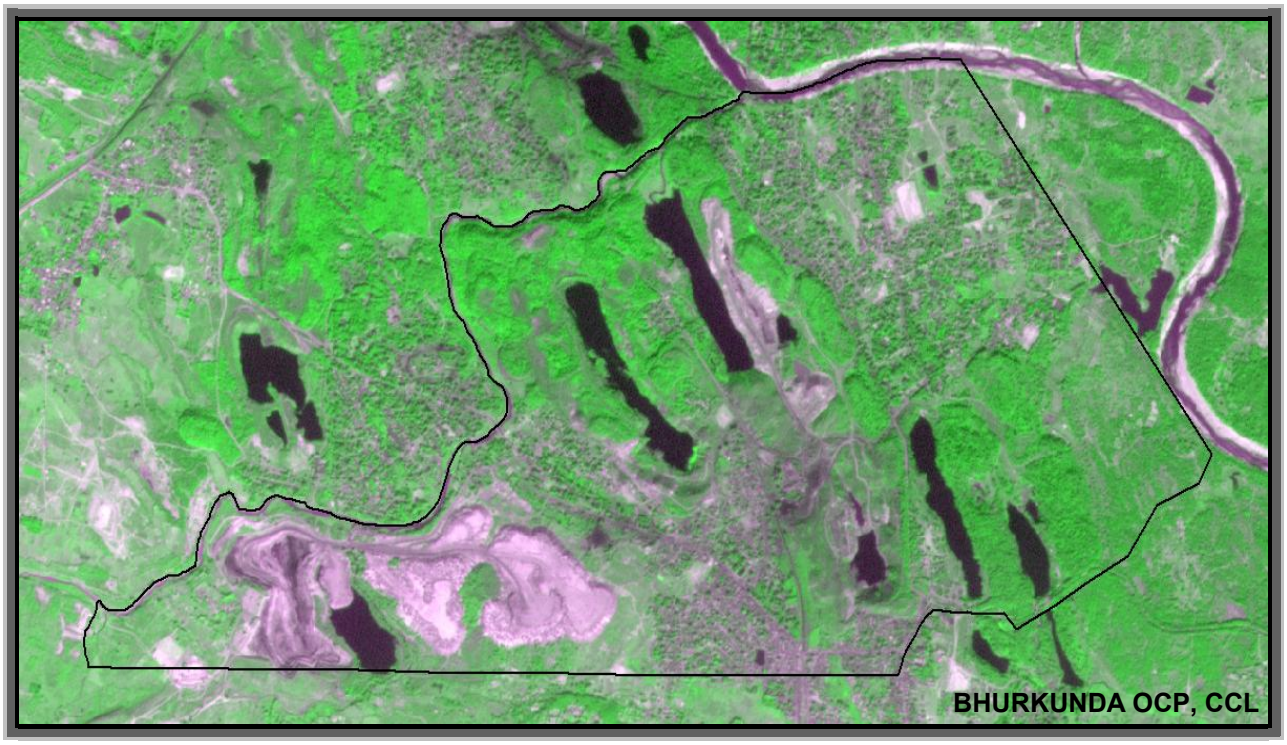
Land Restoration / Reclamation Monitoring of Open Cast Coal Mines of Central Coalfields Limited producing less than 5 m cu m. (Coal+ OB) based on Satellite Data for the Year 2016



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Central Coalfields Limited

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cmpdi

A Mini-Ratna Company

Land Restoration / Reclamation Monitoring of Open Cast Coal Mines of Central Coalfields Limited producing less than 5 m cu m. (Coal+ OB) based on Satellite Data for the Year 2016

March 2017

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

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(11) Author	Priyanka Bhatta, Assistant Manager (RSC)
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Executive summary

1.0 Project

Land restoration/reclamation monitoring of 11 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 opencast 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 5576.06 hectares of the 11 OC projects Viz. Ara, Bhurkunda, Pichri, Pindra, Sirka, Dhori, Bokaro, Kargali, Rajhara, Religera and Sarubera considered for monitoring during year 2016; total excavated area is only 1991.48 ha. Out of which 808.11 ha area (40.58%) has been planted, 602.42 ha area (30.25%) has been backfilled and 580.95 ha area (29.17%) is under active mining. It is evident from the analysis that 70.83% area of the OC projects have already been reclaimed and balance 29.17% area is under active mining. Project wise details are given inTable-1 & Fig.-1.

- Of the total area reclaimed by CCL, 40.58% is under biological reclamation (plantation) and 30.25% is under technical reclamation. Out of 11 projects of CCL, Ara OCP ranks on top for land reclamation (83.74%) followed by Bokaro OCP (83.33%) and Sarubera OCP (79.40%).

Table - 1

Projectwise Land Reclamation Status in Opencast Projects of CCL based on Satellite Data of the year 2016

(% Calculated in terms of Total Mined-Out Area)

Area in Hectare

Sl. No.	Project		Plantation/ Vegetation		Under Backfilling		Active Mining		Total Excavated Area		Total Reclaimed area	
	Name	Leasehold	ii		iii		iv		ii+iii+iv		ii+iii	
		i	2013	2016	2013	2016	2013	2016	2013	2016	2013	2016
1	*Ara*	*525.75*	86.03	86.03	32.50	55.84	50.89	27.55	169.42	169.42	118.53	141.87
			50.78	*50.78*	*19.18*	*32.96*	*30.04*	*16.26*			*69.96*	*83.74*
2	*Bhurkunda*	*910.16*	220.43	234.91	77.70	110.88	81.32	102.32	379.45	448.11	298.13	345.79
			58.09	*52.42*	*20.48*	*24.74*	*21.43*	*22.83*			*78.57*	*77.17*
3	*Pichri*	*40.13*	8.25	8.25	0.00	0.00	13.19	13.19	21.44	21.44	8.25	8.25
			38.48	*38.48*	*0.00*	*0.00*	*61.52*	*61.52*			*38.48*	*38.48*
4	*Pindra*	*326.54*	3.85	3.86	9.76	9.76	24.71	24.71	38.32	38.33	13.61	13.62
			10.05	*10.07*	*25.47*	*25.46*	*64.48*	*64.47*			*35.52*	*35.53*
5	*Sirka*	*362.4*	10.61	10.61	20.16	20.16	91.09	89.61	121.86	120.38	30.77	30.77
			8.71	*8.81*	*16.54*	*16.75*	*74.75*	*74.44*			*25.25*	*25.56*
6	*Dhori*	*294.32*	22.82	22.82	43.88	43.88	30.91	30.91	97.61	97.61	66.70	66.70
			23.38	*23.38*	*44.95*	*44.95*	*31.67*	*31.67*			*68.33*	*68.33*
7	*Bokaro*	*607.3*	165.27	165.01	79.36	79.40	48.86	48.89	293.49	293.30	244.63	244.41
			56.31	*56.26*	*27.04*	*27.07*	*16.65*	*16.67*			*83.35*	*83.33*
8	*Kargali*	*785*	178.22	178.23	154.72	154.71	102.07	102.08	435.01	435.02	332.94	332.94
			40.97	*40.97*	*35.57*	*35.56*	*23.46*	*23.47*			*76.54*	*76.53*
9	*Rajhara*	*736.36*	0.00	0.00	7.12	7.80	46.71	53.46	53.83	61.26	7.12	7.80
			0.00	*0.00*	*13.23*	*12.73*	*86.77*	*87.27*			*13.23*	*12.73*
10	*Religera*	*301.75*	42.88	42.88	75.41	69.25	54.51	60.67	172.80	172.80	118.29	112.13
			24.81	*24.81*	*43.64*	*40.08*	*31.55*	*35.11*			*68.45*	*64.89*
11	*Sarubera*	*686.35*	55.51	55.51	50.74	50.74	27.56	27.56	133.81	133.81	106.25	106.25
			41.48	*41.48*	*37.92*	*37.92*	*20.60*	*20.60*			*79.40*	*79.40*
TOTAL (CCL)		5576.06	**793.87**	**808.11**	**551.35**	**602.42**	**571.82**	**580.95**	**1917.04**	**1991.48**	**1345.22**	**1410.53**
			41.41	*40.58*	*28.76*	*30.25*	*29.83*	*29.17*	*34.38*	*35.71*	*70.17*	*70.83*

Note: *In reference of the above Table, different parameters are classified as follows:*

*1. Area under **Biological Reclamation** includes Areas under Plantation done on Backfill, External OB Dumps.*

*2. Area under **Technical Reclamation** includes Area under Backfilling & OB Dumps.*

*3. Area under **Active Mining** includes Coal Quarry, Advance Quarry Site, Quarry filled with water, if any.*

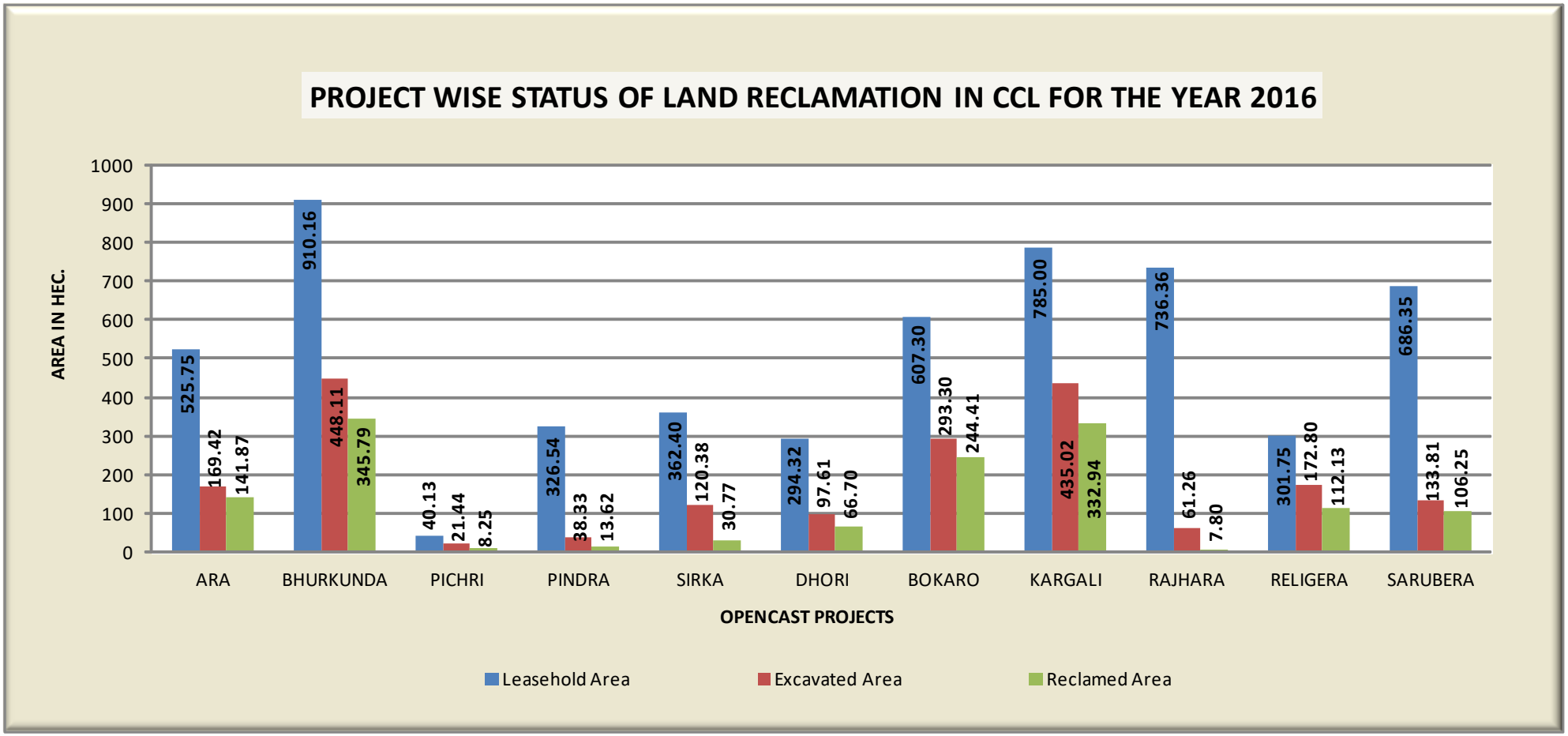


Figure 1: Project wise status of Land Reclamation in CCL for the year 2016

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 scarcest 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 affect 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 environment for land acquisition by coal companies in future.

1.2 Keeping above in view, M/s Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/Env/2011/4706 dated 12.10.2012 for monitoring of opencast mines of less than 5 million m3 per annum capacity (Coal + OB) from the year 2012 at intervals of three years. The result of land reclamation status of all such mines is to be published on the website of CIL, (www.coalindia.in), CMPDI,(www.cmpdi.co.in) and the concerned coal companies in public domain. Detailed reports are 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 2016 carried out for 11 OC projects of Central Coalfields Ltd. Producing less than 5 m.c.m (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, 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 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 Fig. 2. Following steps are involved in land reclamation/ restoration monitoring:

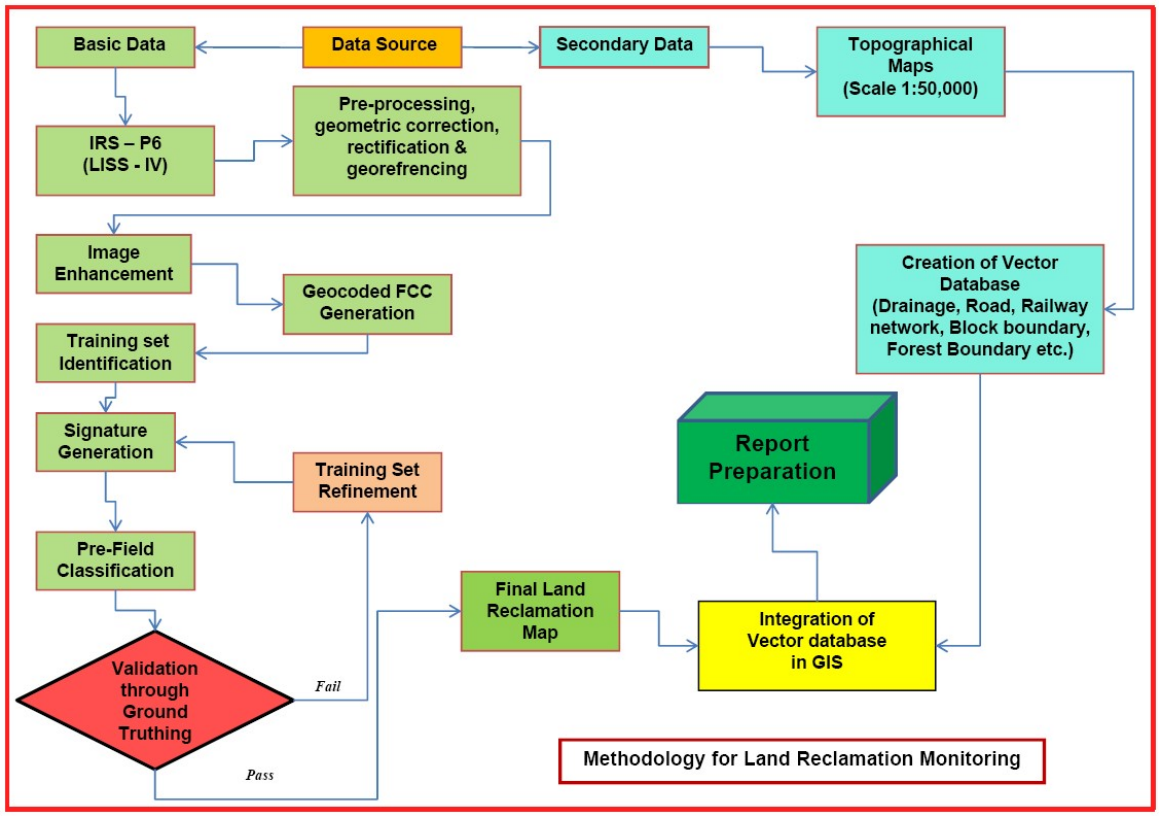


Figure-2: Methodology of Land Reclamation Monitoring

3.1 Data Procurement:

After browsing the data quality and date of pass on NRSC site, data order 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 v2014. Methodology involves the following major steps:

- **Rectification & Geo-referencing:**

  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, geo-referencing is required for correction of image data using ground control points (GCP) to male it compatible to SOI topo-sheet.

- **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 14 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 are 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 v2014 s/w and given in table 2.

- **Overlay of Vector database**

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

- **Pre-field map preparation**

  Pre-field map is prepared for validation of 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 of Central Coalfields Ltd.

Following 11 OC Projects producing less than 5 million m^3 (Coal +OB) of Central Coalfields Ltd. Have been taken up during the year 2016 for land reclamation monitoring:

- Ara
- Bhurkunda
- Pichri
- Pindra
- Sirka
- Dhori
- Bokaro
- Kargali
- Rajhara
- Religera
- Sarubera

4.1 Area statistics of different land use classes present in OC projects in the year 2016 is given in table 2. Land use maps derived from the satellite data is given in Plate No. 1 to 11. Land use statuses are shown in fig. 3-13 and field photographs showing plantation and backfilled area in mining project is shown in Photos 1-6.

4.2 Study reveals that 70.83% of excavated area has already been reclaimed by CCL in the OC Projects, out of which 40.58% area has been planted and 30.25% area are backfilled.

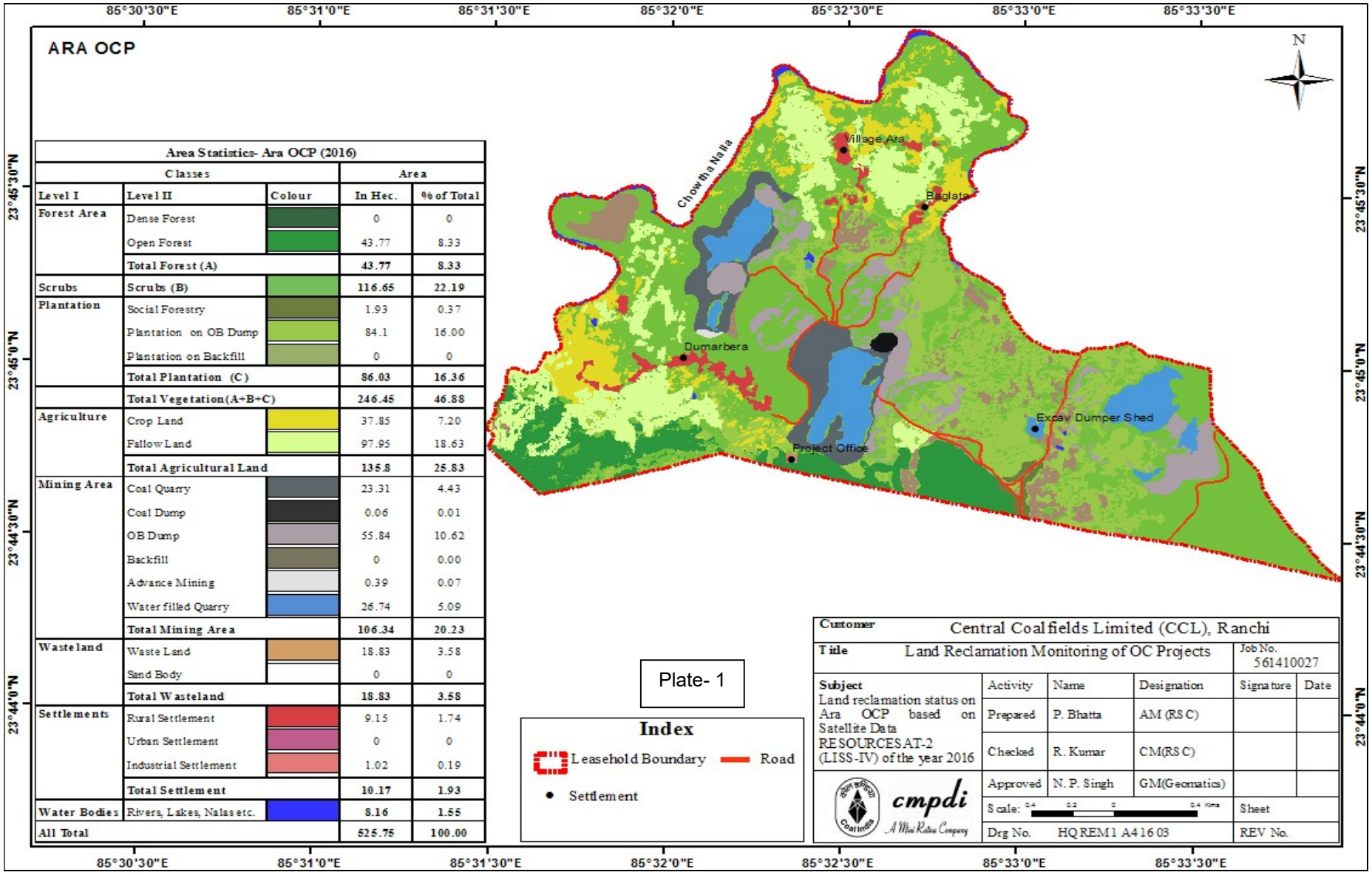
4.3 After analyzing the satellite data of the year 2016, it is evident that plantation carried out on backfilled area, OB dumps as well as under social forestry in all the 11 mines of CCL taken for study, has reached 40.58% till now. It can also be seen from table 1 that the total area of reclamation has reached 70.83% till the year 2016.

Table 2: STATUS OF LAND RECLAMATION IN CENTRAL COALFIELDS LIMITED BASED ON SATELLITE DATA OF THE YEAR 2016

(Area in Hectare)

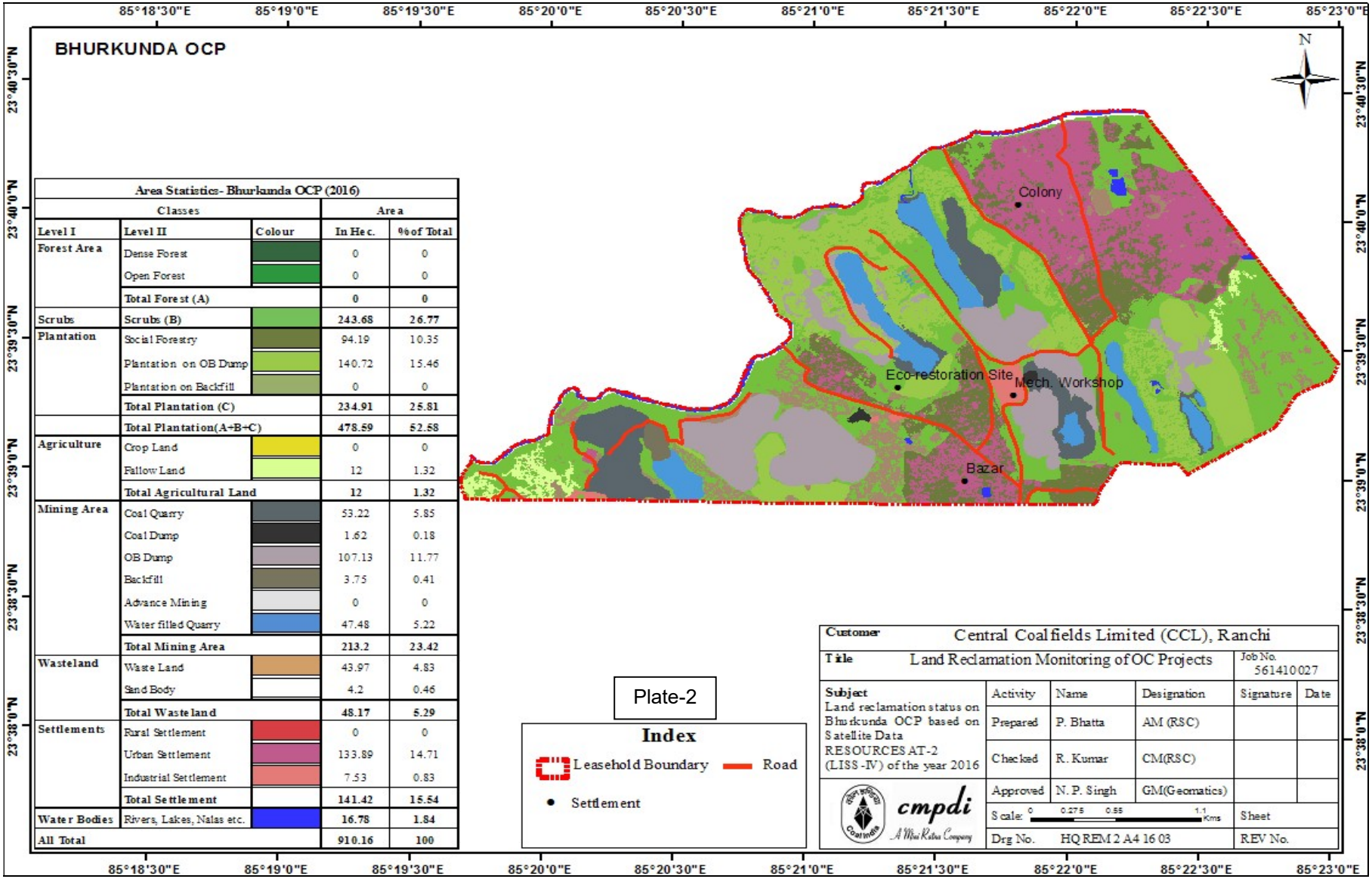
		ARA		BHURKUNDA		PICHRI		PINDRA		SIRKA		DHORI	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FORESTS	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Forest	43.77	8.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Forest (A)	43.77	8.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCRUBS	**Scrubs (B)**	116.65	22.19	243.68	26.77	2.65	6.60	103.00	31.54	110.61	30.52	100.92	34.29
PLANTATION	Social Forestry	1.93	0.37	94.19	10.35	8.25	20.57	3.86	1.18	6.08	1.68	0.00	0.00
	Plantation on OB Dump	84.10	16.00	140.72	15.46	0.00	0.00	0.00	0.00	4.53	1.25	6.66	2.26
	Plantation on Backfill	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.16	5.49
	Total Plantation(***Biological Reclamation*** C)	**86.03**	**16.37**	**234.91**	**25.81**	**8.25**	**20.57**	**3.86**	**1.18**	**10.61**	**2.93**	**22.82**	**7.75**
	Total Vegetation (A+B+C)	**246.45**	**46.89**	**478.59**	**52.58**	**10.90**	**27.17**	**106.86**	**32.72**	**121.22**	**33.45**	**123.74**	**42.04**
ACTIVEMINING	Coal Quarry	23.31	4.43	53.22	5.85	6.18	15.40	19.44	5.95	76.44	21.10	13.09	4.45
	Coal Dump	0.06	0.01	1.62	0.18	0.00	0.00	0.00	0.00	0.00	0.00	1.12	0.38
	Advance Quarry Site	0.39	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Quarry Filled with Water	26.74	5.09	47.48	5.22	7.01	17.46	5.27	1.61	13.17	3.63	16.70	5.67
	Total Area under *Active Mining*	**50.50**	**9.60**	**102.32**	**11.25**	**13.19**	**32.86**	**24.71**	**7.56**	**89.61**	**24.73**	**30.91**	**10.50**
RECLAIMED	Barren OB dump	55.84	10.62	107.13	11.77	0.00	0.00	9.76	3.00	20.16	5.56	25.96	8.82
	Area Under Backfilling	0.00	0.00	3.75	0.41	0.00	0.00	0.00	0.00	0.00	0.00	17.92	6.09
	Total Area under *Technical Reclamation*	**55.84**	**10.62**	**110.88**	**12.18**	**0.00**	**0.00**	**9.76**	**3.00**	**20.16**	**5.56**	**43.88**	**14.91**
	Total Area under Mine Operation	**106.34**	**20.22**	**213.20**	**23.42**	**13.19**	**32.86**	**34.47**	**10.56**	**109.77**	**30.29**	**74.79**	**25.41**
WASELANDS	Waste Lands	18.83	3.58	43.97	4.83	0	0	46.88	14.36	3.89	1.07	7.99	2.71
	Fly Ash Pond/Sand Body	0.00	0.00	4.20	0.46	1.08	2.69	0.00	0.00	0.00	0.00	4.97	1.69
	Total Wastelands	**18.83**	**3.58**	**48.17**	**5.29**	**1.08**	**2.69**	**46.88**	**14.36**	**3.89**	**1.07**	**12.96**	**4.4**
WAIER	Reservoir, nallah, ponds etc.	8.16	1.55	16.78	1.84	1.79	4.46	1.41	0.44	13.57	3.74	5.05	1.72
	Total Waterbodies	**8.16**	**1.55**	**16.78**	**1.84**	**1.79**	**4.46**	**1.41**	**0.44**	**13.57**	**3.74**	**5.05**	**1.72**
AGRICULTURE	Crop Lands	37.85	7.20	0.00	0.00	0.00	0.00	6.51	1.99	13.80	3.81	0.00	0.00
	Fallow Lands	97.95	18.63	12.00	1.32	13.17	32.82	125.86	38.54	68.73	18.97	7.94	2.70
	Total Agriculture	**135.80**	**25.83**	**12.00**	**1.32**	**13.17**	**32.82**	**132.37**	**40.53**	**82.53**	**22.78**	**7.94**	**2.70**
SETTLEMENTS	Urban Settlement	1.02	0.19	133.89	14.71	0.00	0.00	3.35	1.03	23.04	6.36	62.57	21.26
	Rural Settlement	9.15	1.74	0.00	0.00	0.00	0.00	0.77	0.24	6.95	1.91	5.70	1.94
	Industrial Settlement	0.00	0.00	7.53	0.83	0.00	0.00	0.43	0.13	1.43	0.39	1.57	0.53
	Total Settlements	**10.17**	**1.93**	**141.42**	**15.54**	**0.00**	**0.00**	**4.55**	**1.40**	**31.42**	**8.67**	**69.84**	**23.73**
	GRAND TOTAL	**525.75**	**100.0**	**910.16**	**100.0**	**40.13**	**100.00**	**326.54**	**100.0**	**362.40**	**100.00**	**294.32**	**100.00**

		BOKARO		KARGALI		RAJHARA		RELIGERA		SARUBERA		TOTAL	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FOREST	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Forest	0.00	0.00	0.00	0.00	0.00	0.00	3.35	1.11	54.32	7.91	101.44	1.82
	Total Forest (A)	0.00	0.00	0.00	0.00	0.00	0.00	3.35	1.11	54.32	7.91	101.44	1.82
SCRUBS	**Scrubs (B)**	118.53	19.51	175.39	22.34	103.15	14.01	96.58	32.00	135.35	19.72	1306.51	23.43
PLANTATION	Social Forestry	58.54	9.63	72.96	9.29	0.00	0.00	33.15	10.99	6.01	0.88	284.97	5.11
	Plantation on OB Dump	5.45	0.96	103.53	13.19	0.00	0.00	9.73	3.22	49.50	7.21	404.22	7.25
	Plantation on Backfill	101.02	16.62	1.74	0.22	0.00	0.00	0.00	0.00	0.00	0.00	118.92	2.13
	Total Plantation(*Biological Reclamation*C)	**165.01**	**27.21**	**178.23**	**22.70**	**0.00**	**0.00**	**42.88**	**14.21**	**55.51**	**8.09**	**808.11**	**14.49**
	Total Vegetation (A+B+C)	283.54	48.72	353.62	45.04	103.15	14.01	142.81	47.32	246.18	35.72	2218.08	38.74
ACTIVE MINING	Coal Quarry	6.44	1.06	76.25	9.71	38.54	5.23	29.66	9.83	16.83	2.45	359.40	6.45
	Coal Dump	0.00	0.00	0.00	0.00	0.00	0.00	3.56	1.18	0.00	0.00	6.36	0.11
	Advance Quarry Site	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.01
	Quarry Filled with Water	42.45	6.99	25.83	3.29	14.92	2.03	27.45	9.10	10.73	1.56	237.75	4.26
	Total Area under *Active Mining*	**48.89**	**8.05**	**102.08**	**13.00**	**53.46**	**7.26**	**60.67**	**20.11**	**27.56**	**4.01**	**603.90**	**10.83**
RECLAIMED	Barren OB dump	10.08	1.66	154.59	19.69	7.80	1.06	69.25	22.95	49.25	7.18	509.82	9.14
	Area Under Backfilling	69.32	11.41	0.12	0.02	0.00	0.00	0.00	0.00	1.49	0.22	92.60	1.66
	Total Area under *Technical Reclamation*	79.40	13.07	154.71	19.71	7.80	1.06	69.25	22.95	50.74	7.40	602.42	10.80
	Total Area under Mine Operation	128.29	21.12	256.79	32.71	61.26	8.32	129.92	43.06	78.30	11.41	1206.32	21.63
WASTELANDS	Waste Lands	15.01	2.47	2.04	0.26	111.97	15.21	4.59	1.52	165.91	24.17	421.08	7.55
	Fly Ash Pond/Sand Body	42.09	6.93	0.05	0.01	11.89	1.61	0.00	0.00	0.00	0.00	64.28	1.15
	Total Wastelands	57.10	9.4	2.09	0.27	123.86	16.82	4.59	1.52	165.91	24.17	485.36	8.70
WATER	Reservoir, nallah, ponds etc.	20.81	3.42	3.31	0.42	59.23	8.04	0.38	0.13	8.41	1.23	138.90	2.49
	Total Waterbodies	20.81	3.42	3.31	0.42	59.23	8.04	0.38	0.13	8.41	1.23	138.90	2.49
AGRICULTURE	Crop Lands	0.00	0.00	0.00	0.00	23.15	3.14	0.00	0.00	30.17	4.40	111.48	2.00
	Fallow Lands	71.18	11.71	4.22	0.54	335.85	45.61	3.58	1.19	136.66	19.91	877.14	15.73
	Total Agriculture	71.18	11.71	4.22	0.54	359.00	48.75	3.58	1.19	166.83	24.31	988.62	17.73
SETTLEMENTS	Urban Settlement	30.50	5.02	32.99	4.20	0.00	0.00	12.26	4.06	0.00	0.00	299.62	5.37
	Rural Settlement	14.19	2.33	117.48	14.97	27.44	3.73	6.87	2.28	9.23	1.34	197.78	3.55
	Industrial Settlement	1.69	0.28	14.50	1.85	2.42	0.33	1.34	0.44	12.49	1.82	43.40	0.78
	Total Settlements	46.38	7.63	164.97	21.02	29.86	4.06	20.47	6.78	21.72	3.16	540.80	9.70
	GRAND TOTAL	607.30	100.00	785.00	100.00	736.36	100.00	301.75	100.00	686.35	100.00	5576.06	100.00



Area Statistics- Ara OCP (2016)

Classes			Area	
Level I	Level II	Colour	In Hec.	% of Total
Forest Area	Dense Forest		0	0
	Open Forest		43.77	8.33
	Total Forest (A)		**43.77**	**8.33**
Scrubs	**Scrubs (B)**		**116.65**	**22.19**
Plantation	Social Forestry		1.93	0.37
	Plantation on OB Dump		84.1	16.00
	Plantation on Backfill		0	0
	Total Plantation (C)		**86.03**	**16.36**
	Total Vegetation(A+B+C)		**246.45**	**46.88**
Agriculture	Crop Land		37.85	7.20
	Fallow Land		97.95	18.63
	Total Agricultural Land		**135.8**	**25.83**
Mining Area	Coal Quarry		23.31	4.43
	Coal Dump		0.06	0.01
	OB Dump		55.84	10.62
	Backfill		0	0.00
	Advance Mining		0.39	0.07
	Water filled Quarry		26.74	5.09
	Total Mining Area		**106.34**	**20.23**
Wasteland	Waste Land		18.83	3.58
	Sand Body		0	0
	Total Wasteland		**18.83**	**3.58**
Settlements	Rural Settlement		9.15	1.74
	Urban Settlement		0	0
	Industrial Settlement		1.02	0.19
	Total Settlement		**10.17**	**1.93**
Water Bodies	Rivers, Lakes, Nalas etc.		8.16	1.55
All Total			525.75	100.00



Area Statistics- Bhurkunda OCP (2016)				
Classes			Area	
Level I	Level II	Colour	In Hec.	% of Total
Forest Area	Dense Forest		0	0
	Open Forest		0	0
	Total Forest (A)		**0**	**0**
Scrubs	**Scrubs (B)**		**243.68**	**26.77**
Plantation	Social Forestry		94.19	10.35
	Plantation on OB Dump		140.72	15.46
	Plantation on Backfill		0	0
	Total Plantation (C)		**234.91**	**25.81**
	Total Plantation(A+B+C)		**478.59**	**52.58**
Agriculture	Crop Land		0	0
	Fallow Land		12	1.32
	Total Agricultural Land		**12**	**1.32**
Mining Area	Coal Quarry		53.22	5.85
	Coal Dump		1.62	0.18
	OB Dump		107.13	11.77
	Backfill		3.75	0.41
	Advance Mining		0	0
	Water filled Quarry		47.48	5.22
	Total Mining Area		**213.2**	**23.42**
Wasteland	Waste Land		43.97	4.83
	Sand Body		4.2	0.46
	Total Wasteland		**48.17**	**5.29**
Settlements	Rural Settlement		0	0
	Urban Settlement		133.89	14.71
	Industrial Settlement		7.53	0.83
	Total Settlement		**141.42**	**15.54**
Water Bodies	Rivers, Lakes, Nalas etc.		**16.78**	**1.84**
All Total			**910.16**	**100**

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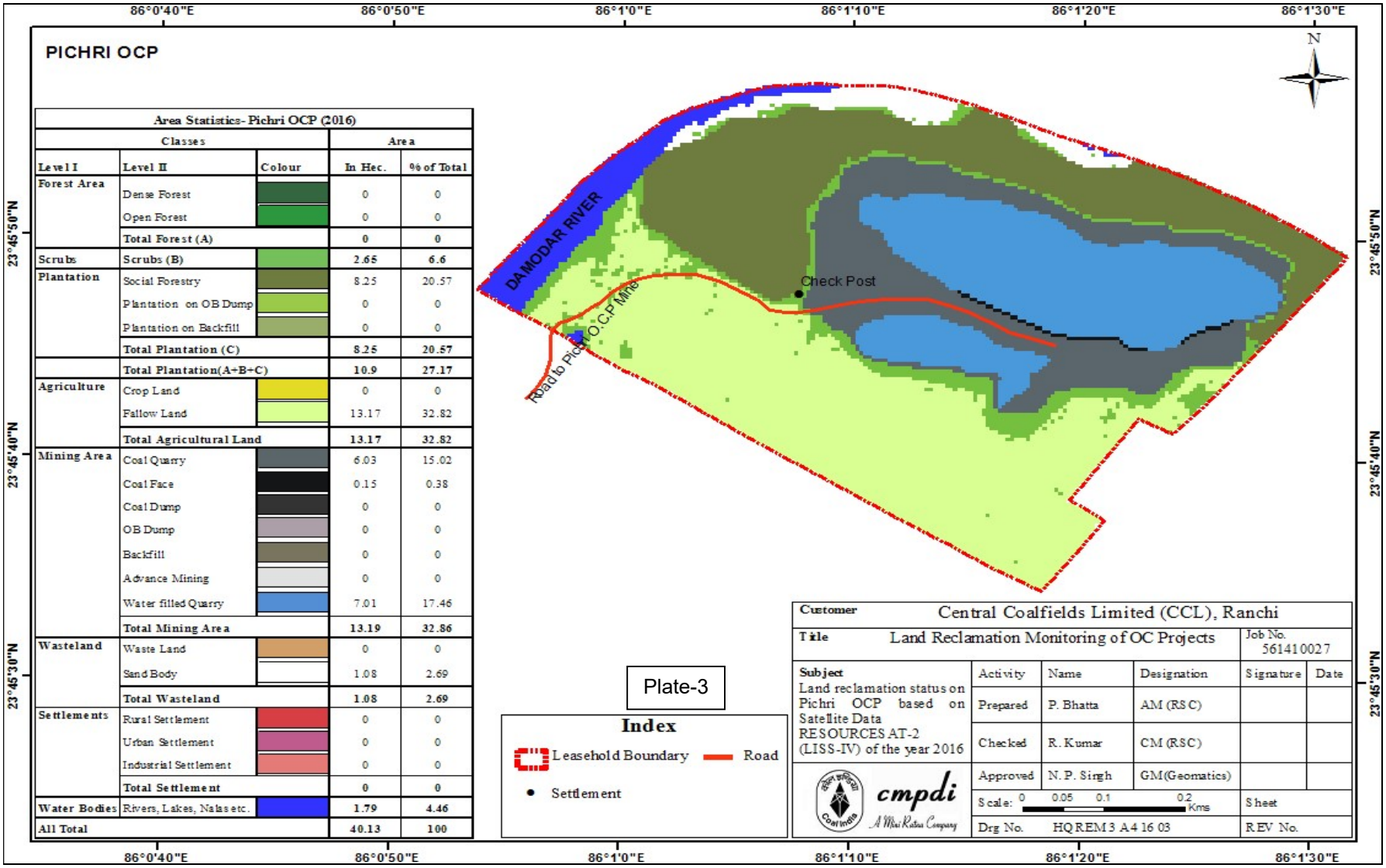
Leasehold Boundary — Road

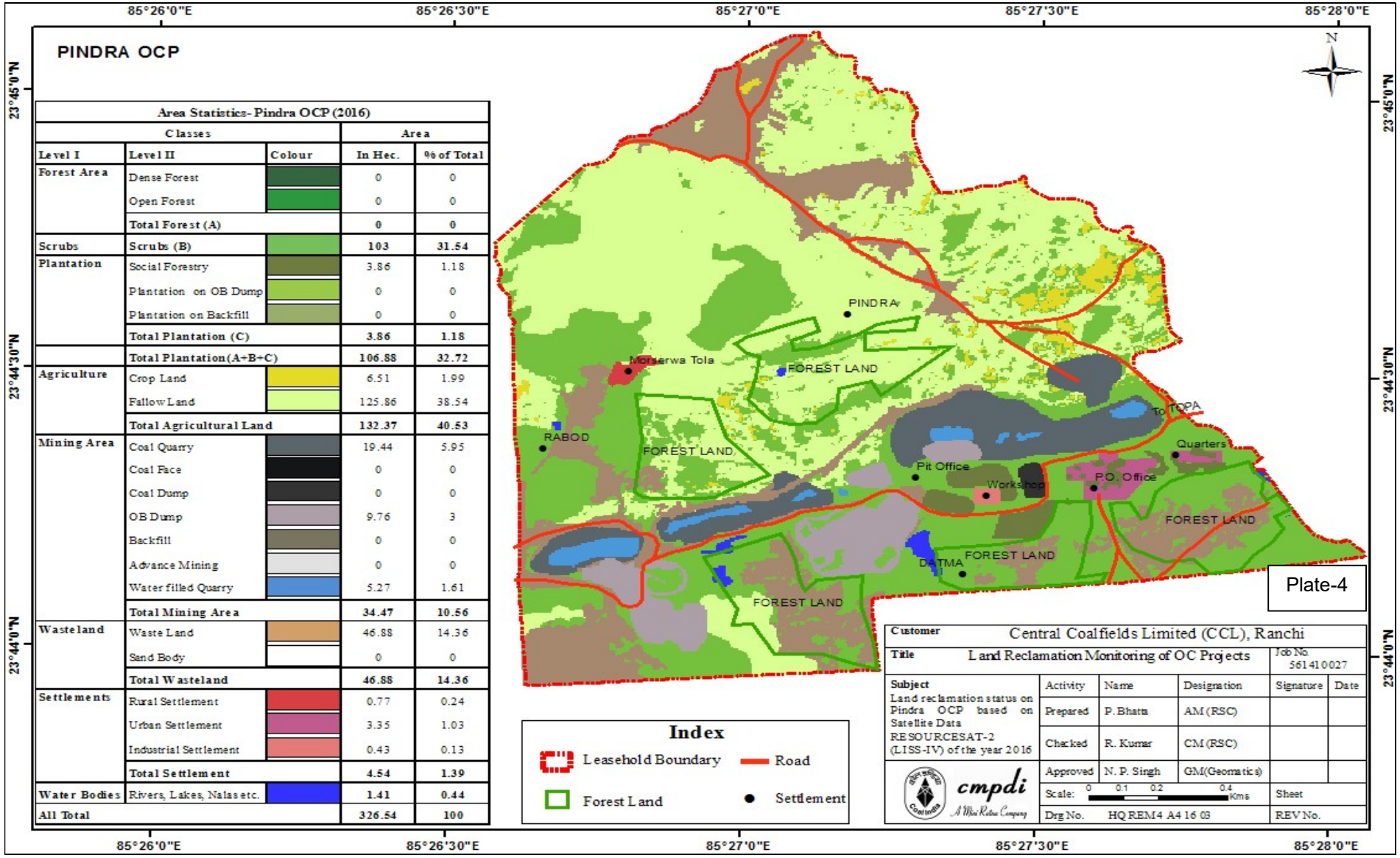
Settlement

Customer	Central Coalfields Limited (CCL), Ranchi				
Title	Land Reclamation Monitoring of OC Projects			Job No. 561410027	
Subject Land reclamation status on Bhurkunda OCP based on Satellite Data RESOURCESAT-2 (LISS-IV) of the year 2016	Activity	Name	Designation	Signature	Date
	Prepared	P. Bhatta	AM (RSC)		
	Checked	R. Kumar	CM(RSC)		
	Approved	N. P. Singh	GM(Geomatics)		
cmpdi A Mini Ratna Company	Scale: 0 0.275 0.55 1.1 Kms			Sheet	
	Drg No. HQ REM 2 A4 16 03			REV No.	



Area Statistics- Pichri OCP (2016)

Classes			Area	
Level I	Level II	Colour	In Hec.	% of Total
Forest Area	Dense Forest		0	0
	Open Forest		0	0
	Total Forest (A)		**0**	**0**
Scrubs	Scrubs (B)		2.65	6.6
Plantation	Social Forestry		8.25	20.57
	Plantation on OB Dump		0	0
	Plantation on Backfill		0	0
	Total Plantation (C)		**8.25**	**20.57**
	Total Plantation(A+B+C)		**10.9**	**27.17**
Agriculture	Crop Land		0	0
	Fallow Land		13.17	32.82
	Total Agricultural Land		**13.17**	**32.82**
Mining Area	Coal Quarry		6.03	15.02
	Coal Face		0.15	0.38
	Coal Dump		0	0
	OB Dump		0	0
	Backfill		0	0
	Advance Mining		0	0
	Water filled Quarry		7.01	17.46
	Total Mining Area		**13.19**	**32.86**
Wasteland	Waste Land		0	0
	Sand Body		1.08	2.69
	Total Wasteland		**1.08**	**2.69**
Settlements	Rural Settlement		0	0
	Urban Settlement		0	0
	Industrial Settlement		0	0
	Total Settlement		**0**	**0**
Water Bodies	Rivers, Lakes, Nalas etc.		1.79	4.46
All Total			40.13	100



Area Statistics- Pindra OCP (2016)

Classes			Area	
Level I	Level II	Colour	In Hec.	% of Total
Forest Area	Dense Forest		0	0
	Open Forest		0	0
	Total Forest (A)		**0**	**0**
Scrubs	**Scrubs (B)**		**103**	**31.54**
Plantation	Social Forestry		3.86	1.18
	Plantation on OB Dump		0	0
	Plantation on Backfill		0	0
	Total Plantation (C)		**3.86**	**1.18**
	Total Plantation(A+B+C)		**106.88**	**32.72**
Agriculture	Crop Land		6.51	1.99
	Fallow Land		125.86	38.54
	Total Agricultural Land		**132.37**	**40.53**
Mining Area	Coal Quarry		19.44	5.95
	Coal Face		0	0
	Coal Dump		0	0
	OB Dump		9.76	3
	Backfill		0	0
	Advance Mining		0	0
	Water filled Quarry		5.27	1.61
	Total Mining Area		**34.47**	**10.56**
Wasteland	Waste Land		46.88	14.36
	Sand Body		0	0
	Total Wasteland		**46.88**	**14.36**
Settlements	Rural Settlement		0.77	0.24
	Urban Settlement		3.35	1.03
	Industrial Settlement		0.43	0.13
	Total Settlement		**4.54**	**1.39**
Water Bodies	Rivers, Lakes, Nalas etc.		**1.41**	**0.44**
All Total			**326.54**	**100**

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Leasehold Boundary — Road

Forest Land — Settlement

Customer	Central Coalfields Limited (CCL), Ranchi				
Title	Land Reclamation Monitoring of OC Projects			Job No. 561410027	
Subject: Land reclamation status on Pindra OCP based on Satellite Data RESOURCESAT-2 (LISS-IV) of the year 2016	Activity	Name	Designation	Signature	Date
	Prepared	P. Bhatta	AM (RSC)		
	Checked	R. Kumar	CM (RSC)		
	Approved	N. P. Singh	GM(Geomatics)		
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	Drg No. HQ REM4 A4 16 03			REV No.	

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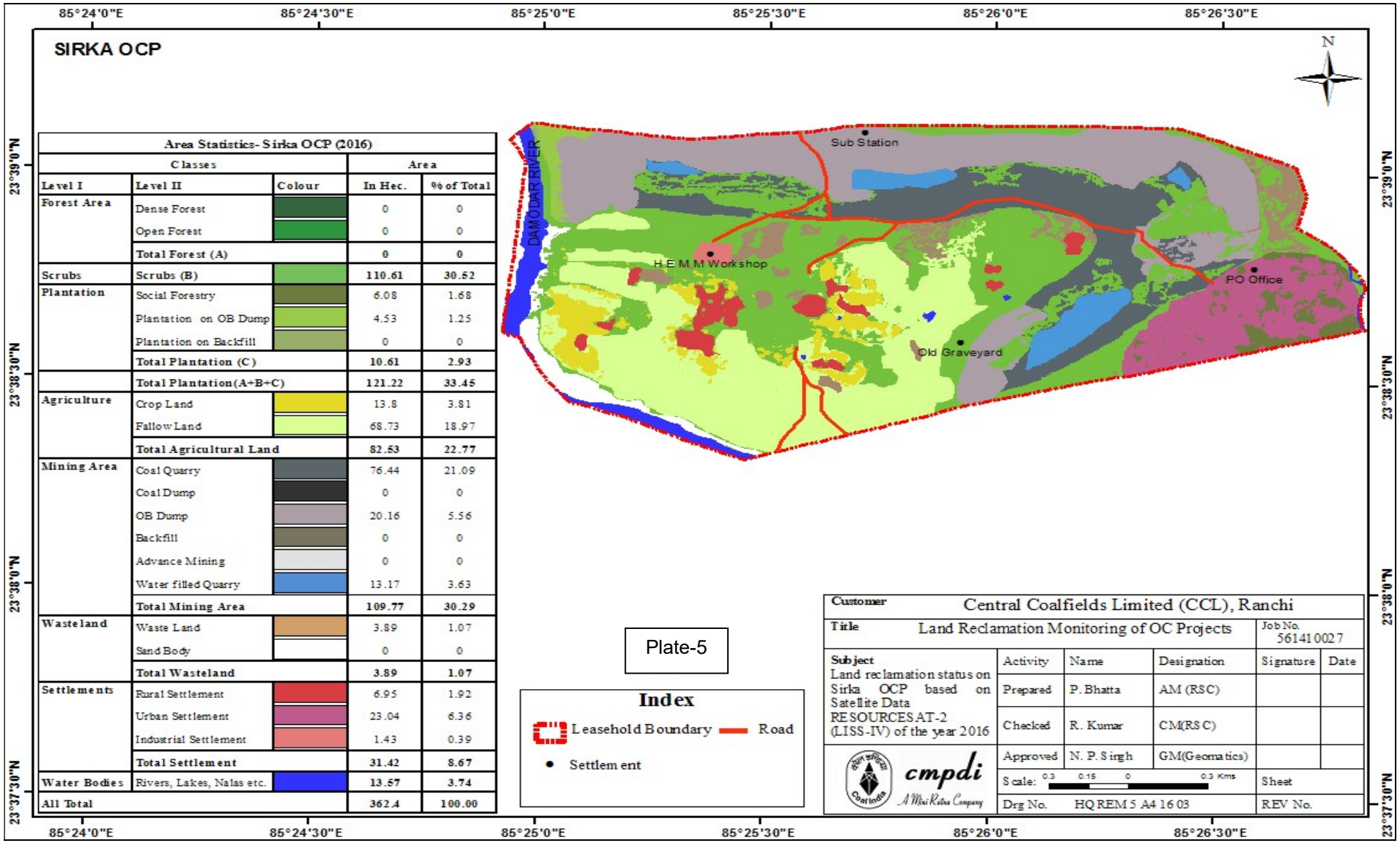
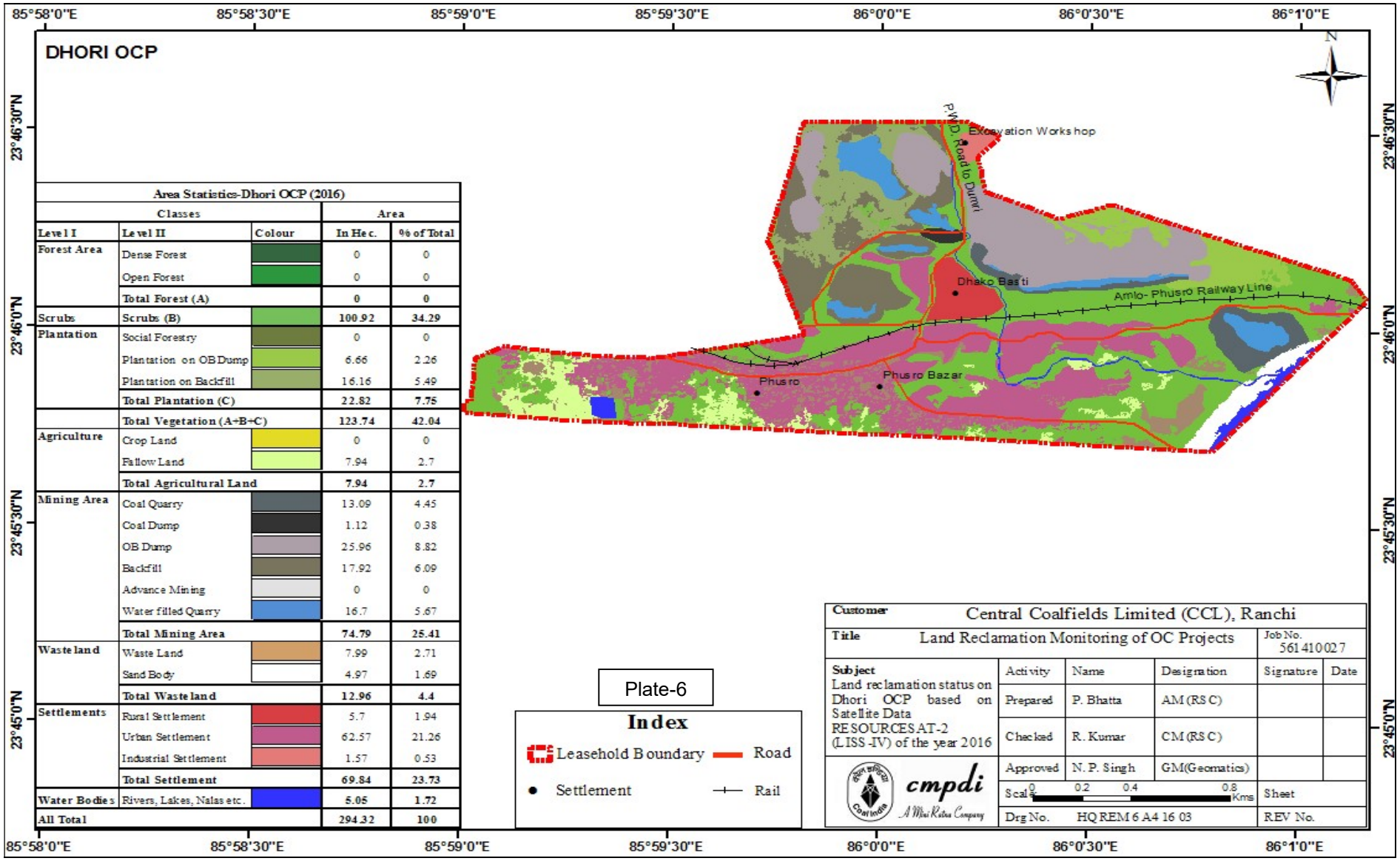


Area Statistics- Sirka OCP (2016)

Classes			Area	
Level I	Level II	Colour	In Hec.	% of Total
Forest Area	Dense Forest		0	0
	Open Forest		0	0
	Total Forest (A)		0	0
Scrubs	Scrubs (B)		110.61	30.52
Plantation	Social Forestry		6.08	1.68
	Plantation on OB Dump		4.53	1.25
	Plantation on Backfill		0	0
	Total Plantation (C)		10.61	2.93
	Total Plantation(A+B+C)		121.22	33.45
Agriculture	Crop Land		13.8	3.81
	Fallow Land		68.73	18.97
	Total Agricultural Land		82.53	22.77
Mining Area	Coal Quarry		76.44	21.09
	Coal Dump		0	0
	OB Dump		20.16	5.56
	Backfill		0	0
	Advance Mining		0	0
	Water filled Quarry		13.17	3.63
	Total Mining Area		109.77	30.29
Wasteland	Waste Land		3.89	1.07
	Sand Body		0	0
	Total Wasteland		3.89	1.07
Settlements	Rural Settlement		6.95	1.92
	Urban Settlement		23.04	6.36
	Industrial Settlement		1.43	0.39
	Total Settlement		31.42	8.67
Water Bodies	Rivers, Lakes, Nalas etc.		13.57	3.74
All Total			362.4	100.00



Area Statistics-Dhori OCP (2016)				
Classes			Area	
Level I	Level II	Colour	In Hec.	% of Total
Forest Area	Dense Forest		0	0
	Open Forest		0	0
	Total Forest (A)		**0**	**0**
Scrubs	**Scrubs (B)**		**100.92**	**34.29**
Plantation	Social Forestry		0	0
	Plantation on OB Dump		6.66	2.26
	Plantation on Backfill		16.16	5.49
	Total Plantation (C)		**22.82**	**7.75**
	Total Vegetation (A+B+C)		**123.74**	**42.04**
Agriculture	Crop Land		0	0
	Fallow Land		7.94	2.7
	Total Agricultural Land		**7.94**	**2.7**
Mining Area	Coal Quarry		13.09	4.45
	Coal Dump		1.12	0.38
	OB Dump		25.96	8.82
	Backfill		17.92	6.09
	Advance Mining		0	0
	Water filled Quarry		16.7	5.67
	Total Mining Area		**74.79**	**25.41**
Wasteland	Waste Land		7.99	2.71
	Sand Body		4.97	1.69
	Total Wasteland		**12.96**	**4.4**
Settlements	Rural Settlement		5.7	1.94
	Urban Settlement		62.57	21.26
	Industrial Settlement		1.57	0.53
	Total Settlement		**69.84**	**23.73**
Water Bodies	Rivers, Lakes, Nalas etc.		**5.05**	**1.72**
All Total			**294.32**	**100**

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Leasehold Boundary — Road

Settlement — Rail

Customer	Central Coalfields Limited (CCL), Ranchi				
Title	Land Reclamation Monitoring of OC Projects			Job No. 561410027	
Subject: Land reclamation status on Dhori OCP based on Satellite Data RESOURCESAT-2 (LISS-IV) of the year 2016	Activity	Name	Designation	Signature	Date
	Prepared	P. Bhatta	AM (RSC)		
	Checked	R. Kumar	CM (RSC)		
cmpdi A Mini Ratna Company	Approved	N. P. Singh	GM(Geomatics)		
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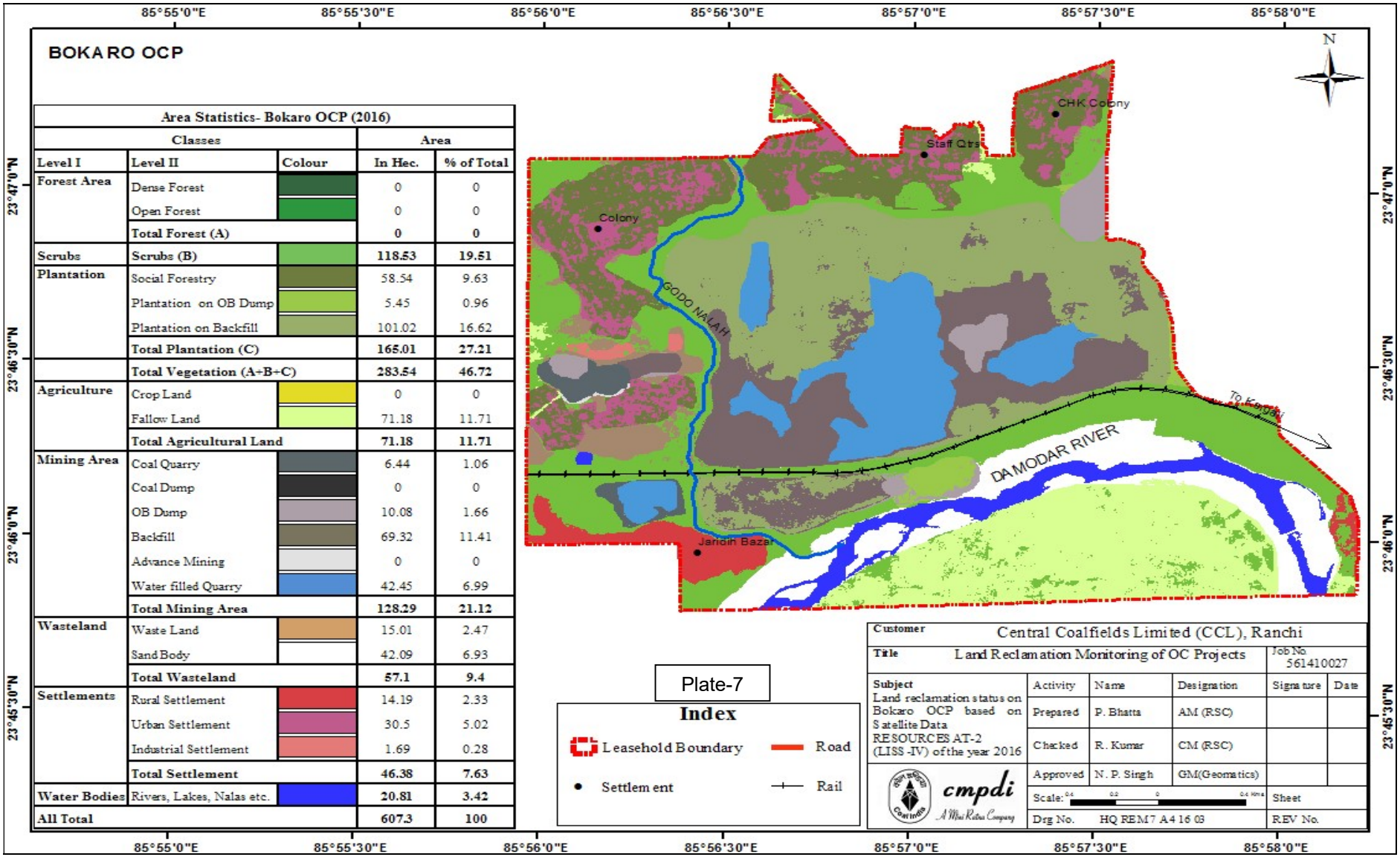
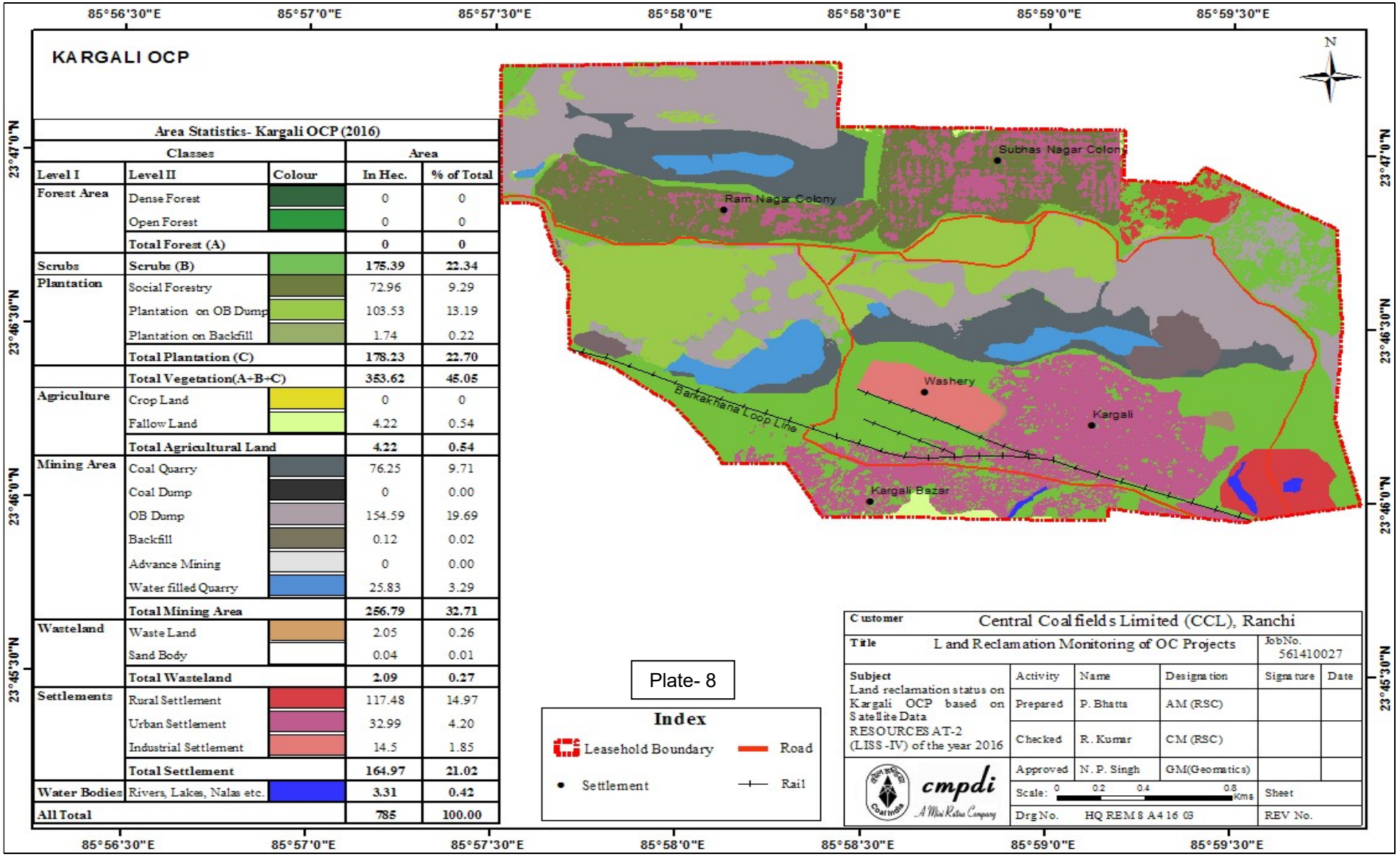
	Drg No. HQ REM 6 A4 16 03			REV No.	



Area Statistics- Bokaro OCP (2016)

Classes			Area	
Level I	Level II	Colour	In Hec.	% of Total
Forest Area	Dense Forest		0	0
	Open Forest		0	0
	Total Forest (A)		**0**	**0**
Scrubs	**Scrubs (B)**		**118.53**	**19.51**
Plantation	Social Forestry		58.54	9.63
	Plantation on OB Dump		5.45	0.96
	Plantation on Backfill		101.02	16.62
	Total Plantation (C)		**165.01**	**27.21**
	Total Vegetation (A+B+C)		**283.54**	**46.72**
Agriculture	Crop Land		0	0
	Fallow Land		71.18	11.71
	Total Agricultural Land		**71.18**	**11.71**
Mining Area	Coal Quarry		6.44	1.06
	Coal Dump		0	0
	OB Dump		10.08	1.66
	Backfill		69.32	11.41
	Advance Mining		0	0
	Water filled Quarry		42.45	6.99
	Total Mining Area		**128.29**	**21.12**
Wasteland	Waste Land		15.01	2.47
	Sand Body		42.09	6.93
	Total Wasteland		**57.1**	**9.4**
Settlements	Rural Settlement		14.19	2.33
	Urban Settlement		30.5	5.02
	Industrial Settlement		1.69	0.28
	Total Settlement		**46.38**	**7.63**
Water Bodies	Rivers, Lakes, Nalas etc.		**20.81**	**3.42**
All Total			**607.3**	**100**



Area Statistics- Kargali OCP (2016)

Classes			Area	
Level I	Level II	Colour	In Hec.	% of Total
Forest Area	Dense Forest		0	0
	Open Forest		0	0
	Total Forest (A)		**0**	**0**
Scrubs	**Scrubs (B)**		**175.39**	**22.34**
Plantation	Social Forestry		72.96	9.29
	Plantation on OB Dump		103.53	13.19
	Plantation on Backfill		1.74	0.22
	Total Plantation (C)		**178.23**	**22.70**
	Total Vegetation(A+B+C)		**353.62**	**45.05**
Agriculture	Crop Land		0	0
	Fallow Land		4.22	0.54
	Total Agricultural Land		**4.22**	**0.54**
Mining Area	Coal Quarry		76.25	9.71
	Coal Dump		0	0.00
	OB Dump		154.59	19.69
	Backfill		0.12	0.02
	Advance Mining		0	0.00
	Water filled Quarry		25.83	3.29
	Total Mining Area		**256.79**	**32.71**
Wasteland	Waste Land		2.05	0.26
	Sand Body		0.04	0.01
	Total Wasteland		**2.09**	**0.27**
Settlements	Rural Settlement		117.48	14.97
	Urban Settlement		32.99	4.20
	Industrial Settlement		14.5	1.85
	Total Settlement		**164.97**	**21.02**
Water Bodies	Rivers, Lakes, Nalas etc.		**3.31**	**0.42**
All Total			**785**	**100.00**

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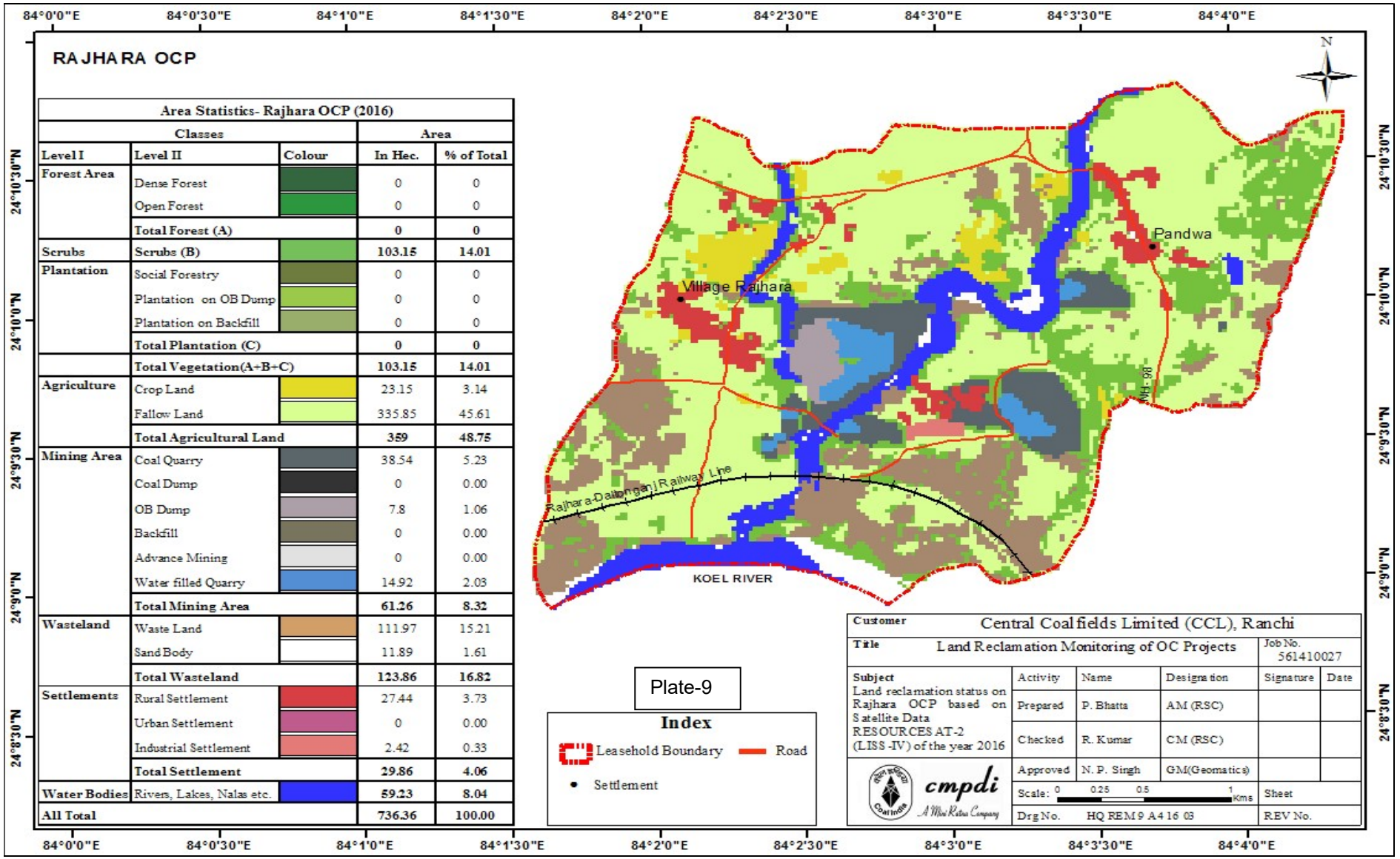
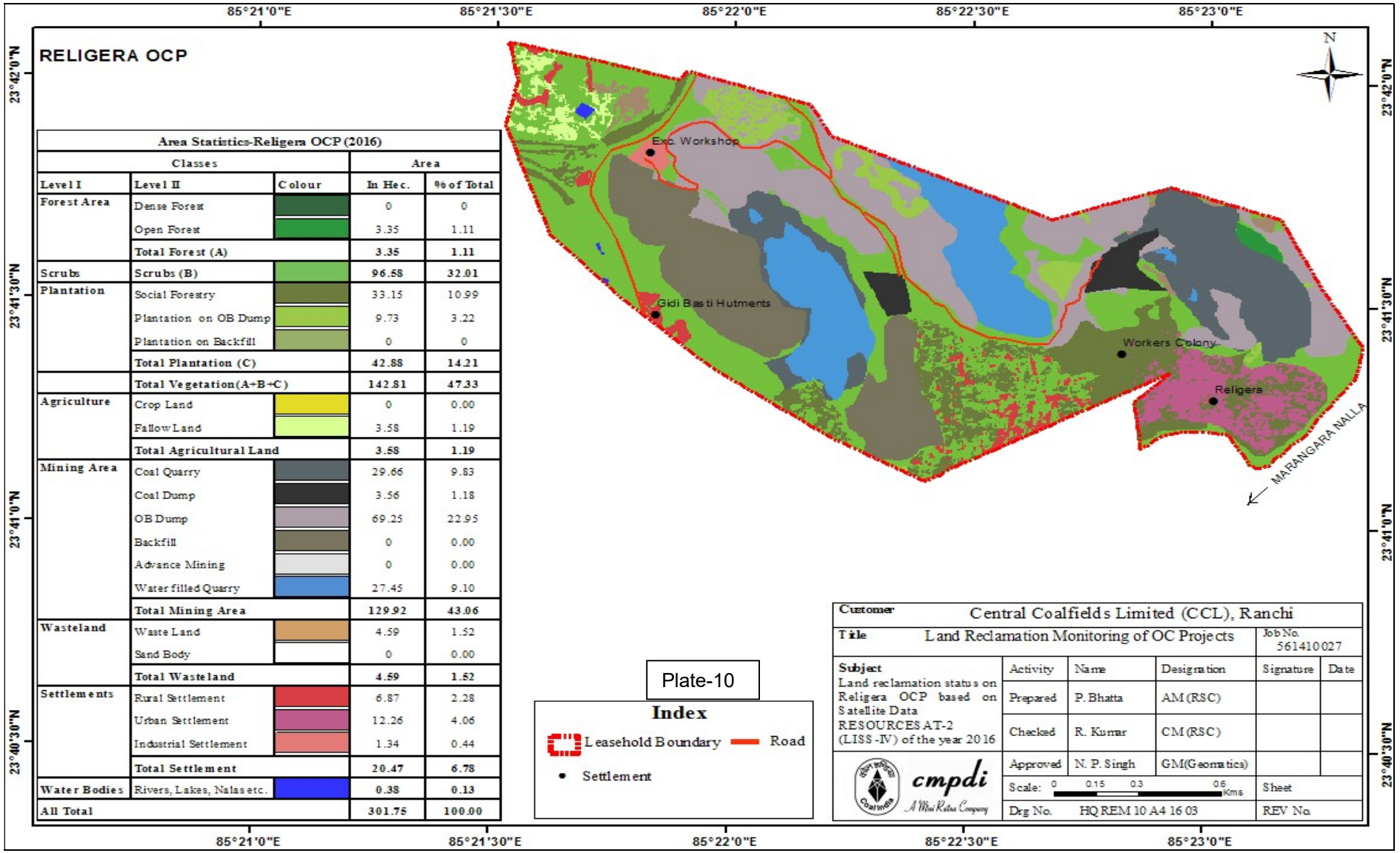
- Leasehold Boundary
- Road
- Settlement
- Rail

Customer	Central Coalfields Limited (CCL), Ranchi				
Title	Land Reclamation Monitoring of OC Projects			Job No. 561410027	
Subject: Land reclamation status on Kargali OCP based on Satellite Data RESOURCESAT-2 (LISS -IV) of the year 2016	Activity	Name	Designation	Signature	Date
	Prepared	P. Bhatta	AM (RSC)		
	Checked	R. Kumar	CM (RSC)		
	Approved	N. P. Singh	GM(Geomatics)		
cmpdi A Mini Ratna Company	Scale: 0 0.2 0.4 0.8 Kms			Sheet	
	Drg No. HQ REM 8 A4 16 03			REV No.	



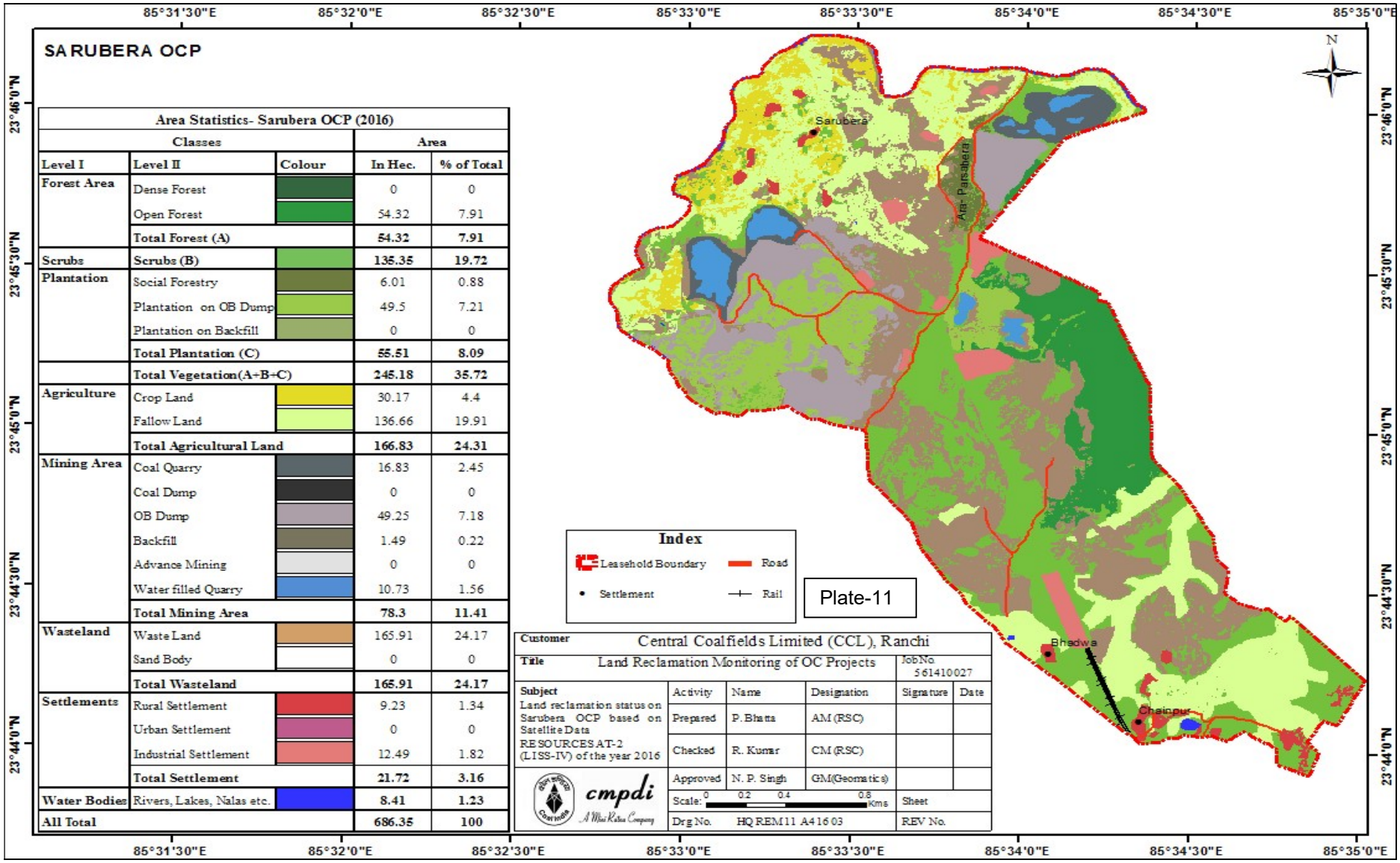
Area Statistics- Rajhara OCP (2016)

Classes			Area	
Level I	**Level II**	**Colour**	**In Hec.**	**% of Total**
Forest Area	Dense Forest		0	0
	Open Forest		0	0
	Total Forest (A)		**0**	**0**
Scrubs	**Scrubs (B)**		**103.15**	**14.01**
Plantation	Social Forestry		0	0
	Plantation on OB Dump		0	0
	Plantation on Backfill		0	0
	Total Plantation (C)		**0**	**0**
	Total Vegetation(A+B+C)		**103.15**	**14.01**
Agriculture	Crop Land		23.15	3.14
	Fallow Land		335.85	45.61
	Total Agricultural Land		**359**	**48.75**
Mining Area	Coal Quarry		38.54	5.23
	Coal Dump		0	0.00
	OB Dump		7.8	1.06
	Backfill		0	0.00
	Advance Mining		0	0.00
	Water filled Quarry		14.92	2.03
	Total Mining Area		**61.26**	**8.32**
Wasteland	Waste Land		111.97	15.21
	Sand Body		11.89	1.61
	Total Wasteland		**123.86**	**16.82**
Settlements	Rural Settlement		27.44	3.73
	Urban Settlement		0	0.00
	Industrial Settlement		2.42	0.33
	Total Settlement		**29.86**	**4.06**
Water Bodies	Rivers, Lakes, Nalas etc.		**59.23**	**8.04**
All Total			**736.36**	**100.00**



Area Statistics-Religera OCP (2016)

Classes			Area	
Level I	Level II	Colour	In Hec.	% of Total
Forest Area	Dense Forest		0	0
	Open Forest		3.35	1.11
	Total Forest (A)		**3.35**	**1.11**
Scrubs	**Scrubs (B)**		**96.58**	**32.01**
Plantation	Social Forestry		33.15	10.99
	Plantation on OB Dump		9.73	3.22
	Plantation on Backfill		0	0
	Total Plantation (C)		**42.88**	**14.21**
	Total Vegetation(A+B+C)		**142.81**	**47.33**
Agriculture	Crop Land		0	0.00
	Fallow Land		3.58	1.19
	Total Agricultural Land		**3.58**	**1.19**
Mining Area	Coal Quarry		29.66	9.83
	Coal Dump		3.56	1.18
	OB Dump		69.25	22.95
	Backfill		0	0.00
	Advance Mining		0	0.00
	Water filled Quarry		27.45	9.10
	Total Mining Area		**129.92**	**43.06**
Wasteland	Waste Land		4.59	1.52
	Sand Body		0	0.00
	Total Wasteland		**4.59**	**1.52**
Settlements	Rural Settlement		6.87	2.28
	Urban Settlement		12.26	4.06
	Industrial Settlement		1.34	0.44
	Total Settlement		**20.47**	**6.78**
Water Bodies	Rivers, Lakes, Nalas etc.		**0.38**	**0.13**
All Total			**301.75**	**100.00**



Area Statistics- Sarubera OCP (2016)				
Classes			Area	
Level I	Level II	Colour	In Hec.	% of Total
Forest Area	Dense Forest		0	0
	Open Forest		54.32	7.91
	Total Forest (A)		**54.32**	**7.91**
Scrubs	**Scrubs (B)**		**135.35**	**19.72**
Plantation	Social Forestry		6.01	0.88
	Plantation on OB Dump		49.5	7.21
	Plantation on Backfill		0	0
	Total Plantation (C)		**55.51**	**8.09**
	Total Vegetation(A+B+C)		**245.18**	**35.72**
Agriculture	Crop Land		30.17	4.4
	Fallow Land		136.66	19.91
	Total Agricultural Land		**166.83**	**24.31**
Mining Area	Coal Quarry		16.83	2.45
	Coal Dump		0	0
	OB Dump		49.25	7.18
	Backfill		1.49	0.22
	Advance Mining		0	0
	Water filled Quarry		10.73	1.56
	Total Mining Area		**78.3**	**11.41**
Wasteland	Waste Land		165.91	24.17
	Sand Body		0	0
	Total Wasteland		**165.91**	**24.17**
Settlements	Rural Settlement		9.23	1.34
	Urban Settlement		0	0
	Industrial Settlement		12.49	1.82
	Total Settlement		**21.72**	**3.16**
Water Bodies	Rivers, Lakes, Nalas etc.		**8.41**	**1.23**
All Total			**686.35**	**100**

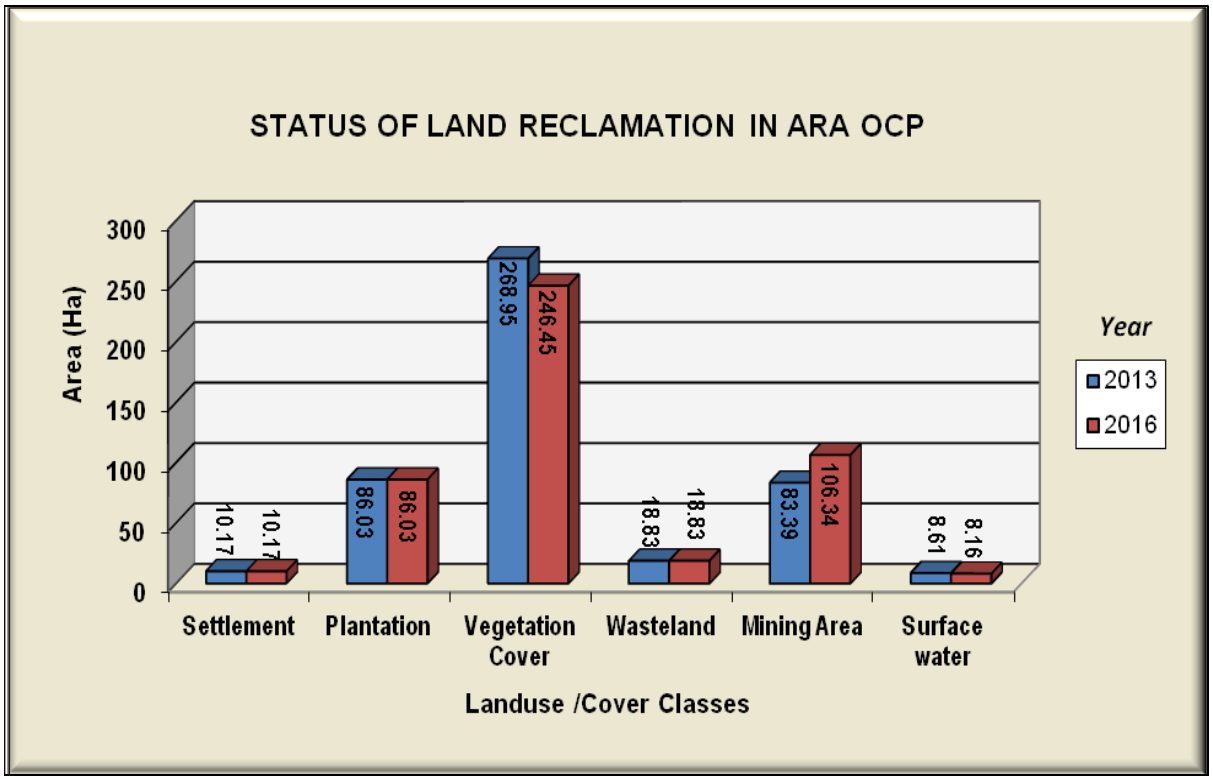


Figure – 3

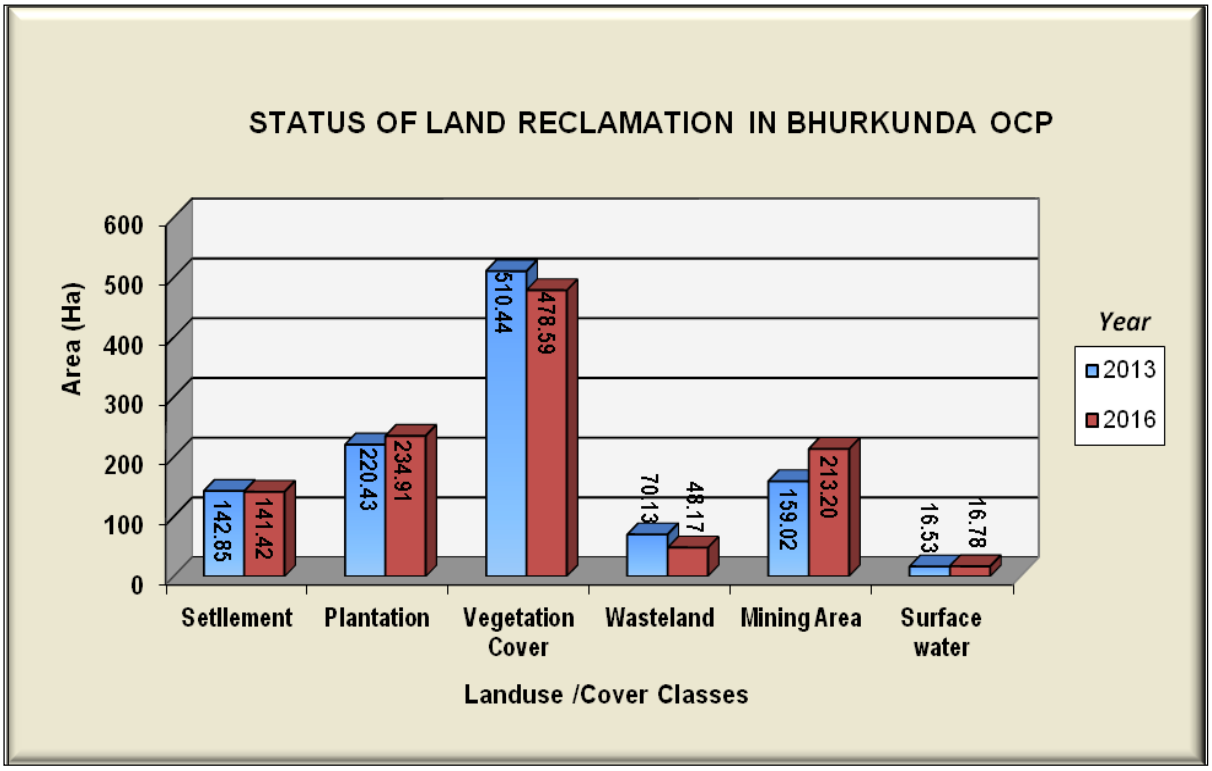


Figure – 4

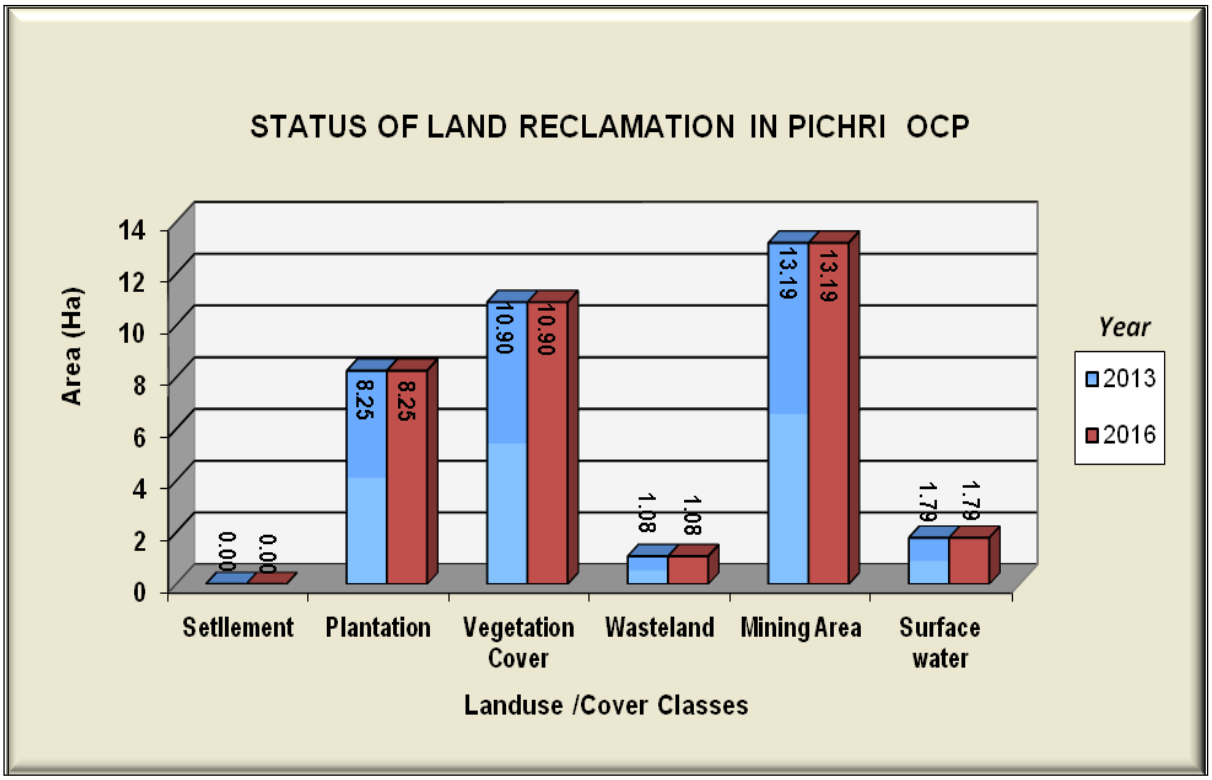


Figure – 5

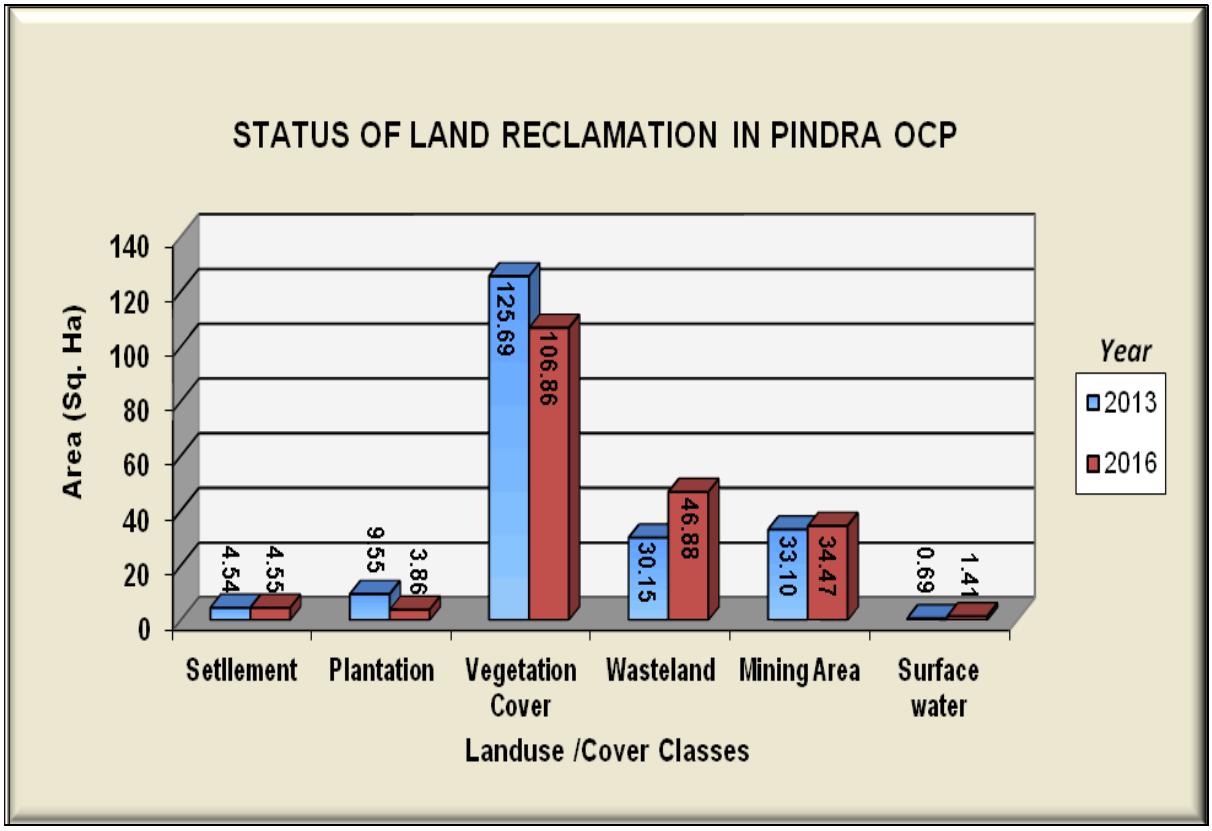


Figure – 6

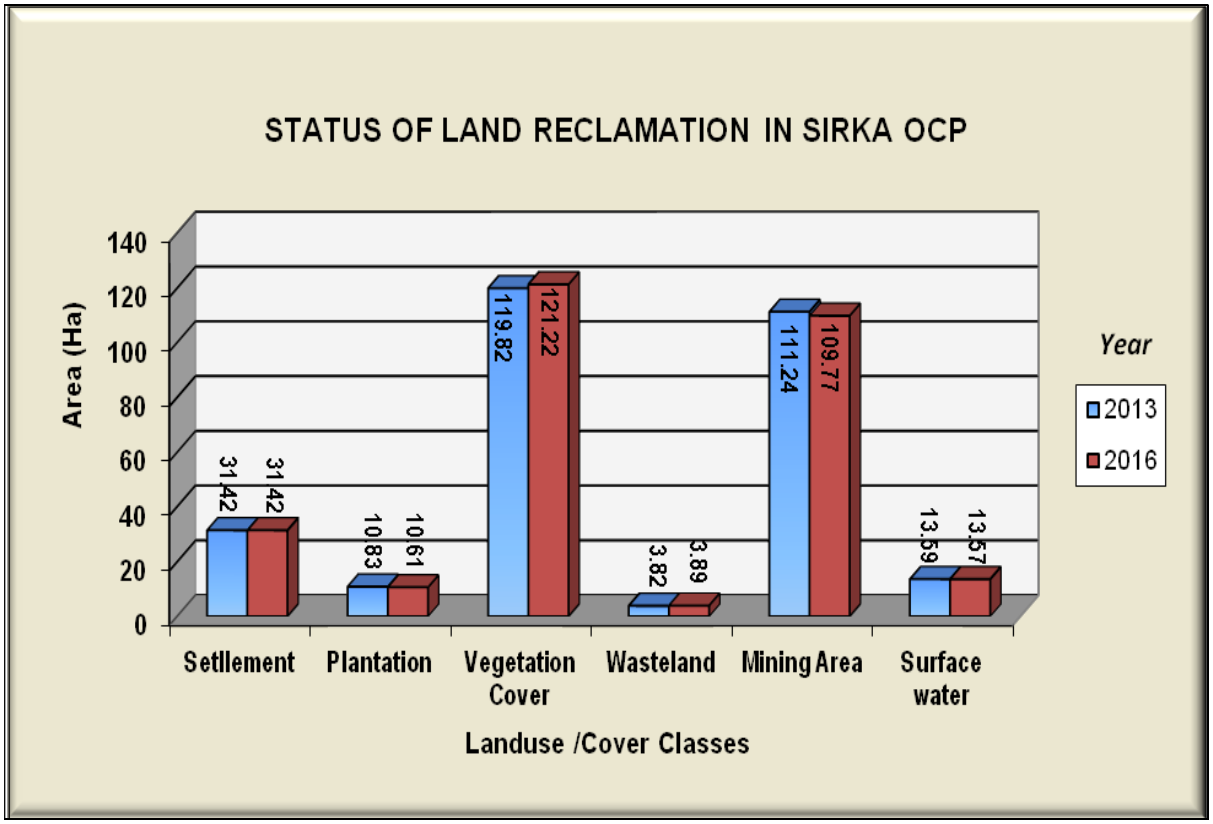


Figure – 7

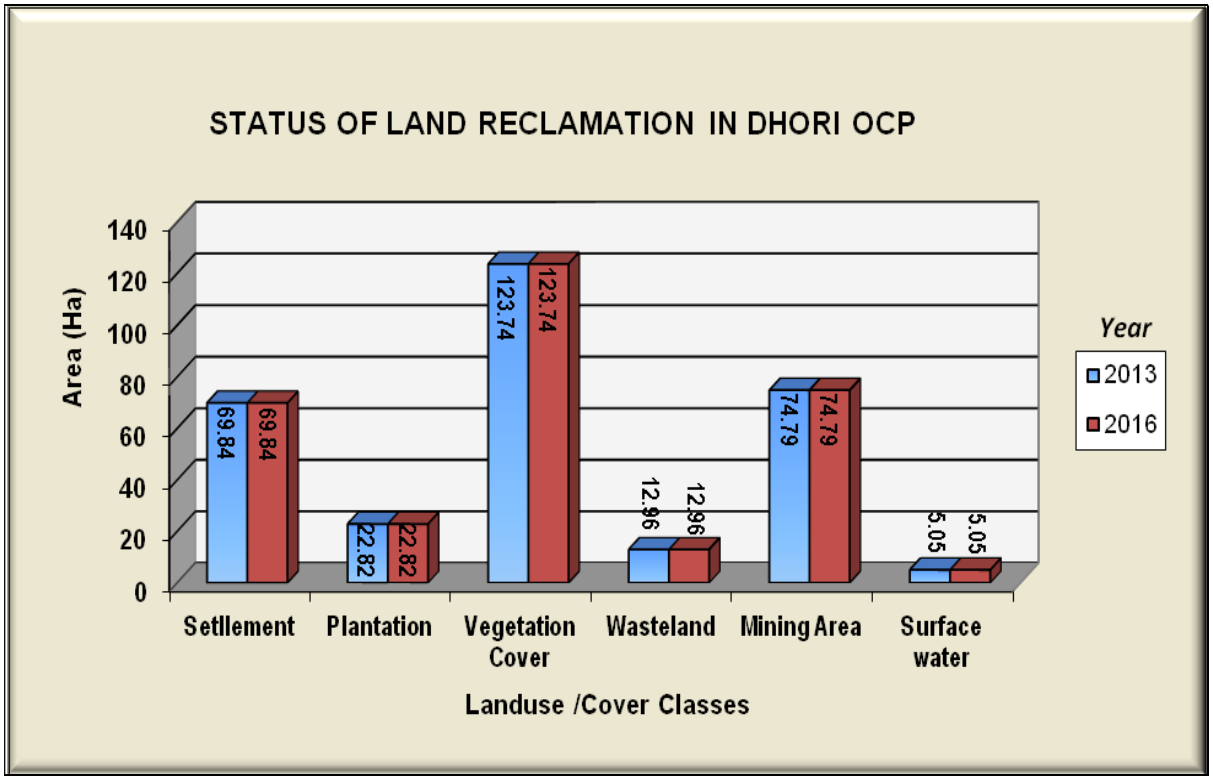


Figure – 8

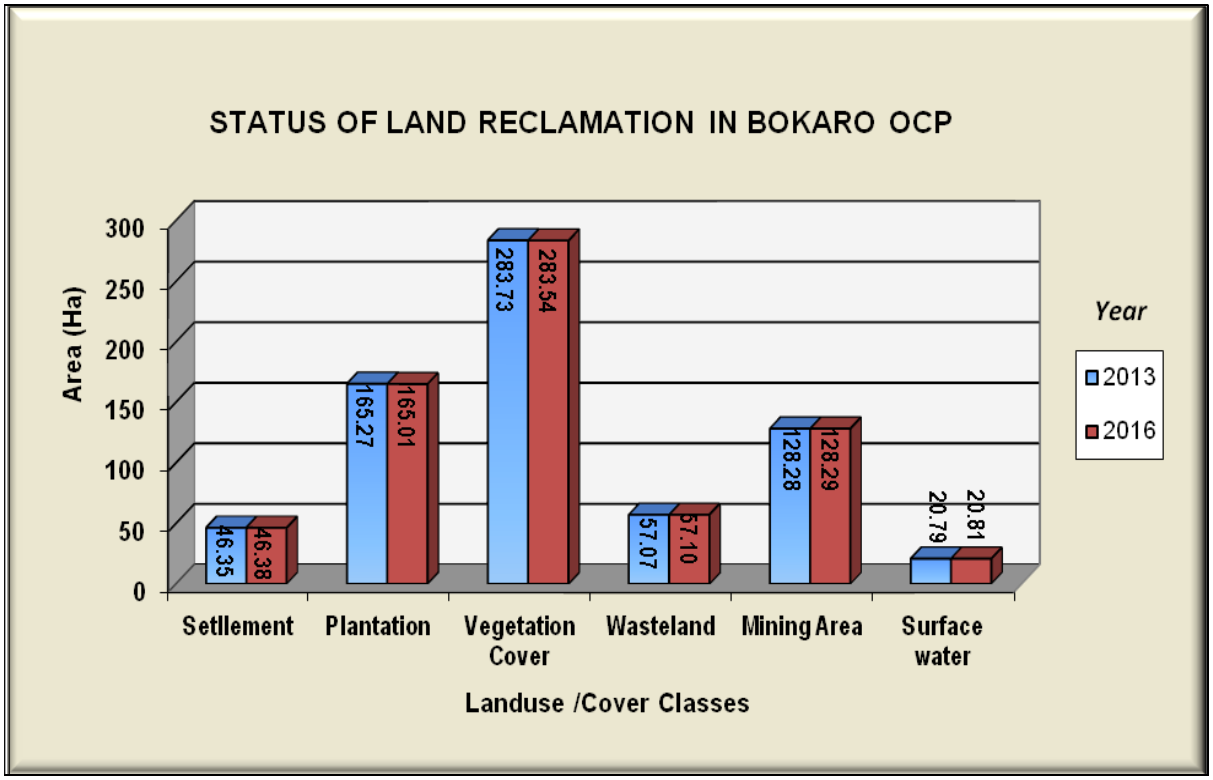


Figure – 9

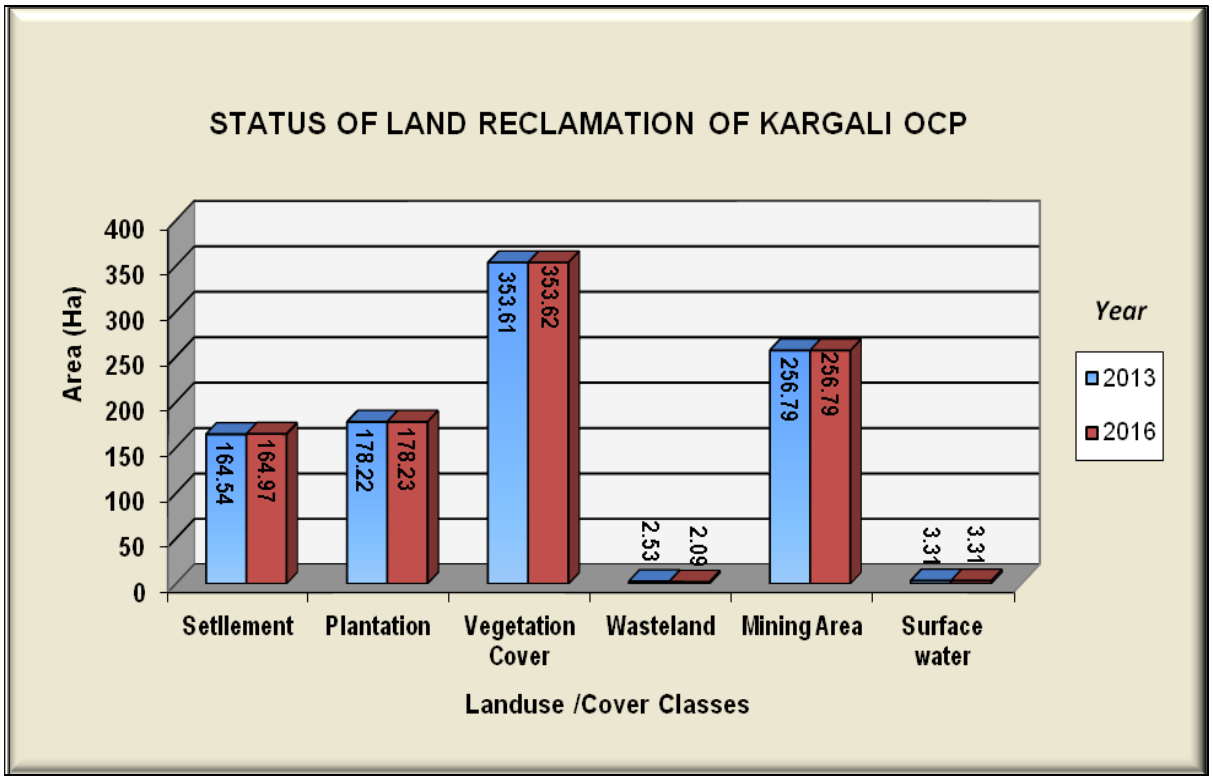


Figure – 10

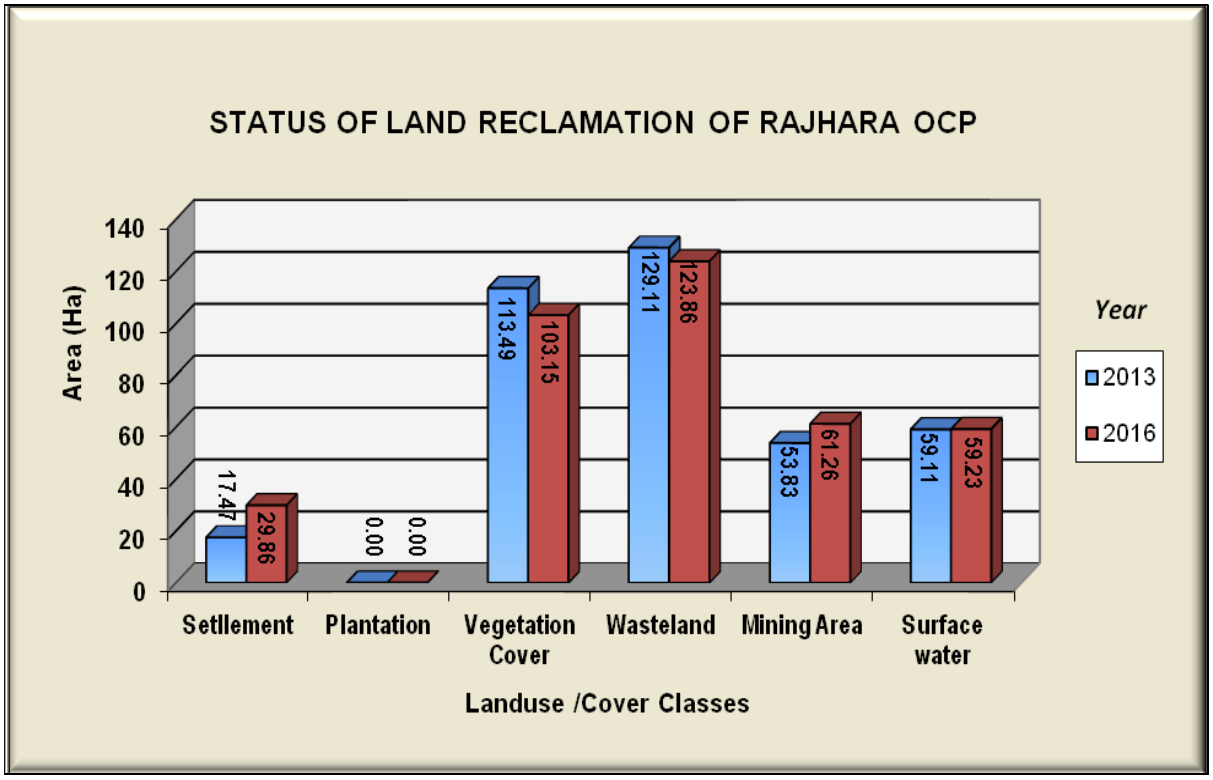


Figure – 11

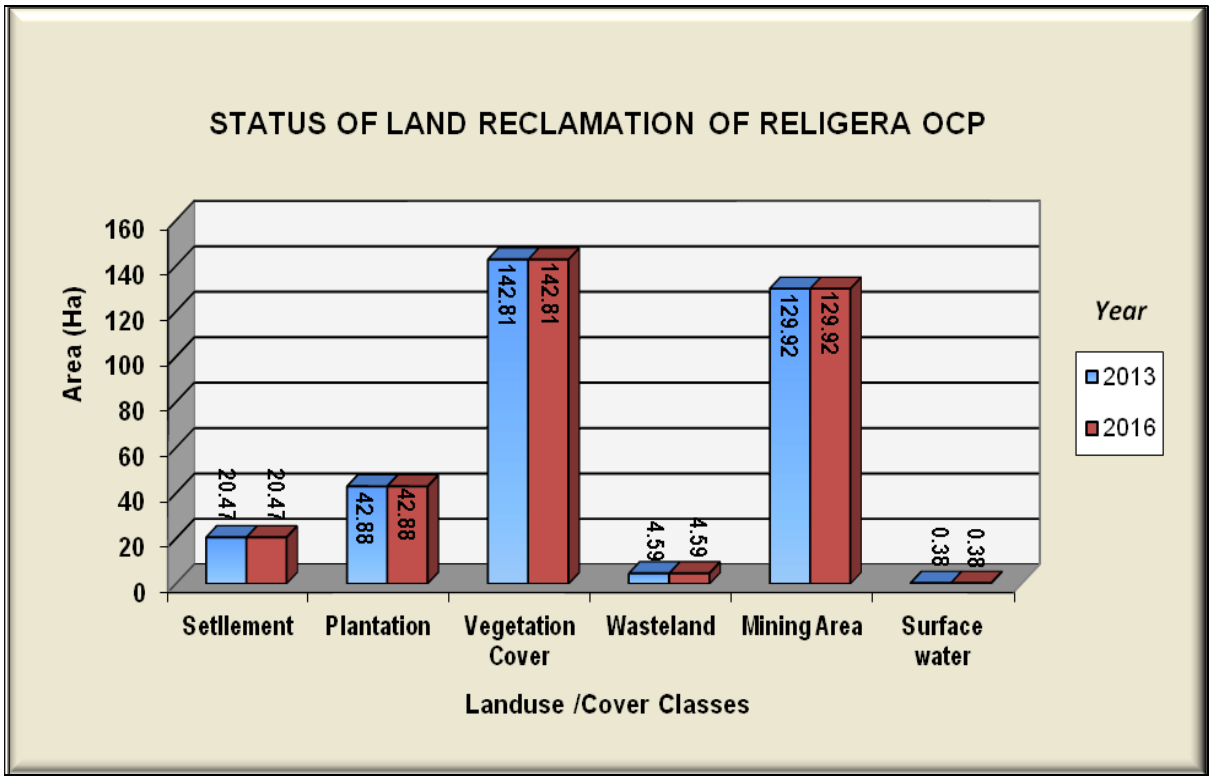


Figure – 12

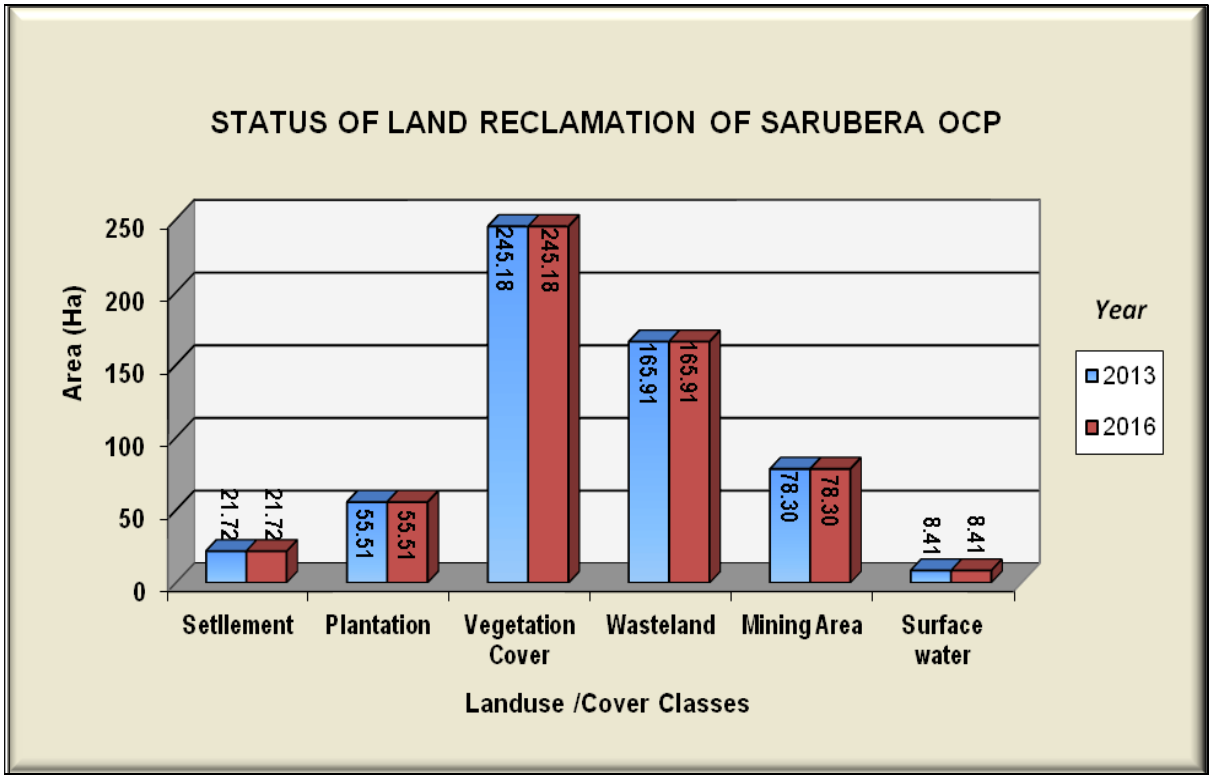

STATUS OF LAND RECLAMATION OF SARUBERA OCP
Area (Ha)
250
200
150
100
50
0
21.72
21.72
55.51
55.51
245.18
245.18
165.91
165.91
78.30
78.30
8.41
8.41
Setllement
Plantation
Vegetation Cover
Wasteland
Mining Area
Surface water
Landuse /Cover Classes
Year
2013
2016

Figure – 13

Photo 1: Plantation on OB Dump (Ara OCP)

Photo 2: Plantation on OB Dump (Bhurkunda OCP)

Photo 3: Plantation on River Embankment (Pichri OCP)

Photo 4: Plantation on OB Dump (Sarubera OCP)

Photo 5: Plantation on OB Dump (Kargali OCP)

Photo 6: Plantation on Backfill (Bokaro OCP)

Central Mine Planning & Design Institute Ltd.
(A Subsidiary of Coal India Ltd.)
Gondwana Place, Kanke Road, Ranchi - 834 008,India
Phone : (+91-0651) 2230001, 2230002, 2230483, Fax (91-0651) 2231851, 2231447
Email : cmpdi2@hub.nic.in, cmpdihq@cmpdi.co.in
website : cmpdi.co.in