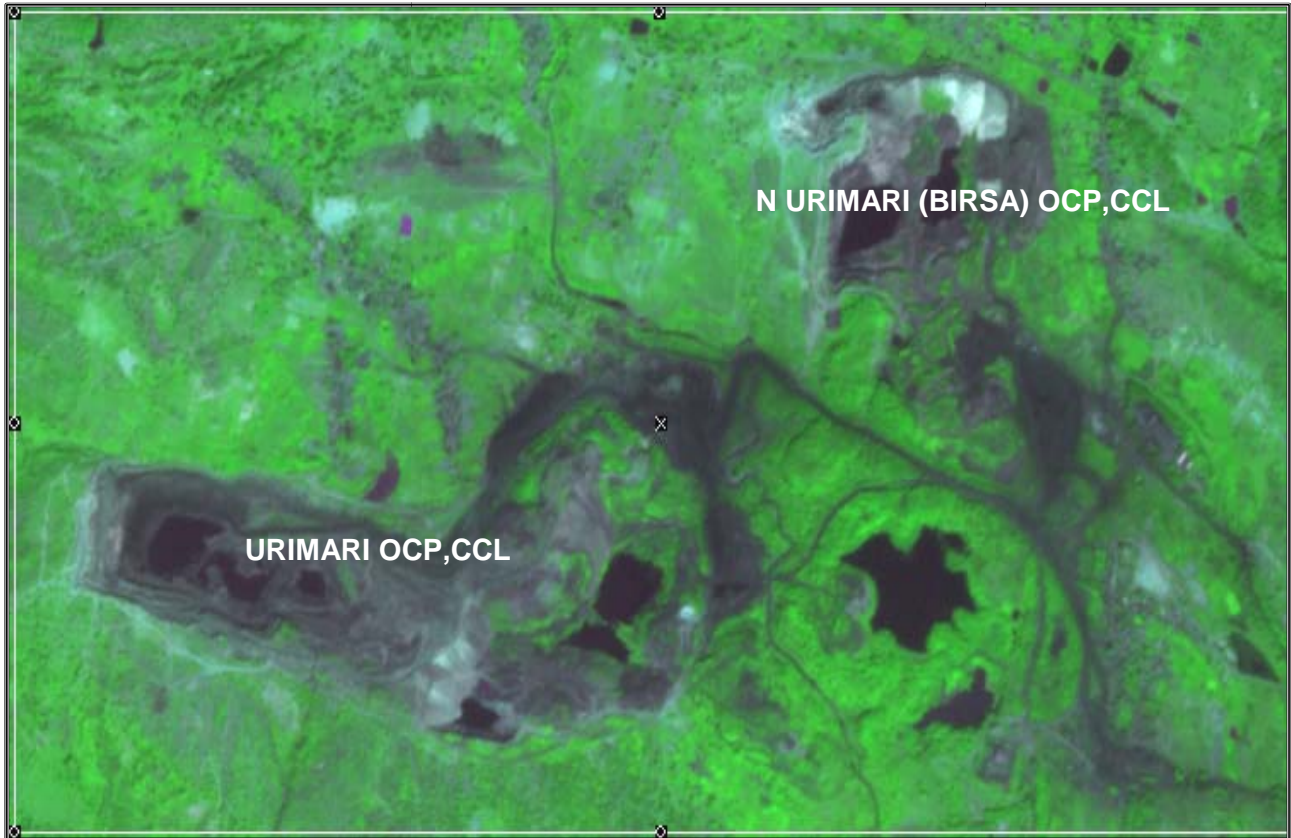


ТОРА ОСР

2011

Land Restoration / Reclamation Monitoring of less than
5 m cu. m. (Coal + OB) Capacity Open Cast Coal Mines of Central
Coalfields Limited Based on Satellite Data for the Year 2011



Submitted to:

**Central Coalfields Limited
Ranchi, Jharkhand**



**Land Restoration / Reclamation Monitoring of less than 5 m. cu. m (Coal
+ OB) capacity Open Cast Coal Mines of Central Coalfields Limited
Based on Satellite Data for the Year 2011**

March-2012



**Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi**

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Executive Summary

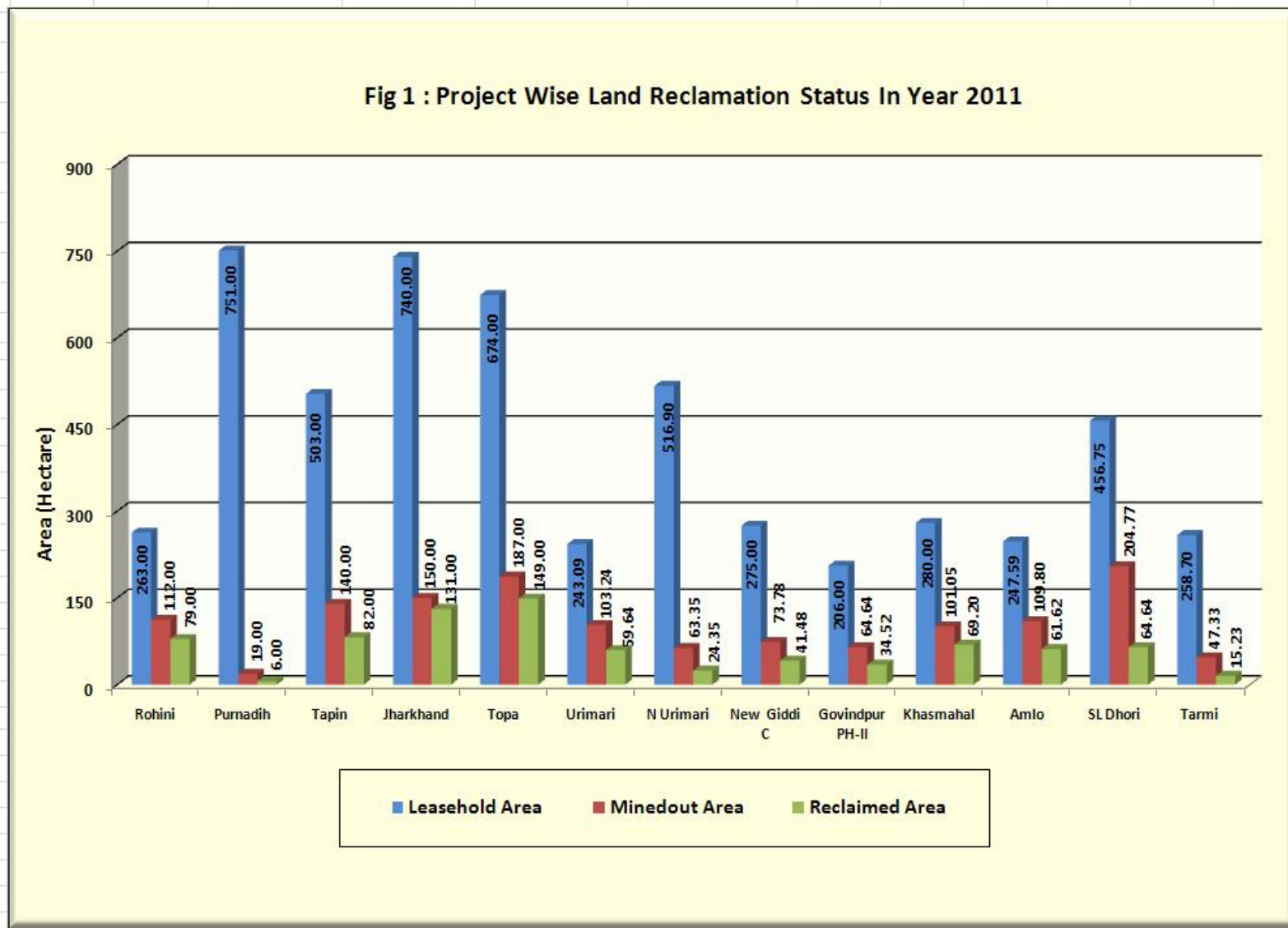
- 1.0 Project** Land restoration / reclamation monitoring of 13 opencast coal mines of Central Coalfields Ltd. (CCL) producing less than 5 million cu. m. (Coal + OB) per year based on satellite data, on every three year basis.
- 2.0 Objective** Objective of the land restoration / reclamation monitoring is to assess the area of backfilled, plantation, social forestry, active mining area, water bodies, and distribution of wasteland, agricultural land and forest land in the leasehold area of the various projects. This will help in assessing the progressive status of mined out land reclamation and to take up remedial measures, if any, required for environmental protection.
- 3.0 Salient Findings**
- Out of the total mine leasehold area of 5415.03 hectares of the 13 OC projects Viz. Rohini, Purnadih, Tapin, Jharkhand, Topa, Urimari, North Urimari, New Giddi-C, Govindpur PH-II, Khasmahal, Amlo, Selected Dhorri and Tarmi considered for monitoring during year 2011; total excavated area is only 1375.96 ha (25.42%) out of which 293.89 ha area (21.36%) has been planted, 523.79 ha area (38.07%) has been backfilled and 558.28 ha area (40.57%) is under active mining. It is evident from the analysis that 59.43% area of the OC projects have already been reclaimed and balance 40.57% area is under active mining. Project wise details are given in Table-1 & Fig -1.
 - Of the total area reclaimed by the Coal companies, 21.36% is under biological reclamation (plantation) and 38.07% is under technical reclamation.

TABLE-1

Project wise Land Reclamation Status in OC projects of Central Coalfields Ltd
Based on Satellite data of the Year 2011

Area in Hectare			% Calculated in respect of total Excaveted area				
SI No.	Projects	Leasehold	Plantation	Backfilled/OB	Active Mining Area	Total Excaveted Area	Total Reclaimed Area
			2011	2011	2011	2011	2011
1	Rohini	263.00	55.00	24.00	33.00	112.00	79.00
			49.11	21.43	29.47		70.54
2	Purnadih	751.00	0.00	6.00	13.00	19.00	6.00
			0.00	31.58	68.43		31.58
3	Tapin	503.00	29.00	53.00	58.00	140.00	82.00
			20.72	37.86	41.43		58.57
4	Jharkhand	740.00	31.00	100.00	19.00	150.00	131.00
			20.67	66.67	12.67		87.33
5	Topa	674.00	92.00	57.00	38.00	187.00	149.00
			49.20	30.49	20.33		79.68
6	Urimari	243.09	8.01	51.63	43.60	103.24	59.64
			7.76	50.01	42.24		57.77
7	North Urimari	516.90	5.37	18.98	39.00	63.35	24.35
			8.48	29.97	61.57		38.44
8	New Giddi C	275.00	15.20	26.28	32.30	73.78	41.48
			20.61	35.62	43.78		56.22
9	Govindpur PH-II	206.00	7.61	26.91	30.12	64.64	34.52
			11.78	41.64	46.60		53.40
10	khasmahal	280.00	32.48	36.72	31.85	101.05	69.20
			32.15	36.34	31.52		68.48
11	Amlo	247.59	13.23	48.39	48.18	109.80	61.62
			12.05	44.08	43.88		56.12
12	Selected Dhori	456.75	3.81	60.83	140.13	204.77	64.64
			1.87	29.71	68.44		31.57
13	Tarmi	258.70	1.18	14.05	32.10	47.33	15.23
			2.50	29.69	67.83		32.18
	Total	5415.03	293.89	523.79	558.28	1375.96	817.68
			21.36	38.07	40.57	25.42	59.43

Fig 1 : Project Wise Land Reclamation Status In Year 2011



1.0 Background

- 1.1 Land is the most important natural resource which embodies soil, water, flora, fauna and total ecosystem. All human activities are based on the land which is the most scarce natural resource in our country. Mining is a site specific industry and it could not be shifted anywhere else from the location where mineral occurs. It is a fact that surface mining activities do effect the land environment due to ground breaking. Therefore, there is an urgent need to reclaim and restore the mined out land for its productive use for sustainable development of mining. This will not only mitigate environmental degradation, but would also help in creating a more congenial environment for land acquisition by coal companies in future.
- 1.2 Keeping above in view, Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/Env/2009/2428 dated 29.12.2009 to Central Mine Planning & Design Institute (CMPDI), Ranchi, for monitoring land reclamation. status of all the opencast coal mines having production of more than 5 million m³ per annum (coal + OB taken together per annum) based on remote sensing satellite data, regularly on annual basis for sustainable development of mining. Further, another work order vide letter no. CIL/WBP/ENV./2011dated23/08/11 was issued by CIL for monitoring of less than 5 million m³ per annum capacity (Coal +OB) projects from the year 2011 at interval of three years. The result of land reclamation status of all such mines to be put on the website of CIL, (www.coalindia.in), CMPDI (www.cmpdi.co.in) and the concerned coal companies in public domain. Detail report to be submitted to Coal India and respective subsidiaries.
- 1.3 Land reclamation monitoring of all opencast coal mining projects would also comply the statutory requirements of Ministry of Environment & Forest (MoEF).Such monitoring would not only facilitate in taking timely mitigation measures against environmental degradation, but would also enable coal companies to utilize the reclaimed land for larger socio-economic benefits in a planned way.

- 1.4 Present report is embodying the finding of the study based on satellite data of the year 2011 carried out for 13 OC projects of Central Coalfields Ltd. producing less than 5 mcm (Coal+OB) per annum.

2.0 Objective

Objective of the land reclamation/restoration monitoring is to assess the area of backfilled, plantation, OB dumps, social forestry, active mining area, settlements and water bodies, distribution of wasteland, agricultural land and forest land in the leasehold area of the project. This is an important step taken up for assessing the progressive status of mined land reclamation and for taking up remedial measures, if any, required for environmental protection.

3.0 Methodology

There are number of steps involved between raw satellite data procurement and preparation of final map. National Remote Sensing Centre (NRSC) Hyderabad, being the nodal agency for satellite data supply in India, provides only raw digital satellite data, which needs further digital image processing for extracting the information and map preparation before uploading the same in the website. Methodology for land reclamation monitoring is given in given in fig 2. Following steps are involved in land reclamation /restoration monitoring:

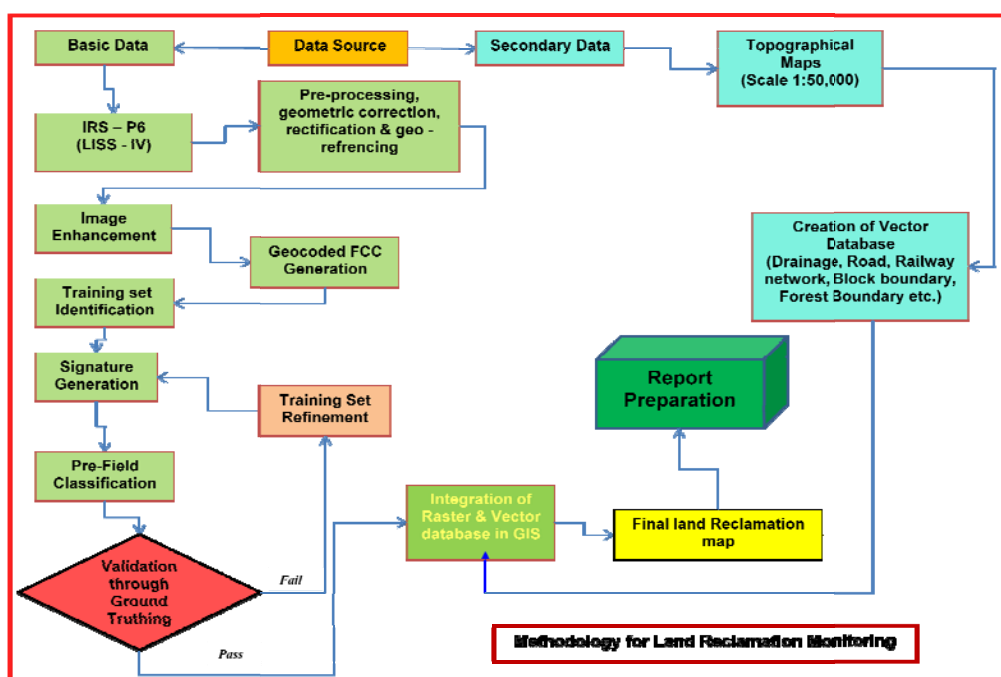


Figure: 2 Methodology for Land Reclamation Monitoring

3.1 Data Procurement: After browsing the data quality and date of pass on internet, supply order for data is placed to NRSC. Secondary data like leasehold boundary, topo sheets are procured for creation of vector database.

3.2 Satellite Data Processing: Satellite data are processed using ERDAS IMAGINE digital image processing s/w. Methodology involves the following major steps:

- **Rectification & Georeferencing:** Inaccuracies in digital imagery may occur due to 'systematic errors' attributed to earth curvature and rotation as well as 'non-systematic errors' attributed to satellite receiving station itself. Raw digital images contain geometric distortions, which make them unusable as maps. Therefore, georeferencing is required for correction of image data using ground control points (GCP) to make it compatible to SOI toposheet.
- **Image enhancement:** To improve the interpretability of the raw data, image enhancement is necessary. Local operations modify the value of each pixel based on brightness value of neighbouring pixels using ERDAS IMAGINE 9.0 s/w. and enhance the image quality for interpretation.
- **Training set selection**

Training set requires to be selected, so that software can classify the image data accurately. The image data are analysed based on the interpretation keys. These keys are evolved from certain fundamental image-elements such as tone/colour, size, shape, texture, pattern, location, association and shadow. Based on the image-elements and other geo-technical elements like land form, drainage pattern and physiography; training sets were selected/identified for each land use/cover class. Field survey was carried out by taking selective traverses in order to collect the ground information (or reference data) so that training sets are selected accurately in the image. This was intended to serve as an aid for classification.

- **Classification and Accuracy assessment**

Image classification is carried out using the maximum likelihood algorithm. The classification proceeds through the following steps: (a) calculation of statistics [i.e. signature generation] for the identified training areas, and (b) the decision boundary of maximum probability based on the mean vector, variance, covariance and correlation matrix of the pixels. After evaluating the statistical parameters of the training sets, reliability test of training sets is conducted by measuring the statistical separation between the classes that resulted from computing divergence matrix. The overall accuracy of the classification was finally assessed with reference to ground truth data.

- **Area calculation**

The area of each land use class in the leasehold is determined using ERDAS IMAGINE v. 9.0 software and given in table 2.

- **Overlay of Vector data base**

Vector data base created based on secondary data. Vector layer like drainage, railway line, leasehold boundary, forest boundary etc. are superimposed on the image as vector layer in the Arc GIS database.

- **Pre-field map preparation**

Pre-field map is prepared for validation of the classification result

3.3 Ground Truthing:

Selective ground verification of the land use classes are carried out in the field and necessary corrections if required, are incorporated before map finalization.

3.4 Land reclamation database on GIS:

Land reclamation database is created on GIS platform to identify the temporal changes identified from satellite data of different cut-off dates.

4.0 Land Reclamation Status in Central Coalfields Ltd.

4.1 Following 13 OC projects producing less than 5 million m³. (Coal + OB together) of Central Coalfields Ltd. have been taken up during the year 2011 for land reclamation monitoring:

- Rohini
- Purnadih
- Tapin
- Jharkhand
- Topa
- Urimari
- North Urimari
- New Giddi-C
- Govindpur PH-II
- Khasmahal
- Amlo
- Selected Dhori
- Tarmi

4.2 Area statistics of different land use classes present in OC projects in the year 2011 is given in Table 2. Land use maps derived from the satellite data is given in Plate no. 1 to 13. Land use statuses are shown in Fig. 3 – 7 and field photographs showing plantation and backfilled area in mining projects are shown in photos 1-6.

4.3 Study reveals that 59.43% of excavated area has already been reclaimed by CCL in the OC projects, out of which 21.36% area has been revegetated and 38.07% area are backfilled.

4.4 After analyzing the satellite data of year 2011, it is evident that plantation carried out on backfilled area, OB dumps as well as under social forestry in all the 13 mines of CCL taken up for study, has reached 21.36 % till now. It can also be seen from the table.1 that the total area of reclamation has reached 59.43% till the year 2011.

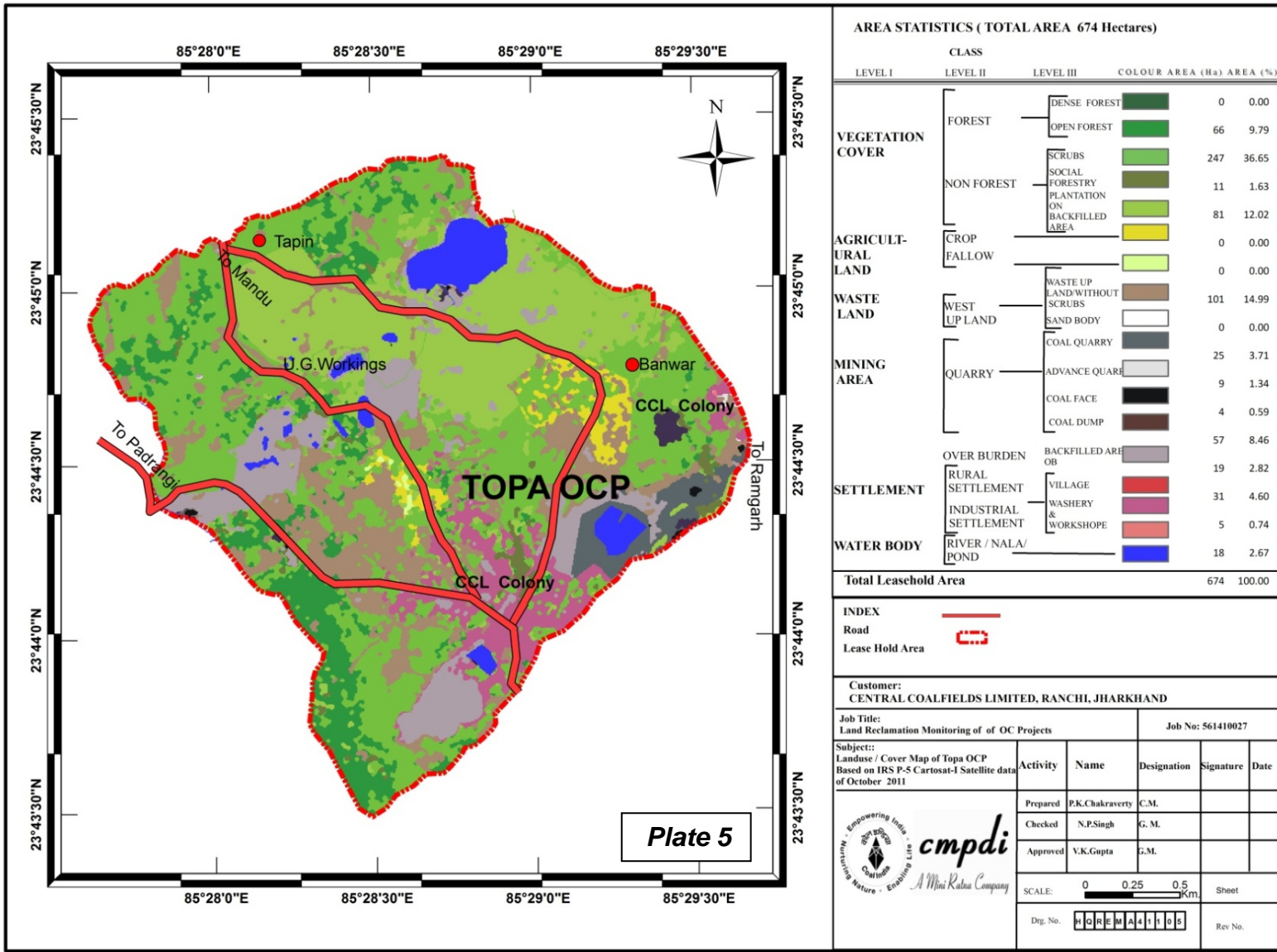
Table-2 STATUS OF LAND RECLAMATION IN CCL BASED ON SATELLITE DATA OF THE YEAR 2011

		Area in Hectare									
		Rohini		Purnadih		Tapin		Jharkhand		Topa	
		Area	%	Area	%	Area	%	Area	%	Area	%
Forest	Dense Forest	0.00	0.00	63.00	8.39	0.00	0.00	5.00	0.68	0.00	0.00
	Open Forest	27.00	10.27	67.00	8.92	107.00	21.27	170.00	22.97	66.00	9.79
	Total Forest	27.00	10.27	130.00	17.31	107.00	21.27	175.00	23.65	66.00	9.79
Scrub	Scrubs	81.00	30.80	338.00	45.01	77.00	15.31	287.00	38.78	247.00	36.65
Plantation	Social Forestry	1.00	0.38	0.00	0.00	6.00	1.19	6.00	0.81	11.00	1.63
	Plantation on OB Dump	54.00	20.53	0.00	0.00	23.00	4.57	25.00	3.38	81.00	12.02
	Total Plantation(Biological Reclamation)	55.00	20.91	0.00	0.00	29.00	5.77	31.00	4.19	92.00	13.65
	Total Vegetation	163.00	61.98	468.00	62.32	213.00	42.35	493.00	66.62	405.00	60.09
Active Mining	Coal Quarry	24.00	9.13	13.00	1.73	57.00	11.33	6.00	0.81	25.00	3.71
	Coal Face	1.00	0.38	0.00	0.00	0.00	0.00	1.00	0.14	0.00	0.00
	Advance quarry site	7.00	2.66	0.00	0.00	0.00	0.00	0.00	0.00	9.00	1.34
	Coal Dump	1.00	0.38	0.00	0.00	1.00	0.20	12.00	1.62	4.00	0.60
	Total Active Mining Area	33.00	12.55	13.00	1.73	58.00	11.53	19.00	2.57	38.00	5.64
Reclaimed	Barren OB Dump	24.00	9.13	6.00	0.80	53.00	10.54	100.00	13.51	57.00	8.46
	Barren backfilled area										
	Waterfilled quarry										
	Total Area Under Technical Reclamation	24.00	9.13	6.00	0.80	53.00	10.54	100.00	13.51	57.00	8.46
	Total Area Under Mine Oparation	57.00	21.67	19.00	2.53	111.00	22.07	119.00	16.08	95.00	14.09
Agriculture	Crop lands	0.00	0.00	101.00	13.45	47.00	9.34	0.00	0.00	0.00	0.00
	Fallow Land	7.00	2.66	91.00	12.11	1.00	0.20	14.00	1.89	0.00	0.00
	Total Agricultural	7.00	2.66	192.00	25.56	48.00	9.54	14.00	1.89	0.00	0.00
Wastelands	Wastelands	12.00	4.56	43.00	5.73	20.00	3.98	42.00	5.68	101.00	14.99
	Fly Ash Pond										
	Sand Body	2.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Wastelands	14.00	5.32	43.00	5.73	20.00	3.98	42.00	5.68	101.00	14.99
Settlements	Urban Settlement	0.00	0.00	0.00	0.00	44.00	8.75	32.00	4.32	31.00	4.60
	Rural Settlement	0.00	0.00	28.00	3.73	38.00	7.55	13.00	1.76	19.00	2.82
	Industrial Settlement	0.00	0.00	0.00	0.00	0.00	0.00	7.00	0.95	5.00	0.74
	Total Settelments(E)	0.00	0.00	28.00	3.73	82.00	16.30	52.00	7.03	55.00	8.16
Waterbody	Waterbodies(F)	22.00	8.37	1.00	0.13	29.00	5.77	20.00	2.70	18.00	2.67
	Grand Total	263.00	100.00	751.00	100.00	503.00	100.00	740.00	100.00	674.00	100.00

Table-2 STATUS OF LAND RECLAMATION IN CCL BASED ON SATELLITE DATA OF THE YEAR 2011

(Area in Hectare)

		URIMARI		NORTH URIMARI		NEW GIDDI C		GOVINDPUR PH-II		KHASMAHAL		AMLO		SEL. DHORI		TARMI		TOTAL	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FORESTS	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.22	14.36	1.14	0.46	4.79	1.05	5.64	2.18	119.79	2.21
	Open Forest	5.07	2.09	4.44	0.86	0.00	0.00	22.77	11.05	50.16	17.91	9.01	3.64	22.53	4.93	19.13	7.39	570.11	10.53
	Total Forest	5.07	2.09	4.44	0.86	0.00	0.00	22.77	11.05	90.37	32.28	10.15	4.10	27.32	5.98	24.77	9.57	689.89	12.74
SCRUBS	Scrubs	60.51	24.89	123.53	23.90	118.38	43.05	82.50	40.05	34.16	12.20	57.97	23.41	77.15	16.89	60.24	23.29	1644.44	30.37
	Social Forestry	0.00	0.00	0.00	0.00	8.72	3.17	0.01	0.00	9.27	3.31	4.93	1.99	1.90	0.42	0.78	0.30	49.61	0.92
PLANTATION	Plantation on OB Dump	8.01	3.30	5.37	1.04	0.00	0.00	6.34	3.08	0.00	0.00	7.63	3.08	0.93	0.20	0.40	0.15	211.68	3.91
	Plantation on Backfill	0.00	0.00	0.00	0.00	6.49	2.36	1.26	0.61	23.22	8.29	0.67	0.27	0.98	0.21	0.00	0.00	32.62	0.60
	Total Plantation (Biological Reclamation)	8.01	3.30	5.37	1.04	15.20	5.53	7.61	3.69	32.48	11.60	13.23	5.34	3.81	0.83	1.18	0.46	293.89	5.43
	Total Vegetation	73.59	30.27	133.34	25.80	133.59	48.58	112.87	54.79	157.01	56.08	81.35	32.86	108.28	23.71	86.19	33.32	2628.22	48.54
ACTIVE MINING	Coal Quarry	27.70	11.39	23.31	4.51	18.28	6.65	12.34	5.99	17.74	6.34	16.44	6.64	102.55	22.45	27.68	10.70	371.04	6.85
	Coal Face	0.00	0.00	0.00	0.00	0.31	0.11	0.86	0.42	1.98	0.71	1.21	0.49	0.36	0.08	0.00	0.00	6.72	0.12
	Coal Dump	5.98	2.46	8.62	1.67	5.49	2.00	1.66	0.80	9.54	3.41	10.04	4.06	14.33	3.14	3.61	1.40	77.27	1.43
	Advance Quarry Site	2.22	0.91	3.36	0.65	3.89	1.41	1.50	0.73	2.59	0.93	5.68	2.29	0.80	0.18	0.00	0.00	36.04	0.67
	Quarry Filled With Water	7.70	3.17	3.71	0.72	4.33	1.58	13.76	6.68	0.00	0.00	14.81	5.98	22.09	4.84	0.81	0.31	67.21	1.24
	Total Area under Active Mining	43.60	17.94	39.00	7.54	32.30	11.75	30.12	14.62	31.85	11.39	48.18	19.46	140.13	30.68	32.10	12.41	558.28	10.31
RECLAIMED	Barren OB Dump	20.77	8.54	8.64	1.67	23.44	8.52	15.60	7.57	31.93	11.40	14.68	5.93	19.11	4.18	10.20	3.94	384.37	7.10
	Barren Backfilled Area	30.86	12.69	10.34	2.00	2.84	1.03	11.31	5.49	4.79	1.71	33.71	13.62	41.72	9.13	3.85	1.49	139.42	2.57
	Total Area under Technical Reclamation	51.63	21.24	18.98	3.67	26.28	9.55	26.91	13.06	36.72	13.11	48.39	19.54	60.83	13.32	14.05	5.43	523.79	9.67
WASTELANDS	Waste Lands	46.69	19.21	74.47	14.41	14.70	5.35	10.65	5.17	16.11	5.75	58.18	23.50	116.68	25.55	81.32	31.43	636.80	11.76
	Fly Ash Pond / Sand Body	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.04
	Total Wasteland	46.69	19.21	74.47	14.41	14.70	5.35	10.65	5.17	16.11	5.75	58.18	23.50	116.68	25.55	81.32	31.43	638.80	11.80
WATERBODIES	Reservoir, nallah, ponds	0.34	0.14	3.94	0.76	3.09	1.12	0.44	0.21	0.96	0.34	0.78	0.32	1.45	0.32	0.34	0.13	101.34	1.87
	Total Waterbodies	0.34	0.14	3.94	0.76	3.09	1.12	0.44	0.21	0.96	0.34	0.78	0.32	1.45	0.32	0.34	0.13	101.34	1.87
AGRICULTURE	Crop Lands	13.89	5.71	47.93	9.27	32.83	11.94	20.59	10.00	5.52	1.97	0.00	0.00	1.01	0.22	10.25	3.96	280.02	5.17
	Fallow Lands	12.20	5.02	181.66	35.14	16.50	6.00	3.77	1.83	20.06	7.16	2.24	0.90	12.38	2.71	29.04	11.23	390.85	7.22
	Total Agriculture	26.09	10.73	229.59	44.42	49.61	17.94	24.36	11.82	25.28	9.14	2.24	0.90	13.39	2.93	39.29	15.19	670.85	12.39
SETTLEMENTS	Urban Settlement	0.00	0.00	0.52	0.10	9.84	3.58	0.00	0.00	7.80	2.78	1.92	0.78	0.00	0.00	0.00	0.00	127.08	2.35
	Rural Settlement	1.15	0.47	16.26	3.15	3.53	1.28	0.66	0.32	1.17	0.42	3.27	1.32	7.03	1.54	1.69	0.65	132.76	2.45
	Industrial Settlement	0.00	0.00	0.80	0.15	2.35	0.85	0.00	0.00	2.79	1.00	3.28	1.32	8.96	1.96	3.72	1.44	33.90	0.63
	Total Settlement	1.15	0.47	17.58	3.40	25.23	9.17	0.66	0.32	11.76	4.20	8.47	3.42	15.99	3.50	5.41	2.09	303.25	5.60
	Grand Total	243.09	100.00	516.90	100.00	275.00	100.00	206.00	100.00	280.00	100.00	247.59	100.00	456.75	100.00	258.70	100.00	5415.03	100.00



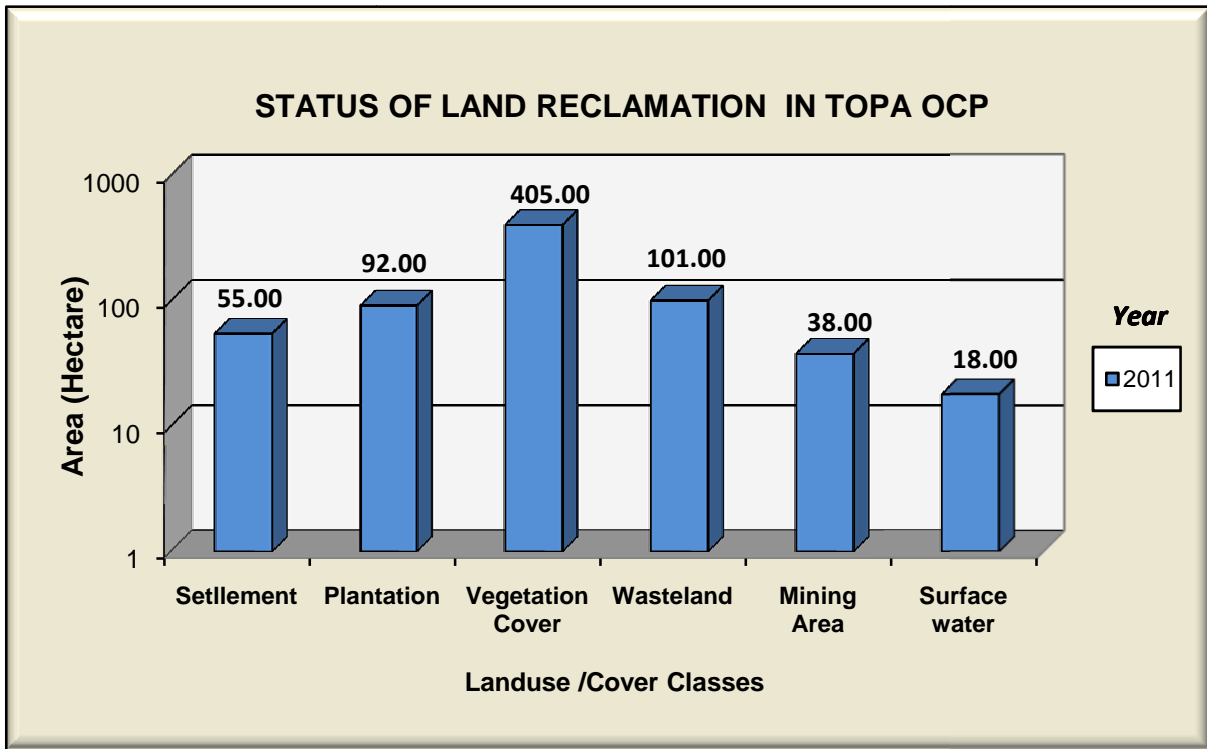


FIGURE - 7

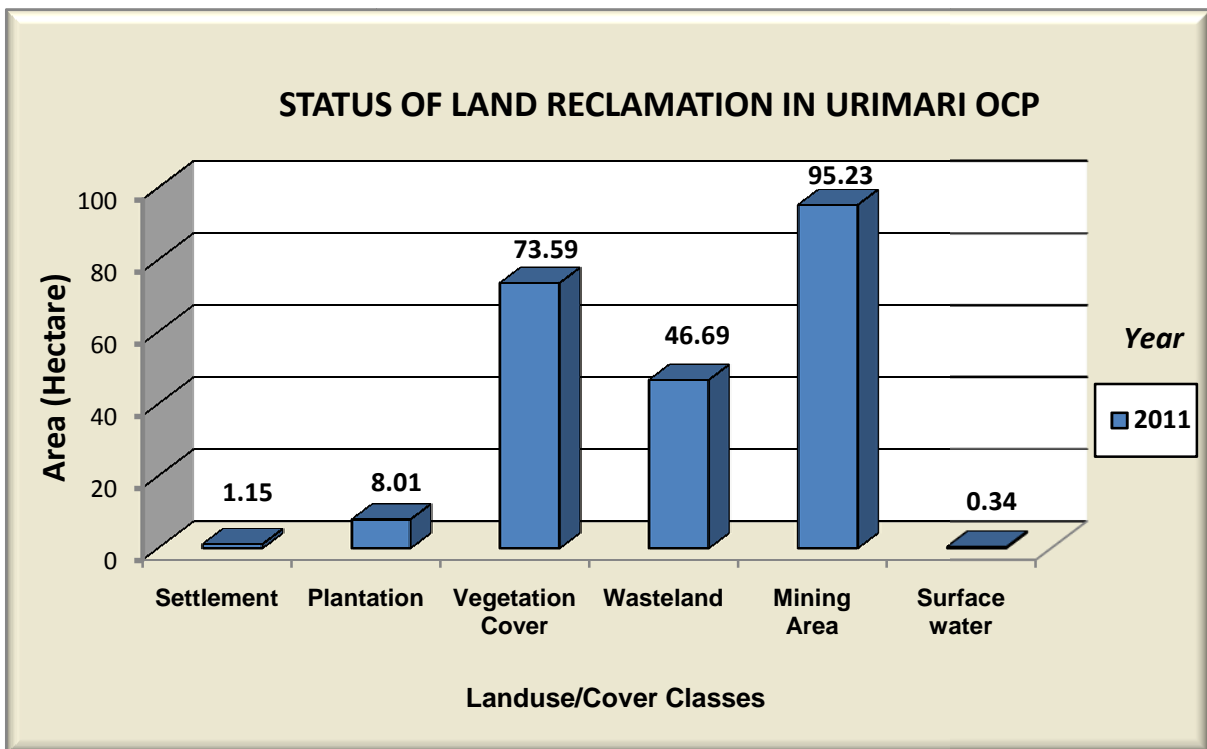


FIGURE - 8