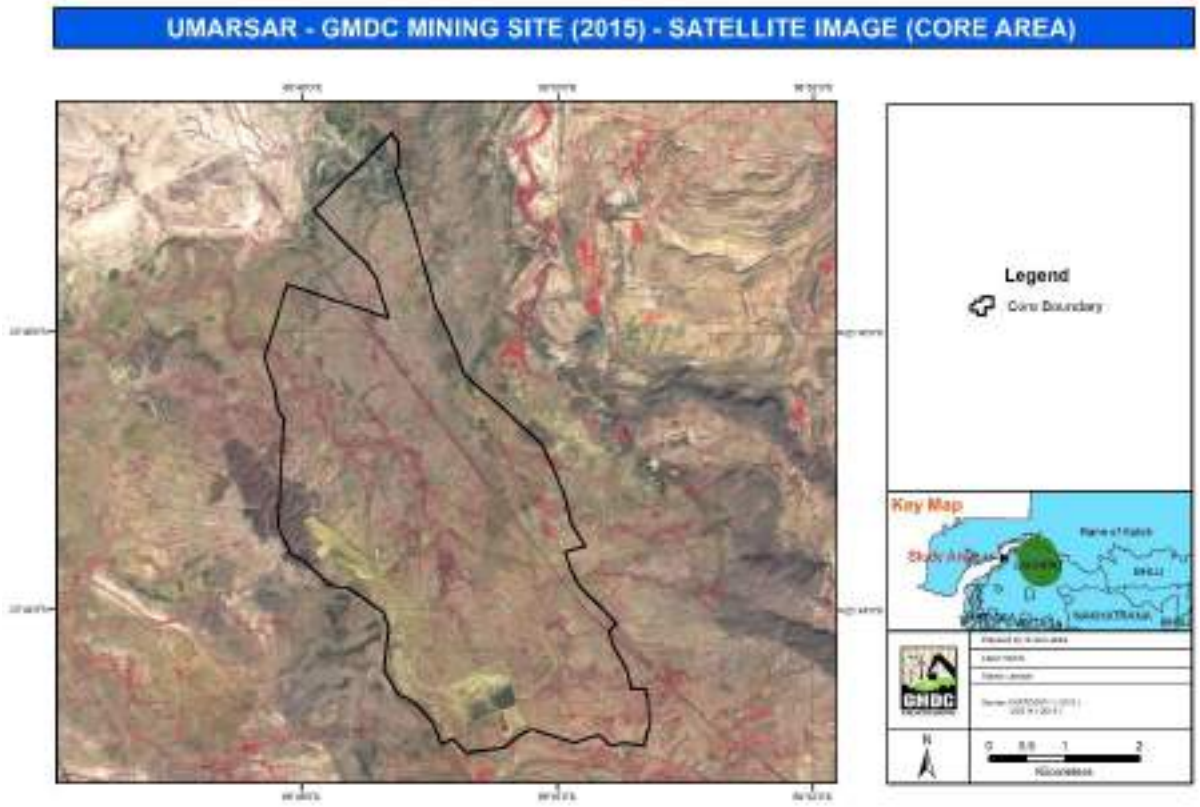

Fig 3.1.5 Satellite image of GMDC Umarsar core mine area (2015)

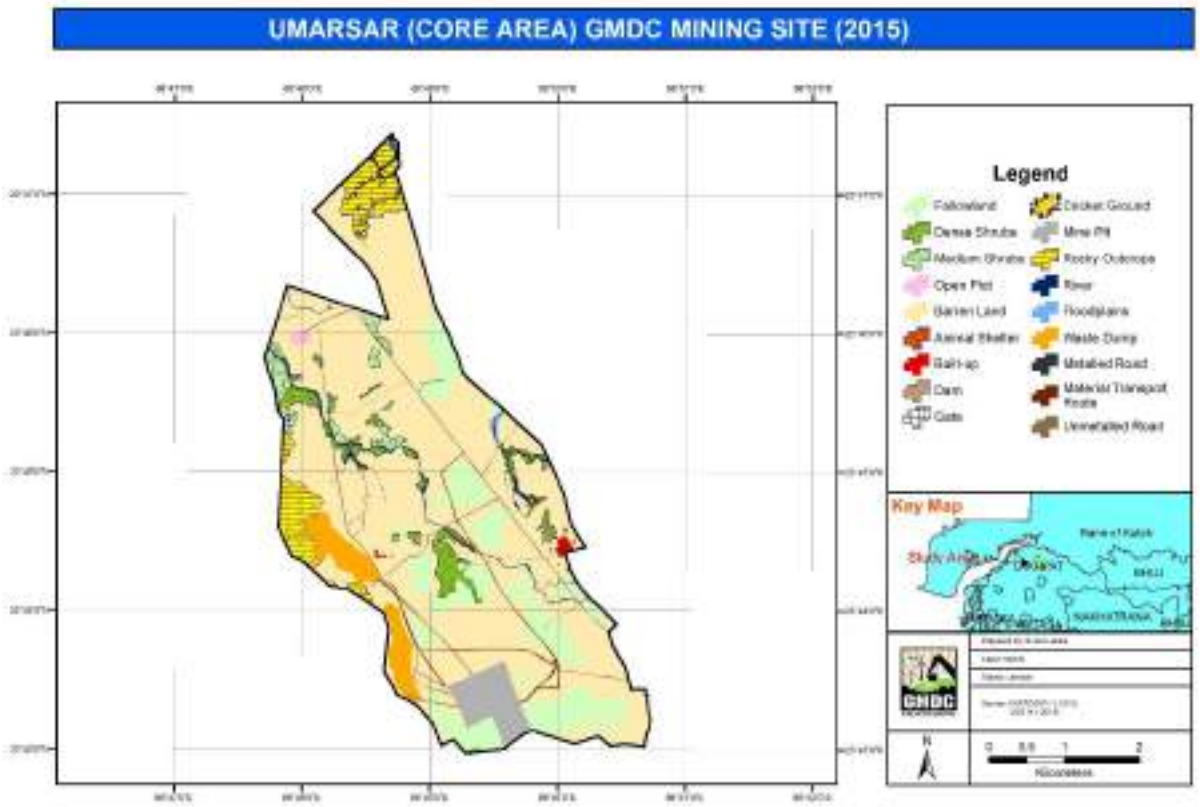

Fig 3.1.6 Land use map of GMDC Umarsar core mine area (2015)

Legends	Area (Hectare)	Percentage
Animal Shelter	2.284	0.1044%
Barren Land	1418.491	64.8672%
Built-up	5.316	0.2431%
Cricket Ground	1.099	0.0502%
Dam	0.929	0.0425%
Dense Shrubs	76.864	3.5150%
Fallowland	299.251	13.6847%
Floodplains	2.930	0.1340%
Gate	0.004	0.0002%
Material Transport Route	15.683	0.7172%
Medium Shrubs	48.883	2.2354%
Metalled Road	6.015	0.2751%
Mine Pit	64.031	2.9281%
Open Plot	4.383	0.2005%
River	27.414	1.2536%
Rocky Outcrops	123.446	5.6452%
Unmetalled Road	20.296	0.9281%
Waste Dump	69.441	3.1755%
Grand Total	**2186.760**	**100.00%**

Table. 3.4 Area table of Land use of GMDC Core mine site (2015)

Observations:

The total mine area of 2186.76 hectare is classified in 18 different classes as shown in the table above . Table 3.4 showing status of Land use/Land cover in in Hectare and in percentage of total for the year 2015. Fig. 3.1.5 and Fig. 3.1.6 shows satellite image and Land use map of mine area resp.

Built-up

The built-up area in 2015 is 4.97 hectare or 0.23% of the total lease area. There is no industrial activities going on within the lease boundary in 2015 other than mining. These Umarsar village is present in Eastern side of the lease boundary. These local set-up of residential colony with closely built structures including all buildings, school, commercial building, trees and other open spaces present within this setup is considered as one unit. There is also a presence of animal shelters with the lease boundary. Cricket playground seem to have be built or present during 2015.

Agriculture area

The majority of the area within the lease in 2015 is barren land with area covering 64.87 % . Other major areas is Agricultural land which is mostly an uncultivated land / Fallow land covering 13.68 % of the total lease area.

Water Regime

There is no major river passing within the lease boundary however there is one small tributary passing from south-east to north-west direction within the lease boundary. Total area covered by river is 27.4 hectare or 1.25%.

Water bodies in terms of lakes or ponds are not noticeable in 2015.

Mining Area

Mine pit area or quarry area mentioned here are the excavated areas with significant surface expressions. There are other areas of quarry or mining activities present within the lease boundary like waste dump, benches etc.

In 2015 mining activities seem to have been started based on satellite image.

Total mine pit area is 2.93 % of total lease boundary while the waste dump area is 3.17%. There is no back fill area present in year 2015.

Rock Outcrops are found to be present within the core lease area in northern and western side.

Shrubs:

There is nearly 5.74 % of shrub land in terms of dense and medium clusters within the core mine boundary. The reduction in the area of shrub land is due to seasonal variation because of which most it is classified as barren land in 2015.

Plantation:

There is no Plantation activities present or visibly seen during the year 2015.

Transportation Network

State Highway or Lakhpat-Gaduli road categorized here as metalled road is passing through the lease boundary from South-east to North-west direction. There are few unmetalled roads or Kaccha road present within the lease boundary including temporary material transport routes. Total area covered by metalled and unmetalled road is 26.3 hectare or 1.19 %. Area covered by material transport route is 15.68 hectare or 0.71 %.

Year 2018

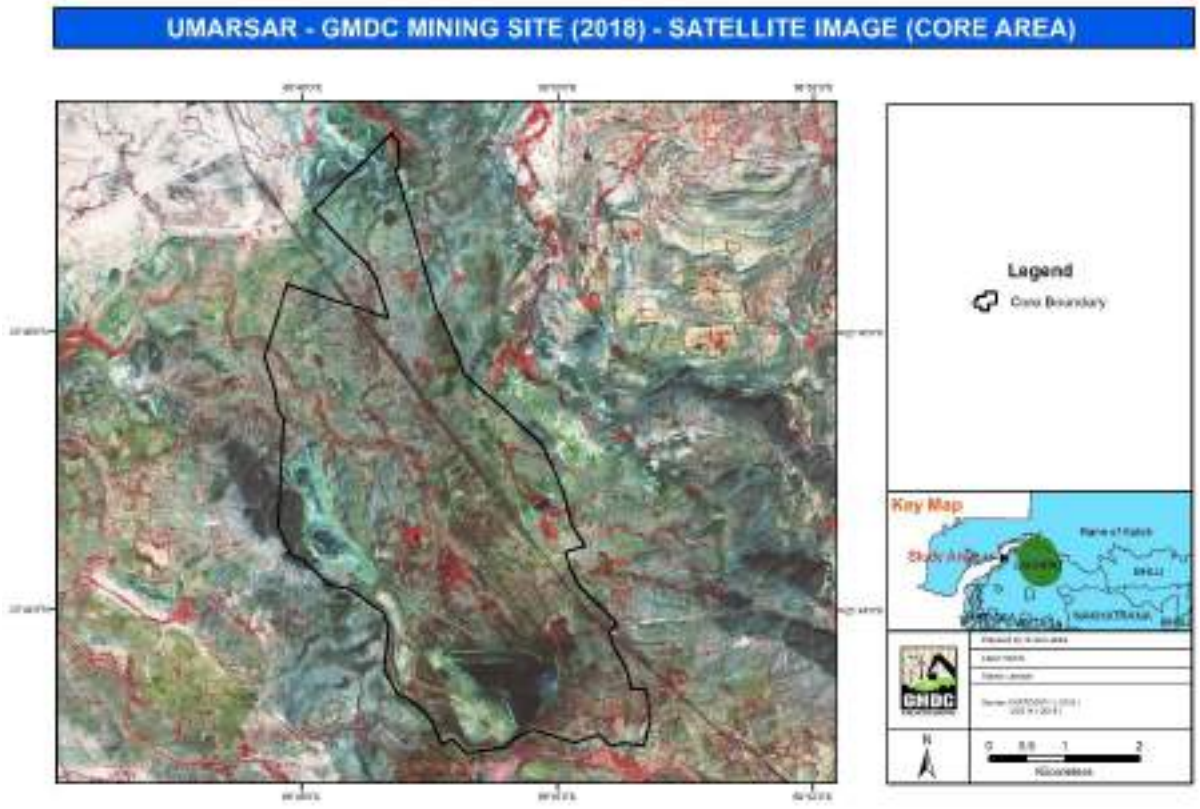

Fig 3.1.7 Satellite image of GMDC Umarsar core mine area (2018)

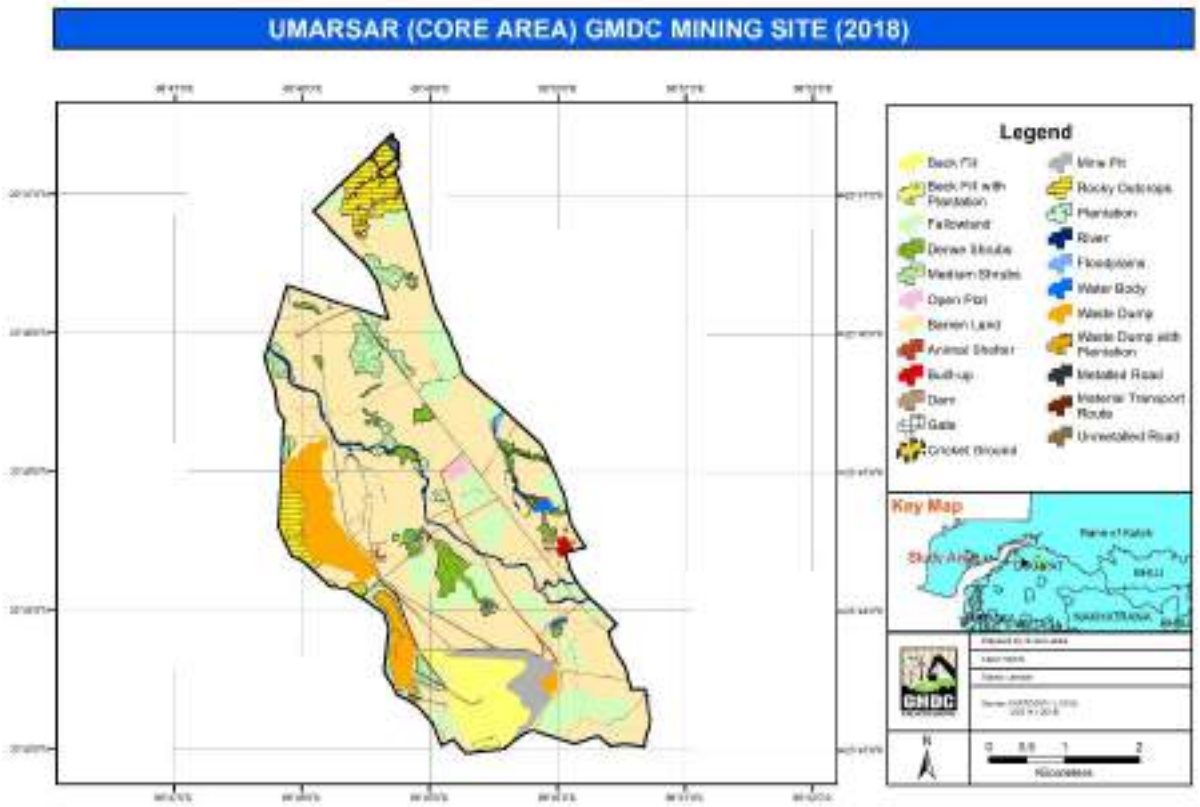

Fig 3.1.8 Land use map of GMDC Umarsar core mine area (2018)

Legends	Area (Hectare)	Percentage
Animal Shelter	3.089	0.1413%
Back Fill	108.273	4.9513%
Barren Land	1255.082	57.3946%
Built-up	5.575	0.2549%
Cricket Ground	1.099	0.0502%
Dam	0.915	0.0418%
Dense Shrubs	83.426	3.8151%
Fallowland	225.860	10.3285%
Floodplains	3.086	0.1411%
Gate	0.004	0.0002%
Material Transport Route	14.449	0.6607%
Medium Shrubs	115.228	5.2694%
Metalled Road	6.618	0.3026%
Mine Pit	41.999	1.9206%
Open Plot	5.840	0.2671%
Plantation	0.372	0.0170%
River	40.789	1.8653%
Rocky Outcrops	101.936	4.6615%
Unmetalled Road	31.388	1.4353%
Waste Dump	135.289	6.1867%
Water Body	6.442	0.2946%
Grand Total	**2186.760**	**100.00%**

Table. 3.5 Area table of Land use of GMDC Core mine site (2018)

Observations:

The total mine area of 2186.76 hectare is classified in 21 different classes as shown in the table above . Table 3.5 showing status of Land use/Land cover in in Hectare and in percentage of total for the year 2018. Fig. 3.1.7 and Fig. 3.1.8 shows satellite image and Land use map of mine area resp.

Built-up

The built-up area in 2018 is 5.213 hectare or 0.24% of the total lease area. There is no industrial activities going on within the lease boundary in 2018 other than mining. These Umarsar village is present in Eastern side of the lease boundary. These local set-up of residential colony with closely built structures including all buildings, school, commercial building, trees and other open spaces present within this setup is considered as one unit. There is also a presence of animal shelters with the lease boundary. Cricket playground seem to have be built or present during 2018.

Agriculture area

The majority of the area within the lease in 2018 is barren land with area covering 57.39 % . Agricultural land which is mostly an uncultivated land / Fallow land is covering 10.32 % of the total lease area.

Water Regime

There is no major river passing within the lease boundary however there is one small tributary passing from south-east to north-west direction within the lease boundary. Total area covered by river is 40.789 hectare or 1.86 %. Water bodies in terms of lakes or ponds cover around 0.29% of total lease area in 2018.

Mining Area

Mine pit area or quarry area mentioned here are the excavated areas with significant surface expressions. There are other areas of quarry or mining activities present within the lease boundary like waste dump, benches etc. In 2018 mining activities seem to have been expanded based on satellite image.

Total mine pit area is 1.92 % of total lease boundary. These included core mine pit area as well as mine pit Benches. Waste dump area is 6.18 %, these includes waste dump, benches and shrubs area. Back fill area is approx. 4.95%. Rock Outcrops are found to be present within the core lease area in northern and western side.

Shrubs:

There is nearly 9.08 % of shrub land in terms of dense and medium clusters within the core mine boundary. The reduction in the area of shrub land is due to seasonal variation because of which most it is classified as barren land in 2018.

Plantation:

There is small amount of Plantation activities present or visibly seen during the year 2018. Plantation area is 0.37 hectare or 0.02% of total lease boundary.

Transportation Network

State Highway or Lakhpat-Gaduli road categorized here as metalled road is passing through the lease boundary from South-east to North-west direction. There are few unmetalled roads or Kaccha road present within the lease boundary including temporary material transport routes. Total area covered by metalled and unmetalled road is 38.0 hectare or 1.73 %. Area covered by material transport route is 14.45 hectare or 0.66 %.

II. Field Visit Photographs:

Fig 3.3.1 Mine Pit with Benches

Fig 3.3.2 Waste Dump with Shrubs

Fig 3.3.3 Waste Dump area

Fig 3.3.4 Built-up structure

Fig 3.3.5 security cabin

Fig 3.3.6 Material Transfer Route

Fig 3.3.7 Clay

Fig 3.3.8 Drone photography set-up

Aerial Photographs:

Drone: IdeaForge – Ninja Model

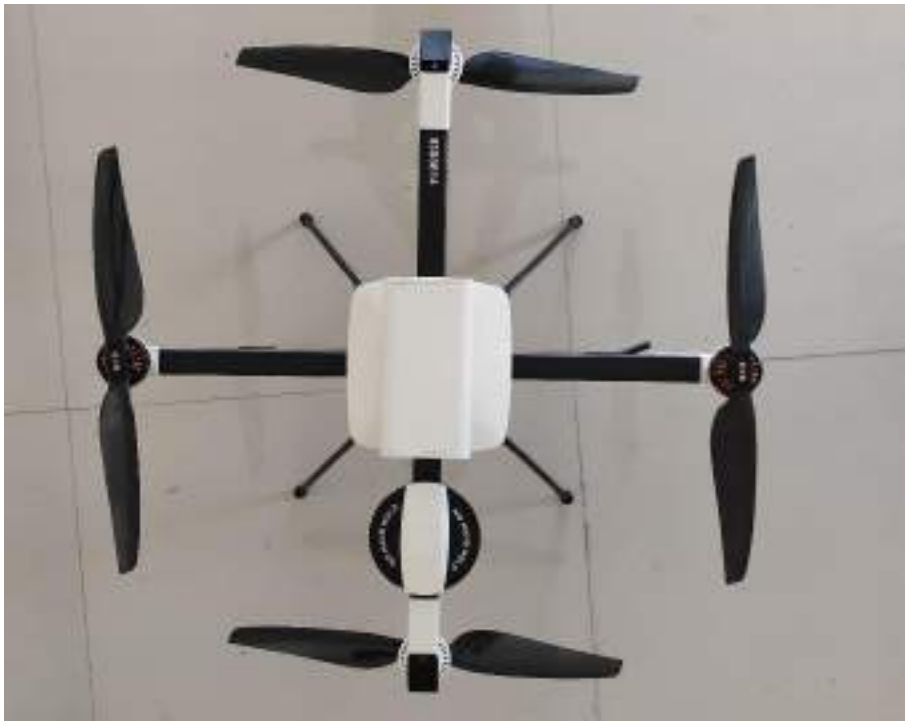

Fig 3.3.9 Ideaforge Ninja Drone used in Aerial Photography

Fig 3.3.10 High resolution Sony 20 mp Camera used for Aerial Survey

Aerial Photography: Umarsar Site:

Flight Plan Photo:

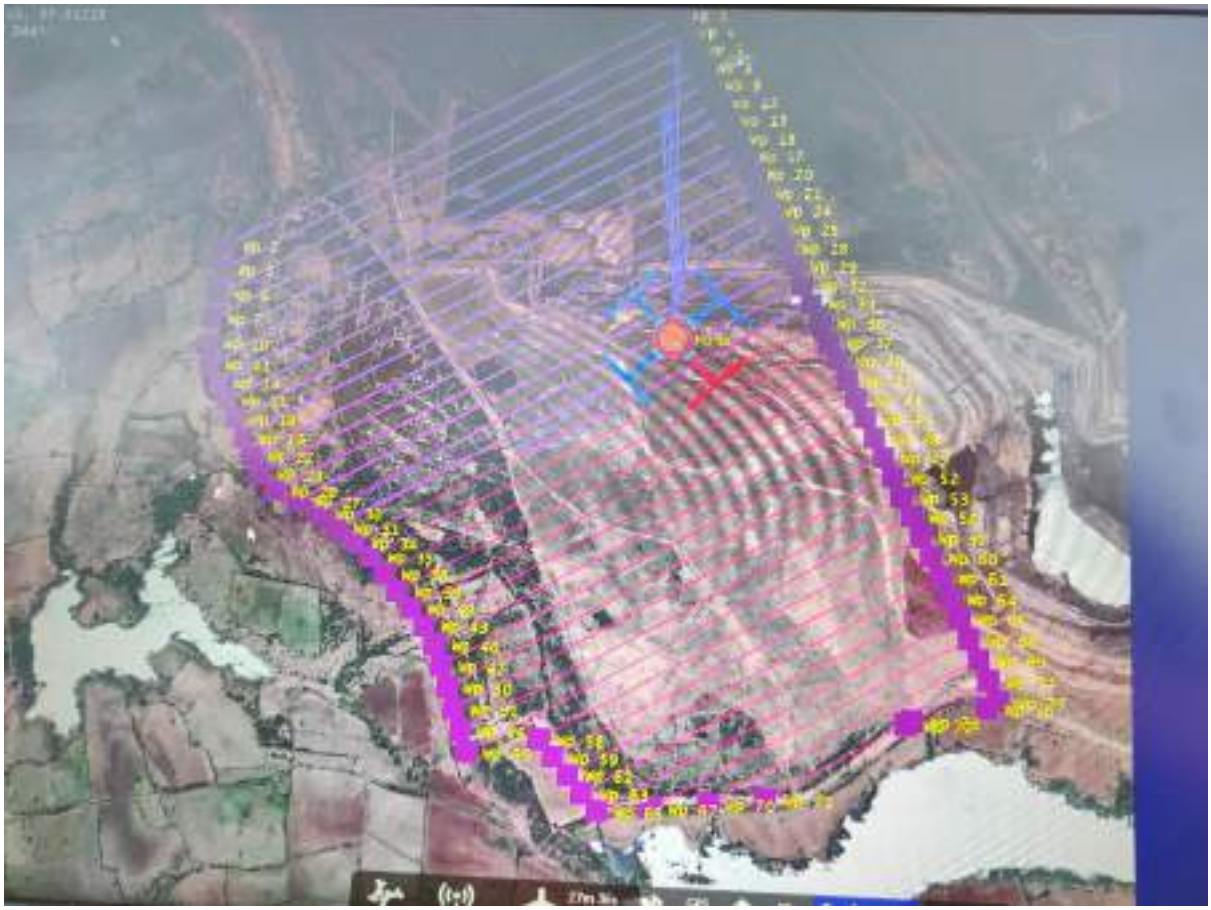

Fig 3.3.11 Flight Plan for Aerial Survey

Fig 3.3.12 Aerial view of Material Transfer Route

Fig 3.3.13 Aerial view of shrubs and drainage

Fig 3.3.14 Aerial view of water body

Fig 3.3.15 Aerial view of of stack

Fig 3.3.16 Aerial view of Mine pit with stack and Benches

Fig 3.3.17 Aerial view of Mine pit with stack and Benches

Fig 3.3.18 Aerial view of shrubs grown over waste dump

Fig 3.3.19 Aerial view of material transfer route

Fig 3.3.20 Aerial view of plantation

Fig 3.3.21 Aerial view of of plantation

CHAPTER 4

TOPOGRAPHY AND DRAINAGE

The area presents varied degree of slopes in the study area. The slope where there is hilly terrain / rocky outcrop are present reaches up to nearly 63.0 degrees while the area near the Kori creek in the Northern direction is either flat or with a very gentle slope. The area adjacent to the mining site also shows high degree of slope due to presence of rock outcrops near the villages of Guneri, Ukher, Umarsar and Chhuger etc.

Study area reaches the maximum altitude of 219 mtrs which is more observed near the hilly terrain, while the minimum elevation recorded is below zero near the Creek area as per the elevation map generated from SRTM data.

There are numerous tributaries seen within the study area because of the presence of rocky terrain. The pattern of the river tributaries is dendritic.

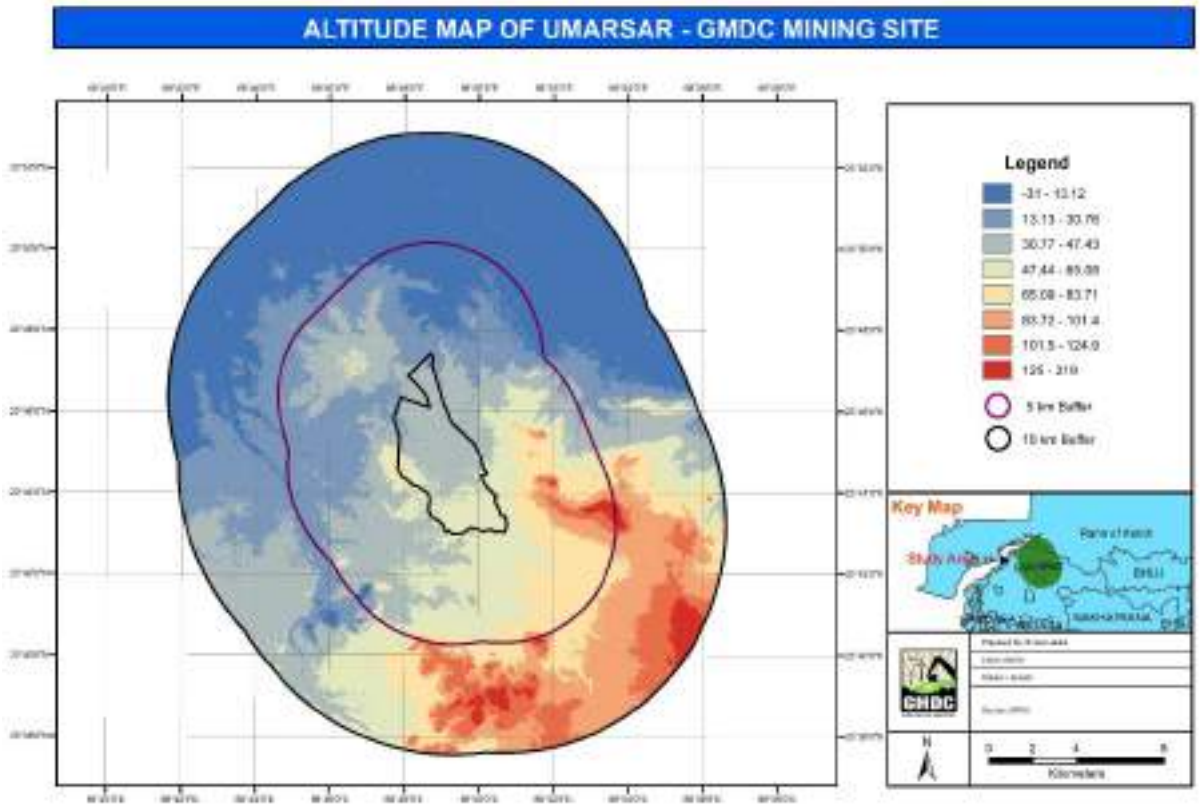

Fig 5.1 Altitude map of study area

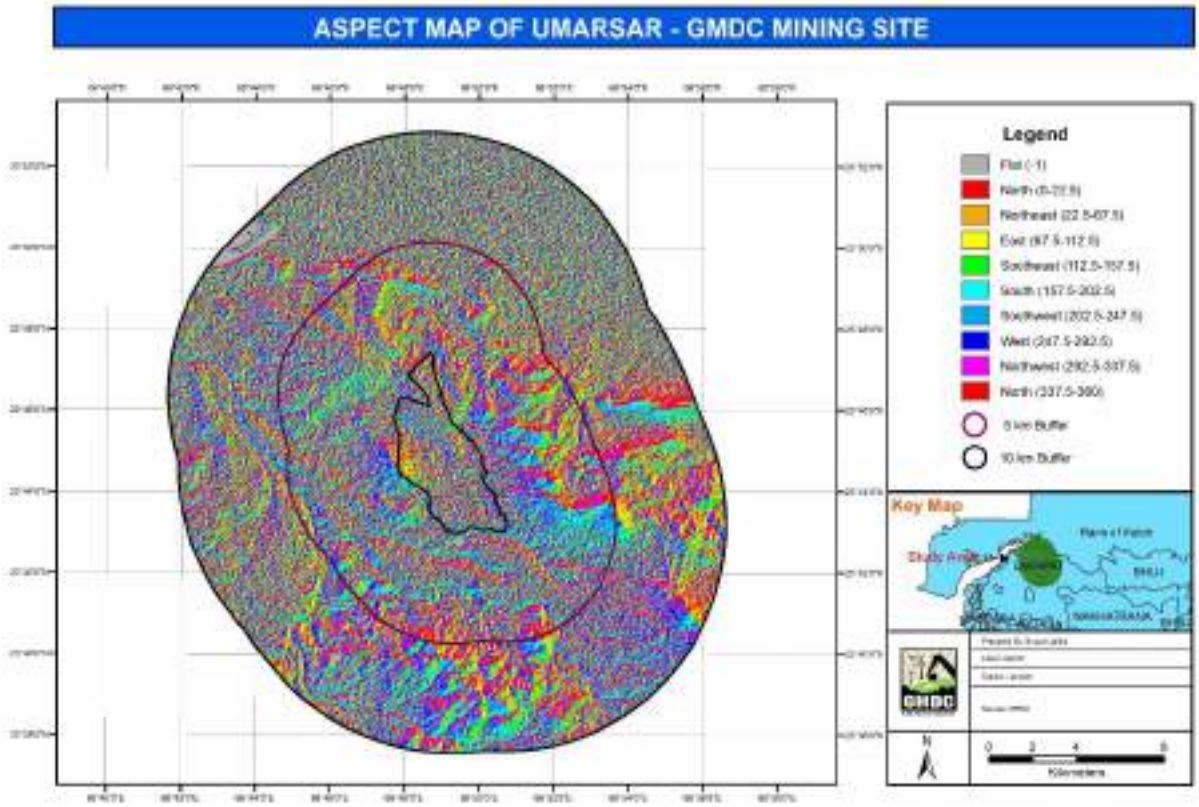

Fig 5.2 Aspect map of study area

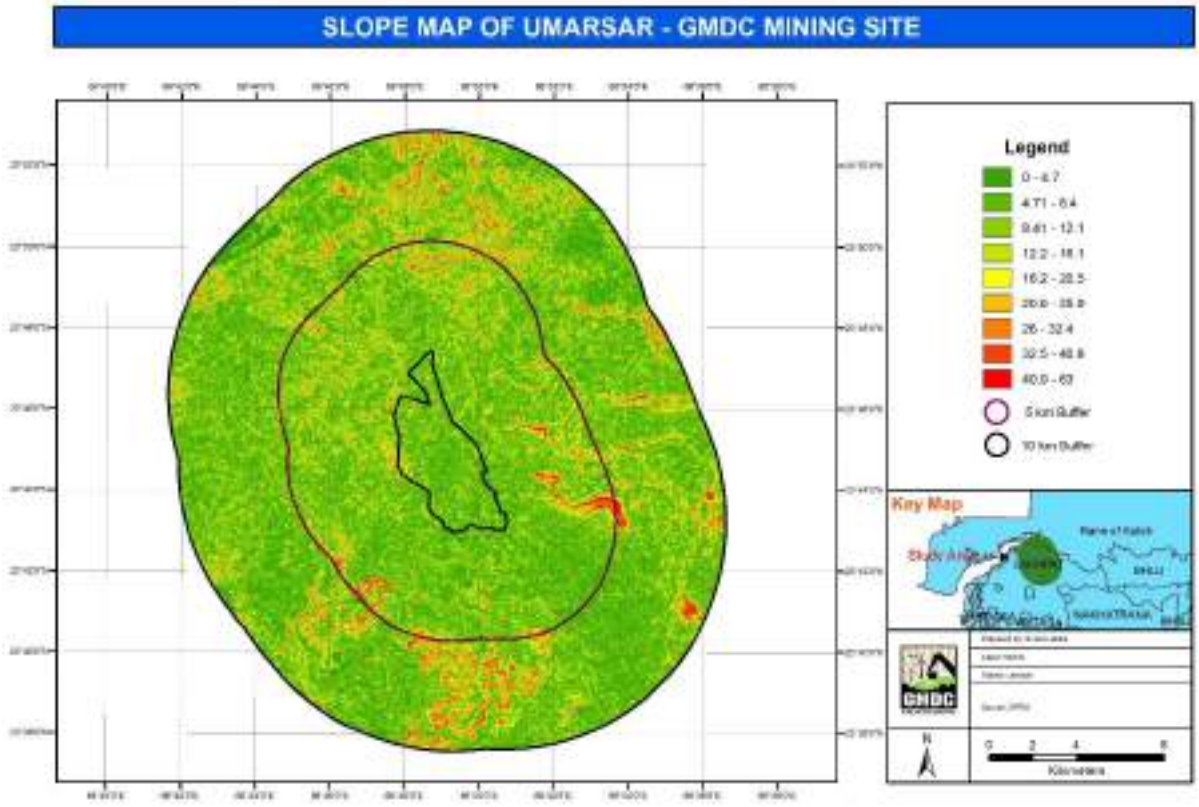

Fig 5.3 Slope map of study area

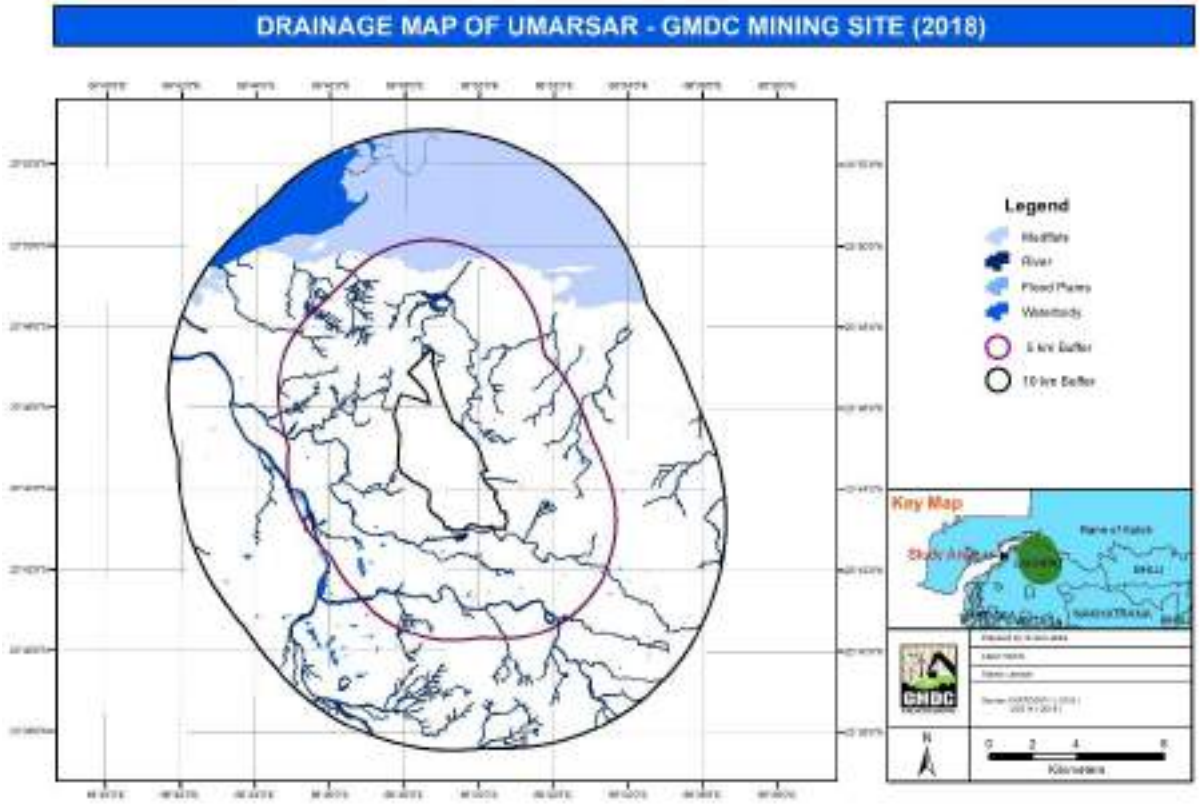

Fig 5.4 Drainage map of study area

CHAPTER 5

LAND USE CHANGE ANALYSIS

Core Area

Umarsar Core Area (Area in Hectare)							
	Area (Year Wise)				Area (Change Analysis)		
Legends	**2018**	**2015**	**2012**	**2009**	**2018-2015**	**2015-2012**	**2012-2009**
Animal Shelter	3.09	2.28	2.63	4.38	0.81	-0.34	-1.75
Back Fill	108.27				108.27		
Barren Land	1255.08	1418.49	1296.27	1304.60	-163.41	122.22	-8.32
Built-up	5.57	5.32	4.29	4.00	0.26	1.02	0.29
Cricket Ground	1.10	1.10	1.10				1.10
Dam	0.92	0.93	0.92	0.91	-0.01	0.01	0.01
Dense Shrubs	83.43	76.86	190.59	75.33	6.56	-113.73	115.26
Crop Land			83.41			-83.41	83.41
Fallowland	225.86	299.25	250.77	398.27	-73.39	48.48	-147.49
Floodplains	3.09	2.93	3.34	2.76	0.16	-0.41	0.58
Gate	0.00	0.00					
Material Transport Route	14.45	15.68			-1.23	15.68	
Medium Shrubs	115.23	48.88	143.33	195.29	66.34	-94.44	-51.96
Metalled Road	6.62	6.02	5.61	4.51	0.60	0.41	1.10
Mine Pit	42.00	64.03			-22.03	64.03	
Open Plot	5.84	4.38			1.46	4.38	
Plantation	0.37				0.37		
River	40.79	27.41	27.70	30.93	13.38	-0.29	-3.22
Rocky Outcrops	101.94	123.45	158.41	157.65	-21.51	-34.97	0.76
Unmetalled Road	31.39	20.30	5.88	8.15	11.09	14.42	-2.27
Waste Dump	135.29	69.44			65.85	69.44	
Water Body	6.44		12.51		6.44	-12.51	12.51
Grand Total	**2186.76**	**2186.76**	**2186.76**	**2186.76**			

Table. 5.1 Area table of change analysis of Core mine site

Result and Discussion

Mining Activities:

There were no mining activities present in 2009 and 2012 based on satellite image. Mining activities is seen to have been started in the southern portion of the lease boundary by the year 2015. These areas was previously classified as an crop land in year 2009 and year 2012. Hence this should affect in terms of reduction in the total area of agriculture in later years. Based on satellite image it can be said that there has be high increase in the area on mining activities in 2018 with current mine pit area covering upto 42.0 hectare and area inclusive of back filled area reaching upto 150.27 hectare of total mine area.

Built-up area

The built-up area occupied by umarsar village in 2009 is 3.76 hectare or 0.17% of the total lease area. There is no industrial activities going on within the lease boundary in 2009. The village is present in Eastern side of the lease boundary. The total built-up area has slightly increased from year 2009 to year 2018. Built-up area in year 2018 was 5.2 hectare.

Plantation

There is no significantly visible Plantation seen in year 2009 as there were no mining activities present during that time. The plantation is seen only in the year 2018 with area covering around 0.37 hectare. These can be considered as slight increase in the overall plantation area over a period of years.

Agriculture Land

There has been slight decrease in the area of total agricultural land inclusive of crop land and fallow land within the mining lease boundary from the year 2009 to year 2018. The total agriculture area in year 2009 was 398.27 hectare while it decreased to 225.86 hectare in 2018. This is because of the increase in the mining activities in those areas.

Water regime

There is no major river passing within the lease boundary however there is one small tributary passing from south-east to north-west direction within the lease boundary.

Water bodies in terms of lakes or ponds occupy around 0.53% of total lease area in 2012 while they were no significantly visible in the previous year of 2009. There has been a slight increase in the overall area of river tributary and waterbody from year 2009. The river area increased from 30.93 hectare in year 2009 to 4.79 hectare in year 2019.