

**Land Restoration / Reclamation Monitoring of less than 5 million
Cu. M. (Coal+OB) Capacity Opencast Coal Mines of Western
Coalfields Limited based on Satellite Data for the Year 2018**



**Submitted to
WESTERN COALFIELDS LIMITED**



cmpdi
A Mini Ratna Company

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March-2019



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**Remote Sensing Cell
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Executive Summary

- 1.0 Project** Land restoration / reclamation monitoring of 12 opencast coal mines of Western Coalfields Ltd. (WCL) producing less than 5 million cu.m. (Coal+OB) per year based on satellite data, regularly basis at an interval of three years.
- 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 in the leasehold area of the project. This will help in assessing the progressive status of mined 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 6035.43 Hectare of the 12 projects Viz. Inder UG to OC, Kamptee Deep, Navin Kunada, Shivpuri, Pauni Expn OC, HLOCM, Ghorawari, Dhorwasa, Damua, Barkuhi, Makardhokra-I, Ambara OC mine considered for monitoring during year-2018-19; total excavated area is 1050.29 (17.40%) of which 86.81 Ha area (8.27%) has been planted on backfill, 476.26 Ha area (45.35%) is under backfilling and balance 487.22 Ha area (46.39%) is under active mining. It is evident from the analysis that 563.07 Ha (53.61%) area of the above OC projects have already been reclaimed (biologically and technically) and balance 487.22 Ha (46.39%) area is under active mining. Project wise details are given in Table-1 & Fig-1.
 - On comparing the status of land reclamation for the year 2018 with respect to the year 2015 in different projects, it is evident from the analysis that area under land reclamation has increased from 491.78 (Yr. 2015) to 563.07 Ha (Yr. 2018). Out of 12 projects of WCL, maximum land reclamation has been carried out in Damua OC project (76.04%) followed by Ambara (73.24%), HLOCM (66.39%) Navin Kunada (64.82%), Ghorawari (63.98%), Dhorwasa (63.53%) , Pauni Expn (53.92%), Kamptee Deep OCP

(48.91% Barkuhi (42.55%) ,Inder Ug to OC (41.53%) , and Shivpuri (33.69%).

- Area under biological reclamation (plantation) has increased from 42.53 Ha (Yr. 2015) to 86.81 (Yr. 2018) whereas area of technical reclamation (area under backfilling) has increased from 449.25Ha (Yr. 2015) to 476.26 Ha (Yr.2018) in WCL.This increase of 44.28 Ha in area of plantation on backfill and 27.01 Ha area under backfilling is the result of the sincere efforts of the Western Coalfields Ltd taken up towards environmental protection.
- It is evident from table-1 that in Makardhokra -I open cast mine, backfilling has not been started till date.
- It is important to note that a new Table format has been designed by Coal India Ltd with new parameters for Biological & Technical Reclamation .For comparative purpose the basic dataset for the year 2015-16 has been fed into new format so that it can be compared with results of 2017-18 as per new format.
- The leasehold Boundary of Ghorawari OCP has been updated this year from 1175.11 Hectare to 1296.01 Hectare. Total area under plantation (Green Cover Generated) in leasehold area of Ghorawari OCP has increased from 34.12 Hectare (Yr2015) to 50.95 Hectare (2018) .This increase of 16.83 hectare in total area under plantation is due to plantation on backfill ,plantation under Social Forestry and plantation on OB.

Table:1
Project wise Land Reclamation Status in Opencast Project of WCL
(Producing less than 5 million Cu.M.of Coal+OB) based on Satellite Data of the year 2018

(Area in Ha)

Sl.No	Project	Total Leasehold Area		Technical Reclamation		Plantation						Area under Active Mining	Total Excavated Area	Total Area under Plantation (% Green Cover Generated in Leasehold)		Total Area under Reclamation			
						Biological Reclamation		Other Plantations											
						Plantation on Excavated / Backfilled Area		Plantation on External Over Burden Dumps		Social Forestry, Advance Plantation Etc.									
1	2	3		4		5		6		7		8		9 (=4+5+8)		10 (=5+6+7)		11 (=4+5)	
		2015	2018	2015	2018	2015	2018	2015	2018	2015	2018	2015	2018	2015	2018	2015	2018	2015	2018
1	Inder Ug to OC	617.84	617.84	57.29	57.29	0.00	0.00	27.64	29.79	37.60	37.96	80.78	80.66	138.07	137.95	65.24	67.75	57.29	57.29
				41.49%	41.53%	0.00%	0.00%					58.51%	58.47%			10.56%	10.97%	41.49%	41.53%
2	Kamptee Deep	462.63	471.44	48.92	51.23	2.95	8.11	61.09	61.39	28.48	37.88	69.47	61.99	121.34	121.33	92.52	107.38	51.87	59.34
				40.32%	42.22%	2.43%	6.68%					57.25%	51.09%			20.00%	22.78%	42.75%	48.91%
3	Navin Kunada	373.00	373.00	91.06	87.46	12.97	19.71	84.92	88.44	4.59	5.05	54.09	58.17	158.12	165.34	102.48	113.20	104.03	107.17
				57.59%	52.90%	8.20%	11.92%					34.21%	35.18%			27.47%	30.35%	65.79%	64.82%
4	Shivpuri	336.29	336.29	12.39	17.98	0.00	6.06	19.25	20.41	16.53	16.53	40.51	47.31	52.90	71.35	35.78	43.00	12.39	24.04
				23.42%	25.20%	0.00%	8.49%					76.58%	66.31%			10.64%	12.79%	23.42%	33.69%
5	Pauni Expn OCP	255.00	255.00	26.54	47.37	2.24	3.83	32.36	36.64	10.00	9.94	37.43	43.76	66.21	94.96	44.60	50.41	28.78	51.20
				40.08%	49.88%	3.38%	4.03%					56.53%	46.08%			17.49%	19.77%	43.47%	53.92%
6	HLOCM	311.66	311.66	69.09	63.64	0.00	6.31	59.55	72.86	33.06	33.54	38.36	35.42	107.45	105.37	92.61	112.71	69.09	69.95
				64.30%	60.40%	0.00%	5.99%					35.70%	33.61%			29.72%	36.16%	64.30%	66.39%
7	Ghorawari	1175.11	1296.01	29.16	32.06	0.00	8.92	21.03	27.60	13.09	14.43	18.14	23.07	47.30	64.05	34.12	50.95	29.16	40.98
				61.65%	50.05%	0.00%	13.93%					38.35%	36.02%			2.90%	3.93%	61.65%	63.98%
8	Dhorwasa	229.56	232.91	57.08	51.07	4.88	11.85	35.69	39.69	10.76	11.47	37.64	36.12	99.60	99.04	51.33	63.01	61.96	62.92
				57.31%	51.57%	4.90%	11.96%					37.79%	36.47%			22.36%	27.05%	62.21%	63.53%
9	Damua	1080.92	1080.92	9.42	8.98	6.34	8.51	8.37	9.97	125.11	138.58	5.75	5.51	21.51	23.00	139.82	157.06	15.76	17.49
				43.79%	39.04%	29.47%	37.00%					26.73%	23.96%			12.94%	14.53%	73.27%	76.04%
10	Barkuhi	237.51	237.51	2.73	13.84	0.00	0.00	0.00	0.00	8.73	8.73	12.98	18.69	15.71	32.53	8.73	8.73	2.73	13.84
				17.38%	42.55%	0.00%	0.00%					82.62%	57.45%			3.68%	3.68%	17.38%	42.55%
11	Makardhokra-1	660.70	660.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.07	55.02	29.07	55.02	0.00	0.00	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			0.00%	0.00%	0.00%	0.00%
12	Ambara	775.52	162.15	45.57	45.34	13.15	13.51	0.00	0.00	58.47	10.55	15.29	21.50	74.01	80.35	71.62	24.06	58.72	58.85
				61.57%	56.43%	17.77%	16.81%					20.66%	26.76%			9.24%	14.84%	79.34%	73.24%
	TOTAL	6515.74	6035.43	449.25	476.26	42.53	86.81	349.90	386.79	346.42	324.66	439.51	487.22	931.29	1050.29	738.85	798.26	491.78	563.07
				48.24%	45.35%	4.57%	8.27%					47.19%	46.39%	14.29%	17.40%	11.34%	13.23%	52.81%	53.61%

(% is calculated with respect to Excavated Area as applicable)

Note : In reference of the above Table-1, different parameters are classified as follows

- 1 Area under Biological Reclamation includes area under plantation done on backfilled area only.
- 2 Area under Technical Reclamation includes areas under barren backfill only.
- 3 Area under Active Mining includes coal quarry, advance quarry & quarry filled with water etc.
- 4 Social forestry and plantation on external OB dump are not included in biological reclamation and are put under other plantation.
- 5 % claculated in respect to total excavated area except for "Total area under plantation" where % has been calculated in terms of leasehold area.

Project wise status of Land Reclamation in WCL for the Year 2018

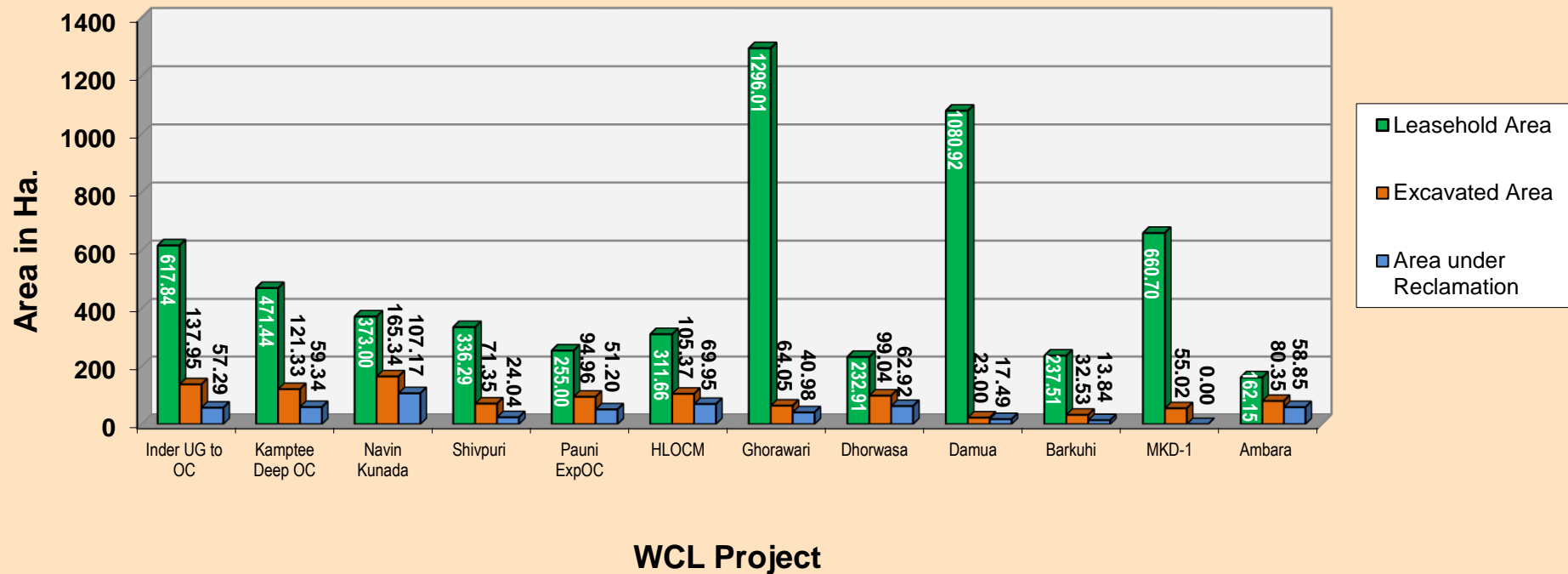


Figure: 1 Land Reclamation status in OC projects producing (less than 5 m.cm Coal+OB) of WCL in the year -2018

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/2011/4706 dated 12.10.12 to Central Mine Planning & Design Institute (CMPDI), Ranchi, for monitoring land reclamation status of all the opencast coal mines having production of less than 5 million m³ per annum (coal + OB taken together per annum) regularly on annual basis and less than 5 million m³ per annum (coal + OB taken together per annum) at interval of three years based on remote sensing satellite data, for sustainable development of mining. Further a revised work order vide letter no:CIL/WBP/Env/2017/DP/8477 dated 21.09.2017 from coal india Ltd for the period of 2017-18 to 201-22 for land reclamation monitoring of opencast projects and 19 major coalfields. According to this work order ,all mines in CIL with output capacity of 5 million cu.m (coal+OB) shall be monitored every year and all mines below this capacity shall be monitored at an interval of three year. 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 2018 carried out for all the OC projects producing less than 5 mcm (Coal+OB) for Western Coalfields Ltd.

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 figure-2. Following steps are involved in land reclamation /restoration monitoring:

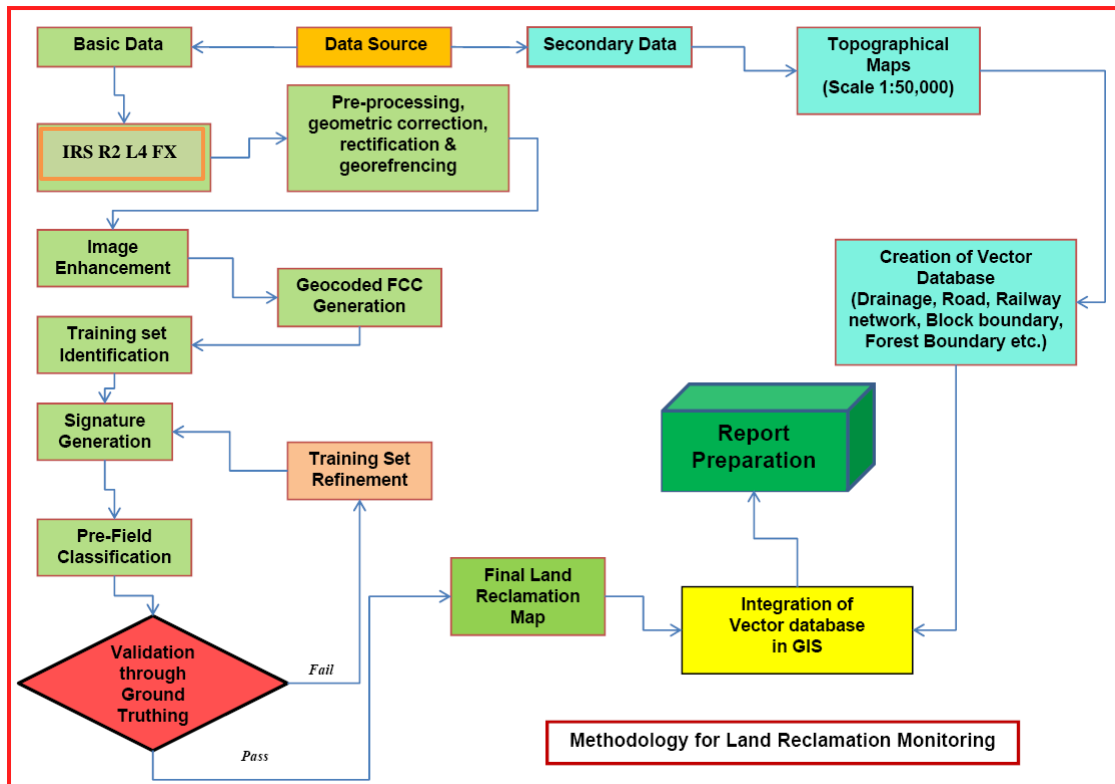


Figure :2 Methodology for Land Reclamation Monitoring

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 version 2014 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 Sol 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 2014 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. 2014 software.

- **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-of dates.

4.0 Land Reclamation Status in Western Coalfields Ltd.

4.1 Following Twelve opencast projects producing less than 5 million cubic m. (Coal + OB together) of Western Coalfields Ltd. have been taken up for land reclamation monitoring during the year 2018-19:

- Inder UG to OC
- Kamptee Deep OC
- Navin Kunada
- Shivpuri
- Pauni Expn
- HLOCM
- Ghorawari
- Dhorwasa
- Damua
- Barkuhi
- Makardhokra-I
- Ambara

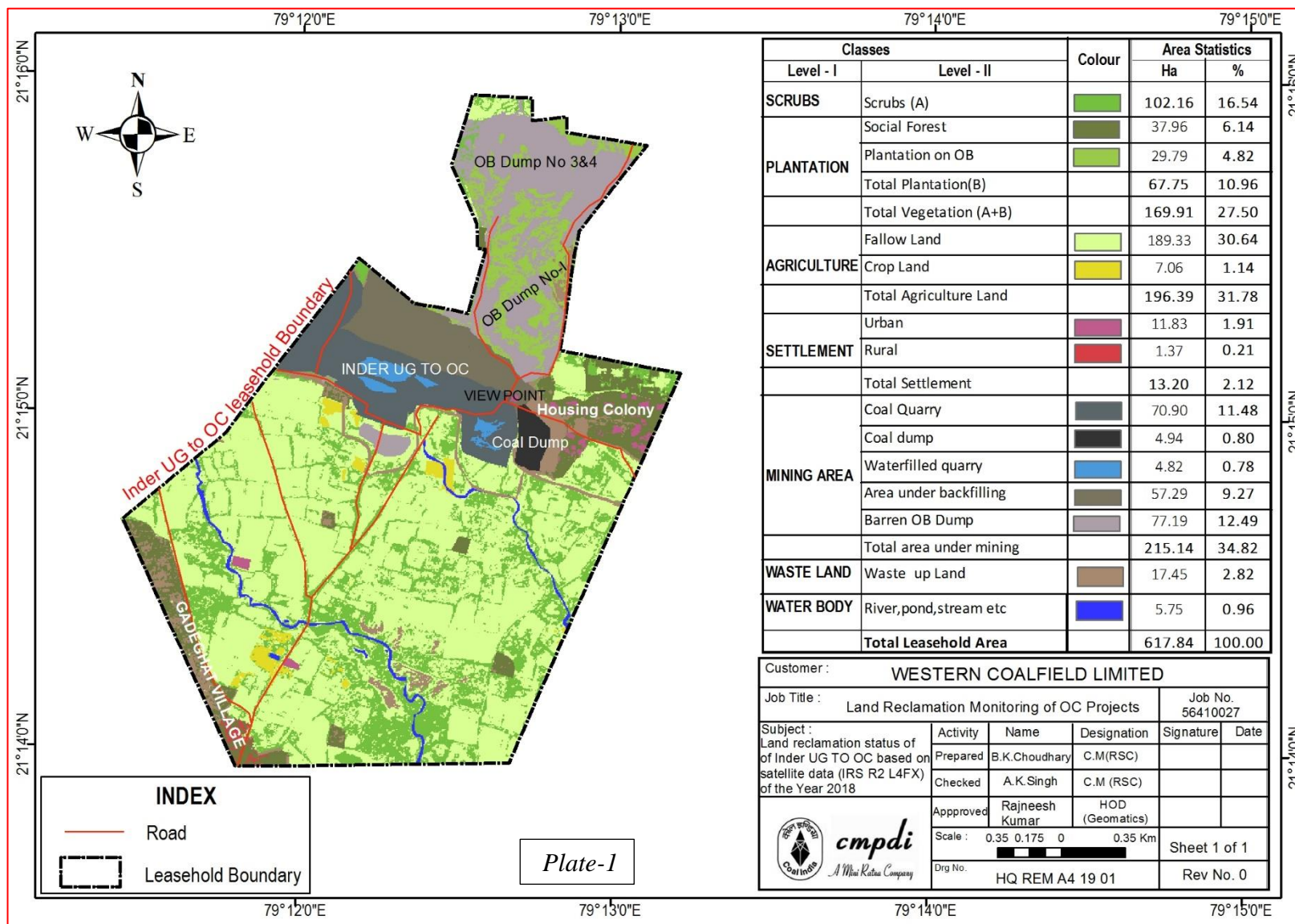
4.2 Area statistics of different land use class present in the mine leasehold of the above projects for the year 2018 are shown in the Table - 2. Land use maps derived from satellite data are shown in Plate 1– 12. Land reclamation status of the above mentioned 12 opencast projects were also prepared for the year 2015 and 2018. Year wise changes in the different land use classes based on satellite data are depicted in Bar Charts in Fig. 3 – 14.

4.3 Study reveals that 563.07 Hectare (53.61%) mining area has already under reclamation by WCL out of which 86.81 Ha (8.27%) area has been revegetated and 476.26 Ha (45.35%) area is under Backfilling. There is an increase of 71.29 Ha area under reclamation in WCL with respect to the year 2015. Out of which 44.28 Ha increase in biological reclamation (plantation) and 27.01 Ha area increase in the technical reclamation (backfilling).

- 4.4** Study indicates that overall all the projects of WCL considered for this study indicate increase or static trend in biological reclamation (plantation on backfill) with respect to the year 2015.
- 4.5** There has been increase in area under technical reclamation (backfilling) in projects of WCL but in projects like Navin Kunada ,HLOCM ,Damua and Ambara OCPs where area under technical reclamation has reduced marginally as compared to the year 2015 as more backfill area have come under (Biological Reclamation)in these projects.
- 4.6** After analyzing the satellite data of year 2015 vs. 2018 it is evident that total area under plantation (Green Cover) carried out on backfilled area, OB dumps as well as under social forestry in all the mines of WCL has increased from 738.85 Hectare to 798.26 Hectare in span of last three year. This increase of 59.41 Hectare area of plantation (Green Cover) in three year time is due to the sincere efforts of WCL towards mine land reclamation.
- 4.7** The leasehold boundary of Ambara OCP has been updated this year which has resulted in significant change in shape and area of leasehold of Ambara OCP i.e 162.15 Ha in the year 2018 as compared to 775.52 Ha in the year 2015, due to which total area under plantation has decreased from 71.62 Ha (Yr. 2015) to 24.06 Ha (Yr. 2018). However percentage green cover generated in leasehold area has increased from 9.24% (Yr. 2015) to 14.84% (Yr. 2018) as percentage Green Cover generated is calculated with respect to leasehold area of respective mine.
- 4.8** Out of 12 projects of WCL ,maximum land reclamation has been carried out in Damua OC projects (76.04%) followed by Ambara (73.24%) ,HLOCM (66.39%) and Navin Kunada (64.82%).

TABLE:2 STATUS OF LAND RECLAMATION /LANDUSE/COVER PATTERN OF OPENCAST MINES IN WCL BASED ON SATELLITE DATA OF THE YEAR 2018

		(Area in Hectare)																												
		Inder UG to OC		Kamptee Deep		Navin Kunada		Shivpuri		Pauni Expn OC		HLOCM		Ghorawari		Dhorwasa		Damua		Barkui		Makardhokra-I		Ambara		Total				
		Area	%	Area	%	Area	%	Area	%	Area	%	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	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	0.00	0.00	0.00	0.00	0.00
	Open 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	140.68	10.85	0.00	0.00	62.19	5.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	202.87	3.36	
	Total 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	0.00	140.68	10.85	0.00	0.00	62.19	5.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	202.87	3.36	
PLANTATION	Scrubs	102.16	16.54	60.81	12.90	19.39	5.20	38.73	11.52	31.82	12.48	5.33	1.71	428.41	33.06	17.87	7.67	293.73	27.17	45.08	18.98	152.87	23.14	17.92	11.05	1214.12	20.12			
	Social Forestry	37.96	6.14	37.88	8.03	5.05	1.35	16.53	4.92	9.94	3.90	33.54	10.76	14.43	1.11	11.47	4.92	138.58	12.82	8.73	3.68	0.00	0.00	10.55	6.51	324.66	5.38			
	Plantation on OB Dump	29.79	4.82	61.39	13.02	88.44	23.71	20.41	6.07	36.64	14.37	72.86	23.38	27.60	2.13	39.69	17.04	9.97	0.92	0.00	0.00	0.00	0.00	0.00	0.00	386.79	6.41			
	Plantation on Backfill	0.00	0.00	8.11	1.72	19.71	5.28	6.06	1.80	3.83	1.50	6.31	2.02	8.92	0.69	11.85	5.09	8.51	0.79	0.00	0.00	0.00	0.00	13.51	8.33	86.81	1.44			
	Total Plantation on backfill	0.00	0.00	8.11	1.72	19.71	5.28	6.06	1.80	3.83	1.50	6.31	2.02	8.92	0.69	11.85	5.09	8.51	0.79	0.00	0.00	0.00	0.00	13.51	8.33	86.81	1.44			
Total Green Cover Generated	67.75	10.96	107.38	22.77	113.20	30.34	43.00	12.79	50.41	19.77	112.71	36.16	50.95	3.93	63.01	27.05	157.06	14.53	8.73	3.68	0.00	0.00	24.06	14.84	798.26	13.23				
Total Vegetation Cover	169.91	27.50	168.19	35.67	132.59	35.54	81.73	24.31	82.23	32.25	118.04	37.87	620.04	47.84	80.88	34.72	512.98	47.45	53.81	22.66	152.87	23.14	41.98	25.89	2215.25	36.71				
ACTIVE MINING	Coal Quarry	70.90	11.48	51.67	10.96	32.93	8.83	30.72	9.13	38.17	14.97	32.77	10.51	15.07	1.16	25.77	11.06	3.12	0.29	16.20	6.82	55.02	8.33	12.12	7.47	384.46	6.37			
	Coal Dump	4.94	0.80	2.70	0.57	4.37	1.17	3.49	1.04	4.03	1.58	2.07	0.66	1.27	0.10	2.63	1.13	0.00	0.00	1.88	0.79	0.00	0.00	1.78	1.10	29.16	0.48			
	Advance Quarry Site	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
	Quarry Filled With Water	4.82	0.78	7.62	1.62	20.87	5.60	13.10	3.90	1.56	0.61	0.58	0.19	6.73	0.52	7.72	3.32	2.39	0.22	0.61	0.26	0.00	0.00	7.60	4.69	73.60	1.22			
	Total Area under Active Mining	80.66	13.06	61.99	13.15	58.17	15.60	47.31	14.07	43.76	17.16	35.42	11.36	23.07	1.78	36.12	15.51	5.51	0.51	18.69	7.87	55.02	8.33	21.50	13.26	487.22	8.07			
RECLAIMED	Barren OB Dump	77.19	12.49	12.70	2.69	45.92	12.31	60.54	18.00	35.61	13.96	47.74	15.32	34.40	2.65	35.08	15.06	20.13	1.86	16.24	6.82	15.13	2.29	0.00	0.00	400.68	6.64			
	Barren Backfilled Area	57.29	9.27	51.23	10.87	87.46	23.45	17.98	5.35	47.37	18.58	63.64	20.42	32.06	2.47	51.07	21.93	8.98	0.83	13.84	5.83	0.00	0.00	45.34	27.96	476.26	7.89			
	Total Area under Technical Reclamation	57.29	9.27	51.23	10.87	87.46	23.45	17.98	5.35	47.37	18.58	63.64	20.42	32.06	2.47	51.07	21.93	8.98	0.83	13.84	5.83	0.00	0.00	45.34	27.96	476.26	14.53			
Total Area Under Mine Operation	215.14	34.82	125.92	26.71	191.55	51.36	125.83	37.42	126.74	49.70	146.80	47.10	89.53	6.90	122.27	52.50	34.62	3.20	48.77	20.52	70.15	10.62	66.84	41.22	1364.16	22.60				
Waste land	Waste Lands	17.45	2.82	38.98	8.27	22.29	5.98	17.40	5.17	24.07	9.44	23.95	7.68	253.11	19.53	11.60	4.98	185.27	17.16	3.78	1.59	25.44	3.85	24.36	15.02	647.70	10.73			
	Fly Ash Pond / Sand Body	0.00	0.00	0.00	0.00	0	0	1.92	0.57	3.32	1.30	0.00	0.00	0.00	0.00	1.22	0.52	16.15	1.49	0.00	0.00	1.60	0.24	0.00	0.00	24.21	0.40			
Total Wasteland	17.45	2.82	38.98	8.27	22.29	5.98	19.32	5.74	27.39	10.74	23.95	7.68	253.11	19.53	12.82	5.50	201.42	18.65	3.78	1.59	27.04	4.09	24.36	15.02	671.91	11.13				
WATERBODIES	Reservoir, nallah, ponds	5.75	0.96	5.16	1.09	2.66	0.73	0.44	0.13	1.14	0.45	6.52	2.09	5.74	0.45	8.94	3.84	9.98	0.93	5.40	2.28	6.47	0.98	0.00	0.00	58.20	0.98			
	Total Waterbodies	5.75	0.96	5.16	1.09	2.66	0.73	0.44	0.13	1.14	0.45	6.52	2.09	5.74	0.45	8.94	3.84	9.98	0.93	5.40	2.28	6.47	0.98	0.00	0.00	58.20	0.98			
AGRICULTURE	Crop Lands	7.06	1.14	20.52	4.35	0.00	0.00	8.36	2.48	0.00	0.00	0.00	0.00	3.52	0.27	0.00	0.00	0.00	0.00	59.00	24.84	26.77	4.05	14.67	9.05	139.90	2.32			
	Fallow Lands	189.33	30.64	93.73	19.88	19.43	5.20	93.28	27.74	16.74	6.56	4.40	1.41	315.49	24.34	7.55	3.24	270.80	25.05	63.07	26.55	376.40	56.97	13.49	8.32	1463.71	24.25			
	Total Agriculture	196.39	31.78	114.25	24.23	19.43	5.20	101.64	30.22	16.74	6.56	4.40	1.41	319.01	24.61	7.55	3.24	270.80	25.05	122.07	51.39	403.17	61.02	28.16	17.37	1603.61	26.57			
SETTLEMENTS	Urban Settlement	11.83	1.91	17.96	3.81	0.56	0.15	3.20	0.95	0.44	0.17	10.16	3.28	6.26	0.48	0.32	0.14	50.09	4.63	3.37	1.42	0.00	0.00	0.81	0.50	105.00	1.72			
	Rural Settlement	1.37	0.21	0.00	0.00	0	0	2.35	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.07	0.31	0.14	0.00	0.00	0.00	0.00	4.83	0.08			
	Industrial Settlement	0.00	0.00	0.98	0.22	3.92	1.04	1.78	0.53	0.32	0.13	1.79	0.57	2.32	0.19	0.13	0.06	0.23	0.02	0.00	0.00	1.00	0.15	0.00	0.00	12.47	0.21			
	Total Settlement	13.20	2.12	18.94	4.03	4.48	1.19	7.33	2.18	0.76	0.30	11.95	3.85	8.58	0.67	0.45	0.20	51.12	4.72	3.68	1.56	1.00	0.15	0.81	0.5	122.30	2.01			
Grand Total	617.84	100.00	471.44	100.00	373.00	100.00	336.29	100.00	255.00	100.00	311.66	100.00	1296.01	100.00	232.91	100.00	1080.92	100.00	237.51	100.00	660.70	100.00	162.15	100.00	6035.43	100.00				



Classes		Colour	Area Statistics	
Level - I	Level - II		Ha	%
SCRUBS	Scrubs (A)		102.16	16.54
	Social Forest		37.96	6.14
PLANTATION	Plantation on OB		29.79	4.82
	Total Plantation(B)		67.75	10.96
	Total Vegetation (A+B)		169.91	27.50
AGRICULTURE	Fallow Land		189.33	30.64
	Crop Land		7.06	1.14
	Total Agriculture Land		196.39	31.78
SETTLEMENT	Urban		11.83	1.91
	Rural		1.37	0.21
	Total Settlement		13.20	2.12
MINING AREA	Coal Quarry		70.90	11.48
	Coal dump		4.94	0.80
	Waterfilled quarry		4.82	0.78
	Area under backfilling		57.29	9.27
	Barren OB Dump		77.19	12.49
	Total area under mining		215.14	34.82
WASTE LAND	Waste up Land		17.45	2.82
WATER BODY	River,pond,stream etc		5.75	0.96
Total Leasehold Area			617.84	100.00

Customer : WESTERN COALFIELD LIMITED

Job Title : Land Reclamation Monitoring of OC Projects Job No. 56410027

Subject : Land reclamation status of Inder UG TO OC based on satellite data (IRS R2 L4FX) of the Year 2018

Activity	Name	Designation	Signature	Date
Prepared	B.K.Choudhary	C.M(RSC)		
Checked	A.K.Singh	C.M (RSC)		
Approved	Rajneesh Kumar	HOD (Geomatics)		

Scale : 0 0.35 0.175 0 0.35 Km

Sheet 1 of 1

Dirg No. HQ REM A4 19 01 Rev No. 0

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Plate-1

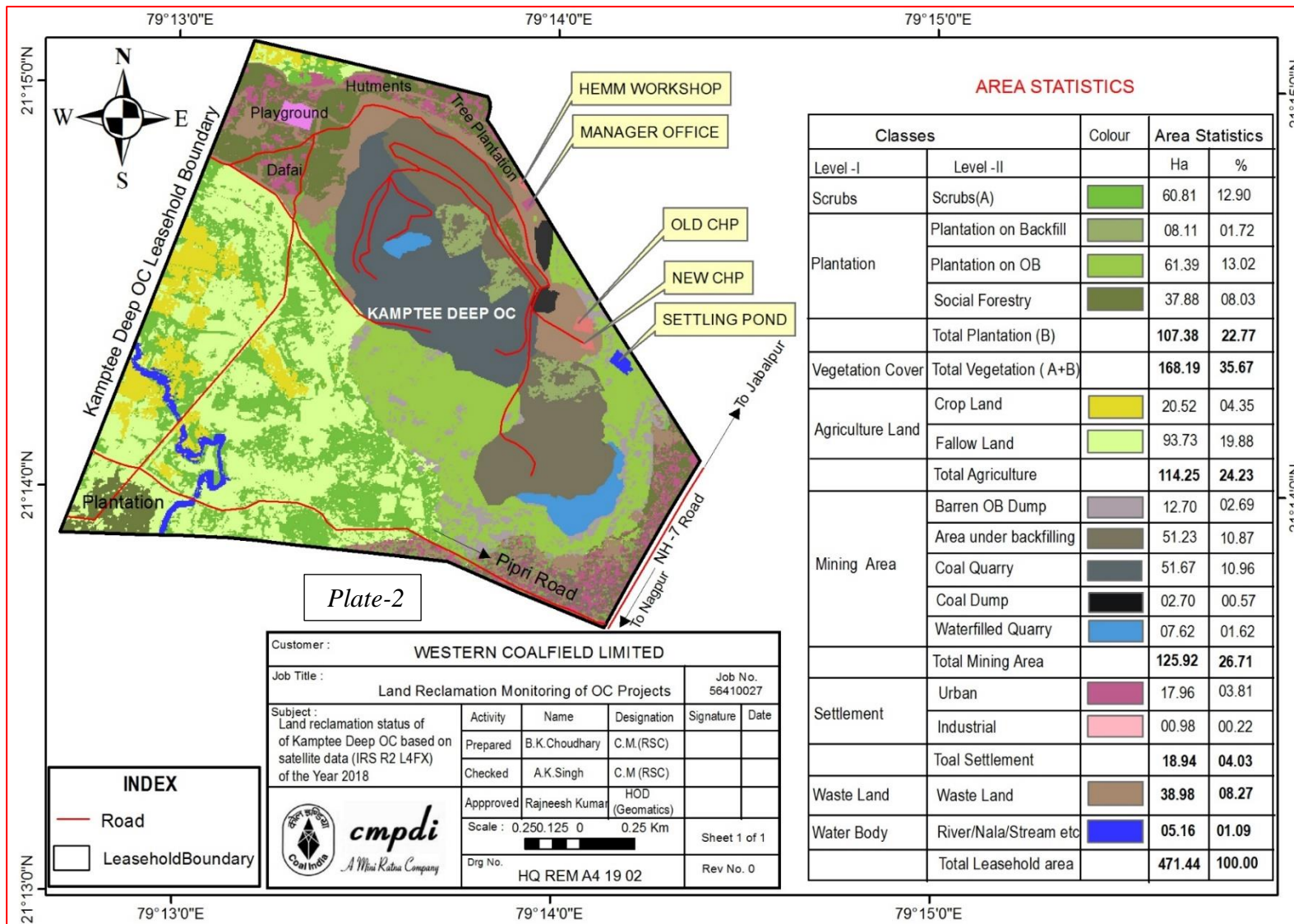


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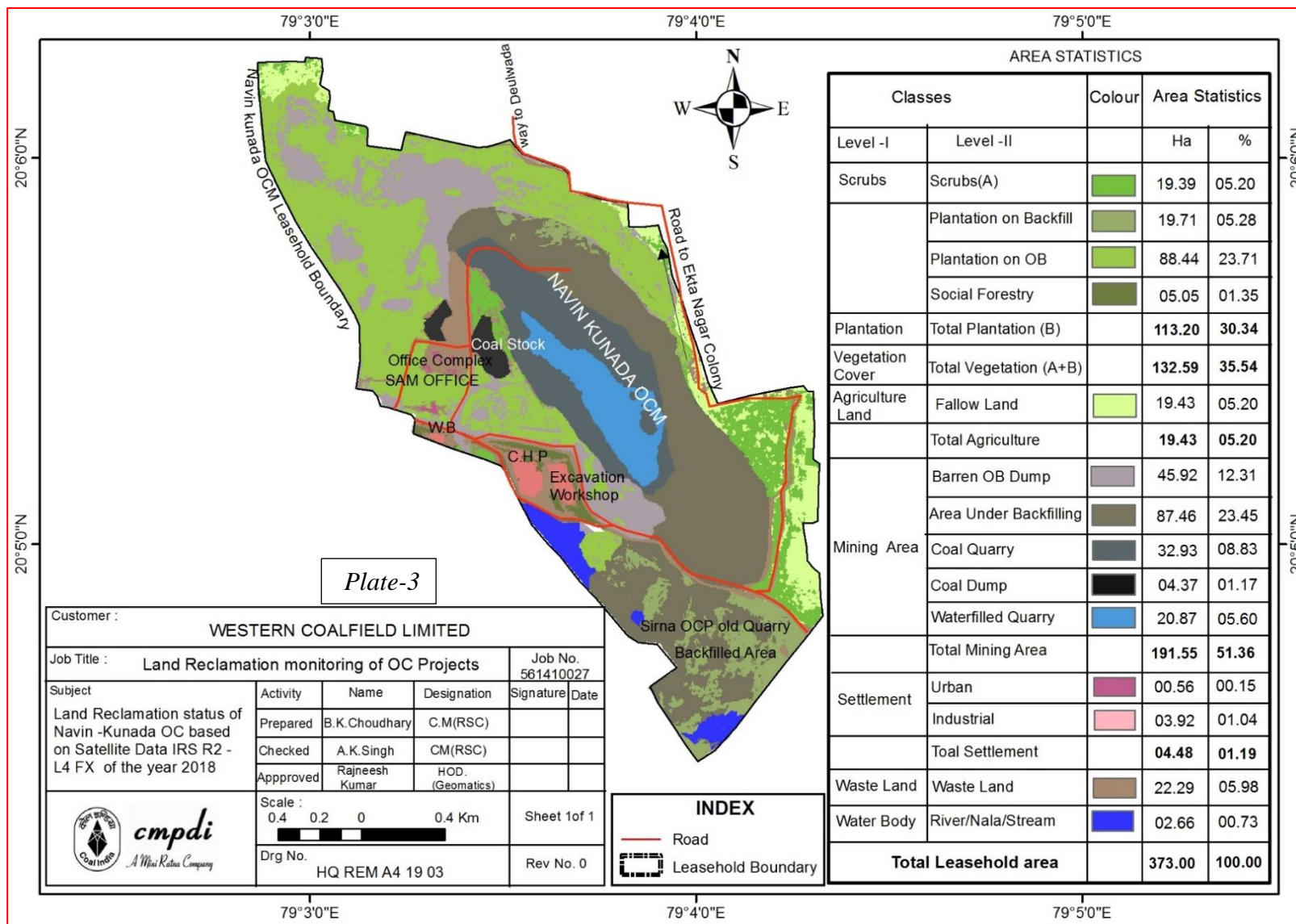
AREA STATISTICS

Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	Scrubs(A)		60.81	12.90
Plantation	Plantation on Backfill		08.11	01.72
	Plantation on OB		61.39	13.02
	Social Forestry		37.88	08.03
	Total Plantation (B)		107.38	22.77
Vegetation Cover	Total Vegetation (A+B)		168.19	35.67
Agriculture Land	Crop Land		20.52	04.35
	Fallow Land		93.73	19.88
	Total Agriculture		114.25	24.23
Mining Area	Barren OB Dump		12.70	02.69
	Area under backfilling		51.23	10.87
	Coal Quarry		51.67	10.96
	Coal Dump		02.70	00.57
	Waterfilled Quarry		07.62	01.62
	Total Mining Area		125.92	26.71
Settlement	Urban		17.96	03.81
	Industrial		00.98	00.22
	Total Settlement		18.94	04.03
Waste Land	Waste Land		38.98	08.27
Water Body	River/Nala/Stream etc		05.16	01.09
	Total Leasehold area		471.44	100.00

INDEX	
	Road
	Leasehold Boundary

Customer : WESTERN COALFIELD LIMITED					
Job Title : Land Reclamation Monitoring of OC Projects				Job No. 56410027	
Subject : Land reclamation status of KAMPTEE DEEP OC based on satellite data (IRS R2 L4FX) of the Year 2018	Activity	Name	Designation	Signature	Date
	Prepared	B.K.Choudhary	C.M.(RSC)		
	Checked	A.K.Singh	C.M.(RSC)		
	Approved	Rajneesh Kumar	HOD (Geomatics)		
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Dwg No. HQ REM A4 19 02			Rev No. 0		





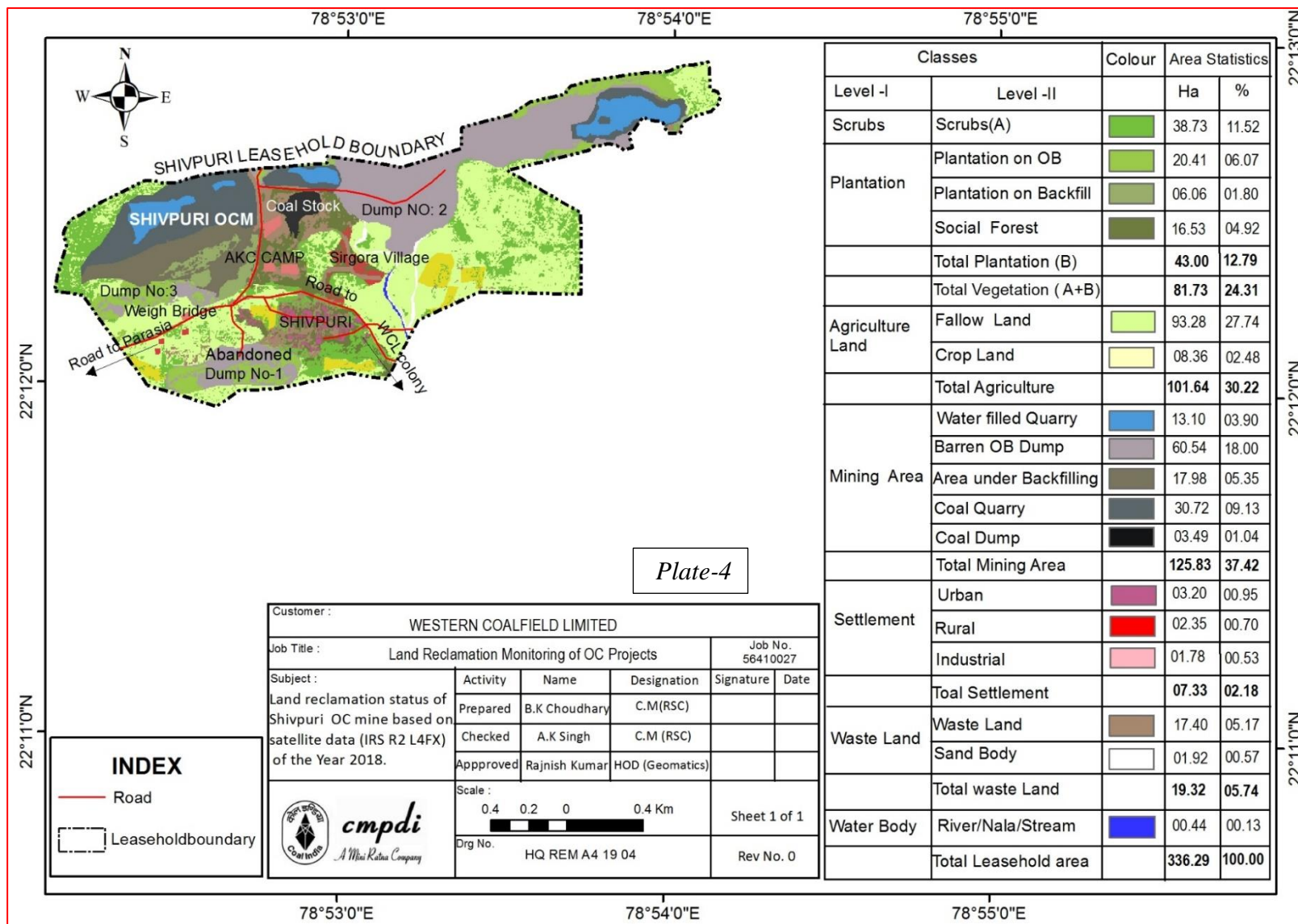
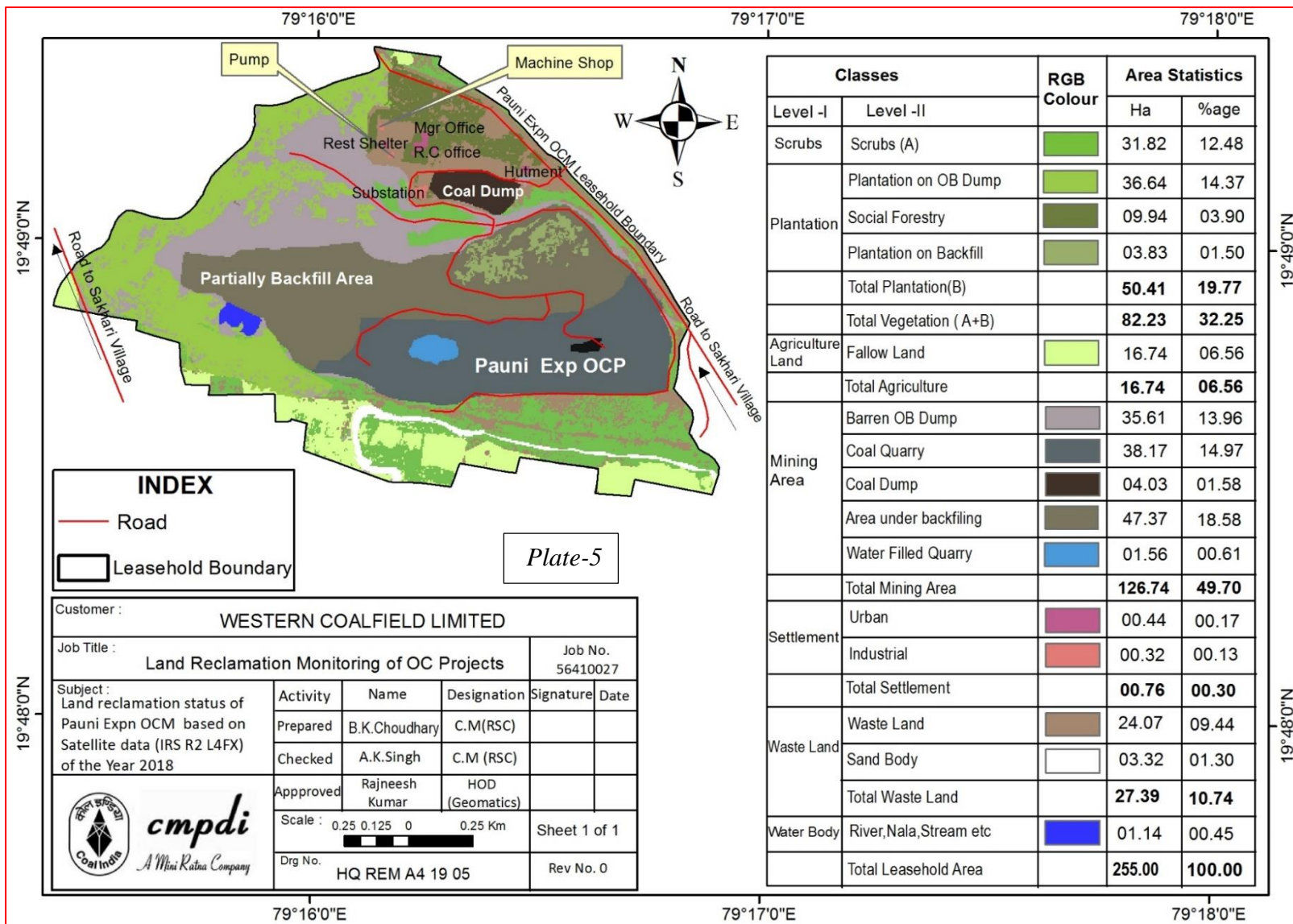


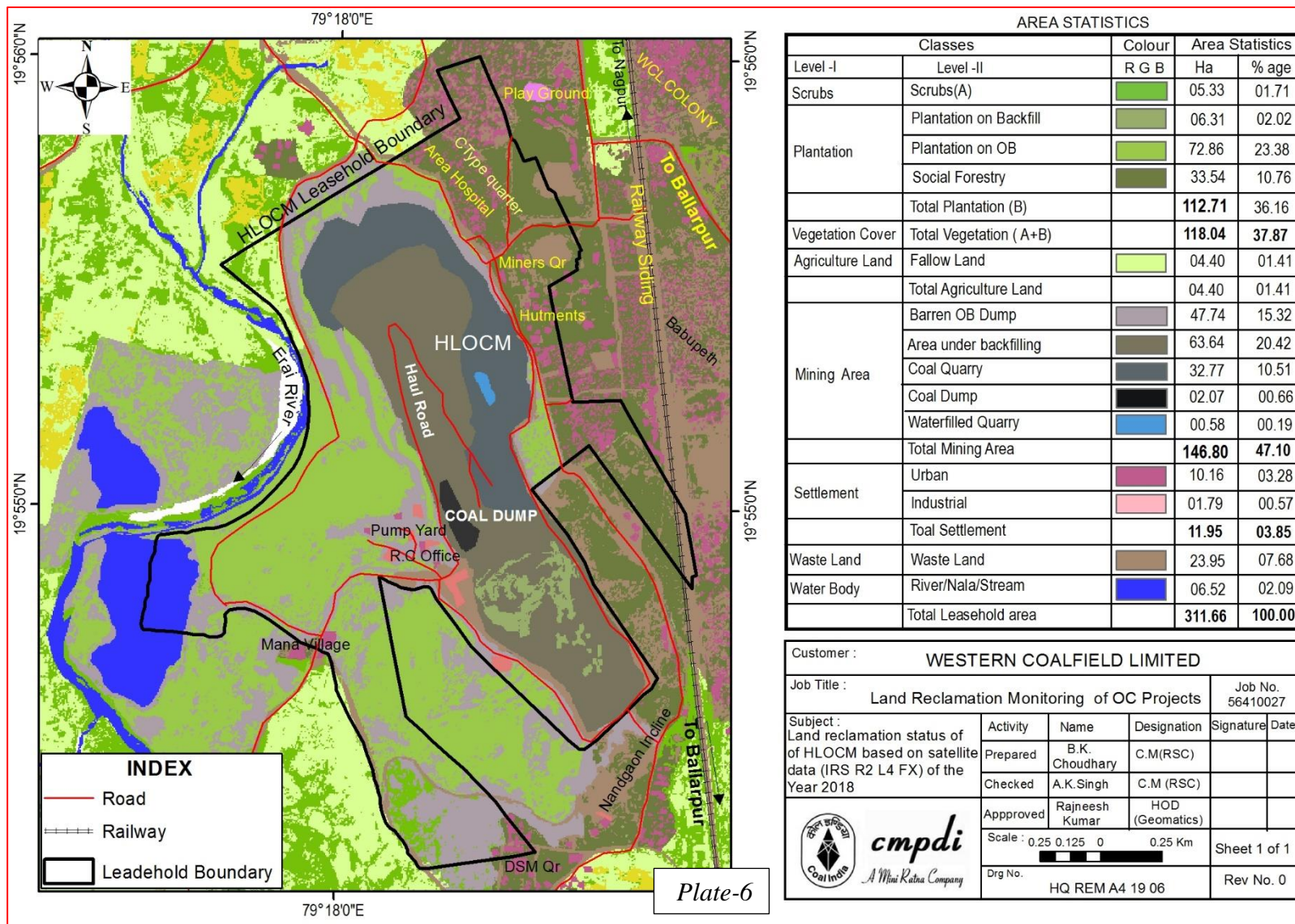
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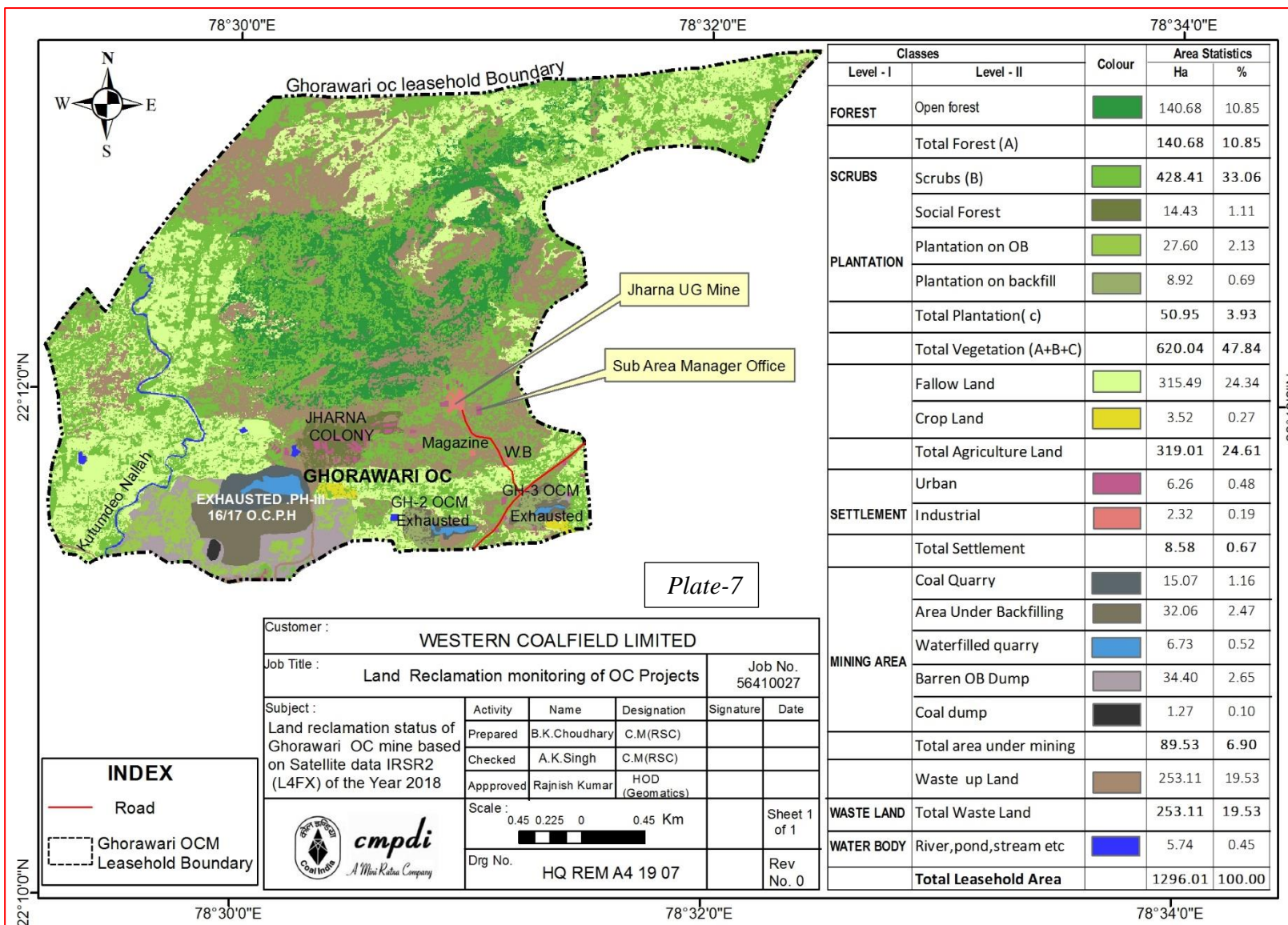
Customer : WESTERN COALFIELD LIMITED					
Job Title : Land Reclamation Monitoring of OC Projects				Job No. 56410027	
Subject : Land reclamation status of Shivpuri OC mine based on satellite data (IRS R2 L4FX) of the Year 2018.	Activity	Name	Designation	Signature	Date
	Prepared	B.K Choudhary	C.M(RSC)		
	Checked	A.K Singh	C.M (RSC)		
	Approved	Rajnish Kumar	HOD (Geomatics)		
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Drg No. HQ REM A4 19 04			Rev No. 0		

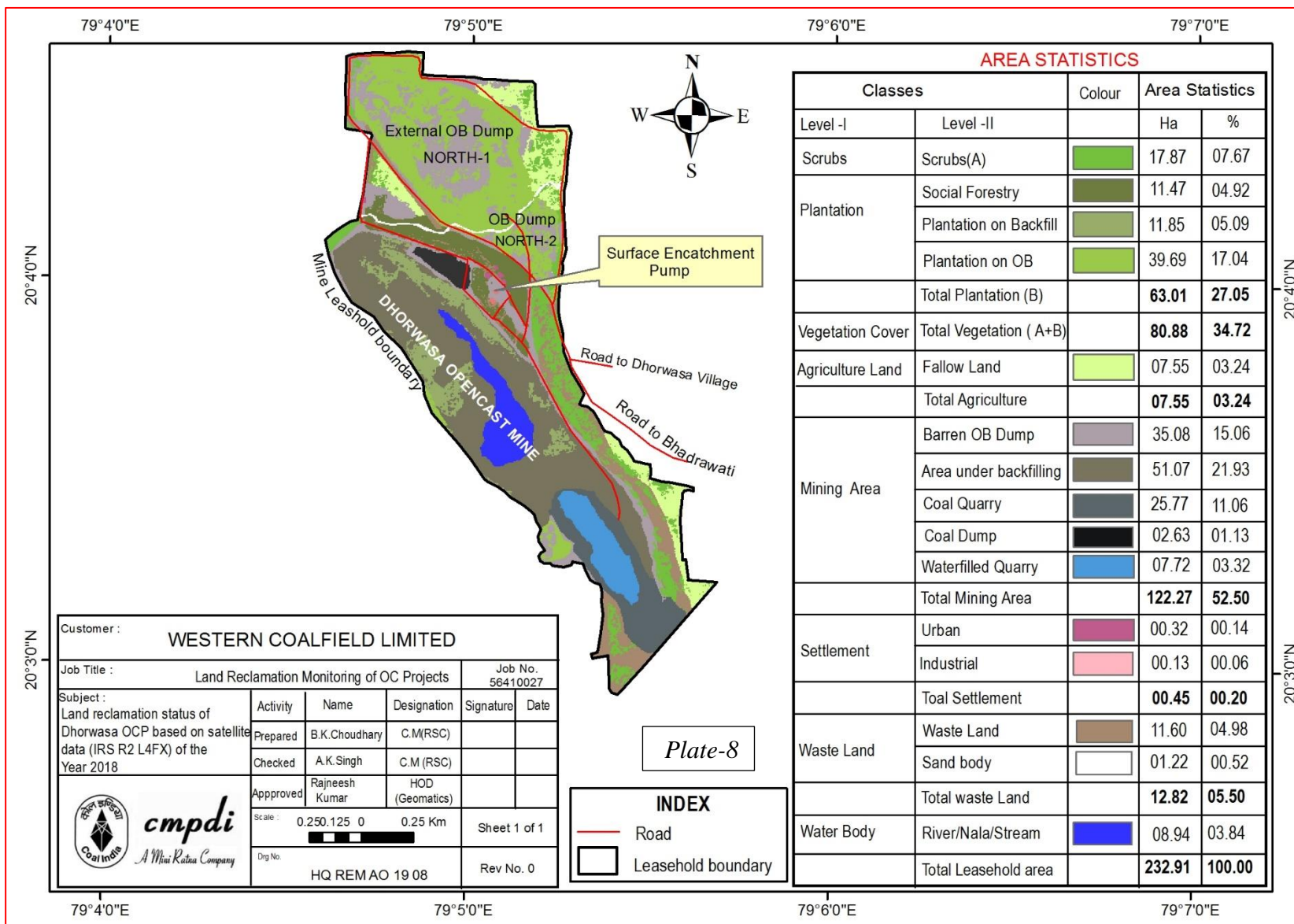
INDEX	
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Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	Scrubs(A)		38.73	11.52
Plantation	Plantation on OB		20.41	06.07
	Plantation on Backfill		06.06	01.80
	Social Forest		16.53	04.92
Total Plantation (B)			43.00	12.79
Total Vegetation (A+B)			81.73	24.31
Agriculture Land	Fallow Land		93.28	27.74
	Crop Land		08.36	02.48
Total Agriculture			101.64	30.22
Mining Area	Water filled Quarry		13.10	03.90
	Barren OB Dump		60.54	18.00
	Area under Backfilling		17.98	05.35
	Coal Quarry		30.72	09.13
	Coal Dump		03.49	01.04
Total Mining Area			125.83	37.42
Settlement	Urban		03.20	00.95
	Rural		02.35	00.70
	Industrial		01.78	00.53
Toal Settlement			07.33	02.18
Waste Land	Waste Land		17.40	05.17
	Sand Body		01.92	00.57
Total waste Land			19.32	05.74
Water Body	River/Nala/Stream		00.44	00.13
Total Leasehold area			336.29	100.00









AREA STATISTICS

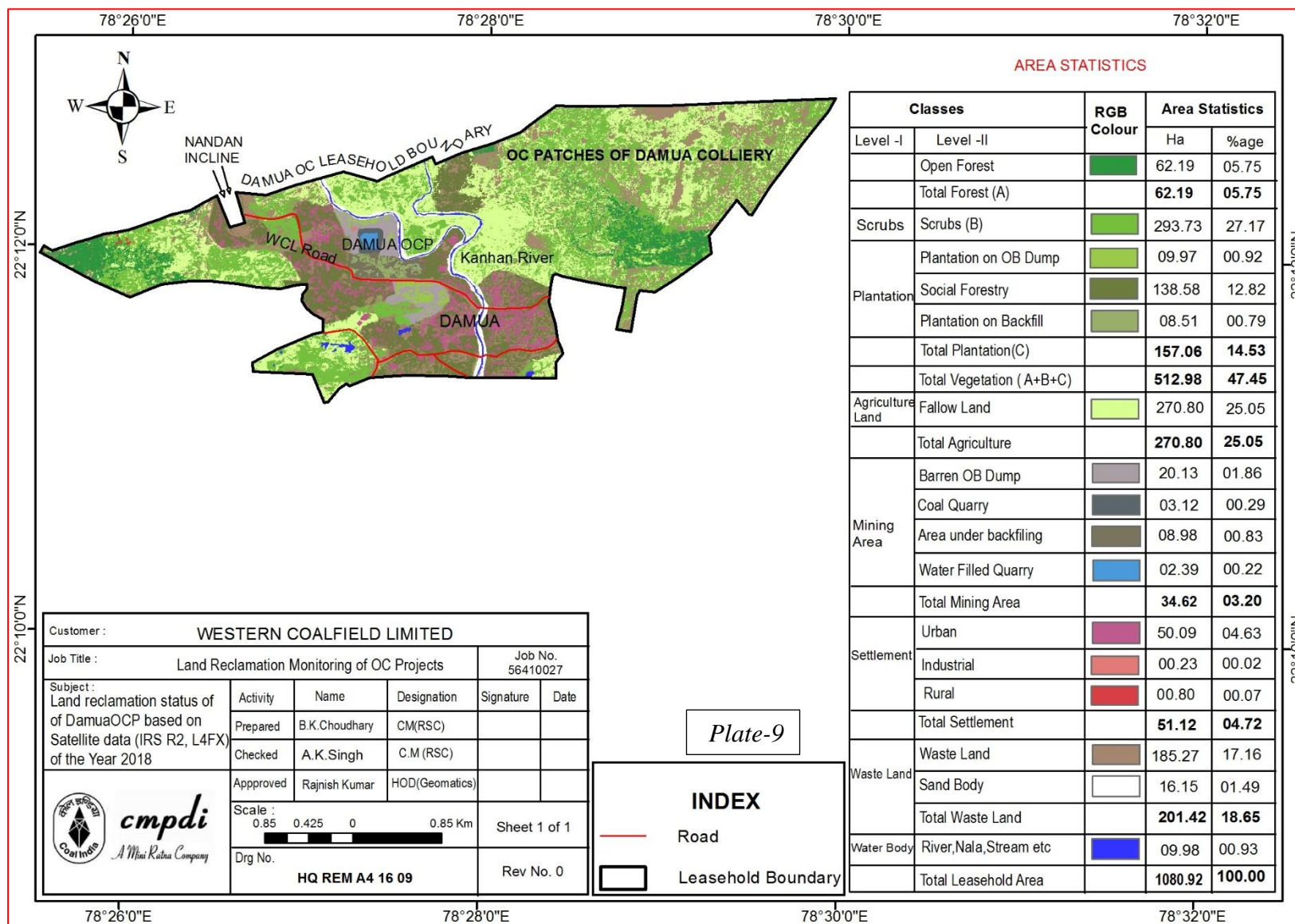
Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	Scrubs(A)		17.87	07.67
Plantation	Social Forestry		11.47	04.92
	Plantation on Backfill		11.85	05.09
	Plantation on OB		39.69	17.04
	Total Plantation (B)		63.01	27.05
Vegetation Cover	Total Vegetation (A+B)		80.88	34.72
Agriculture Land	Fallow Land		07.55	03.24
	Total Agriculture		07.55	03.24
Mining Area	Barren OB Dump		35.08	15.06
	Area under backfilling		51.07	21.93
	Coal Quarry		25.77	11.06
	Coal Dump		02.63	01.13
	Waterfilled Quarry		07.72	03.32
	Total Mining Area		122.27	52.50
Settlement	Urban		00.32	00.14
	Industrial		00.13	00.06
	Total Settlement		00.45	00.20
Waste Land	Waste Land		11.60	04.98
	Sand body		01.22	00.52
	Total waste Land		12.82	05.50
Water Body	River/Nala/Stream		08.94	03.84
	Total Leasehold area		232.91	100.00

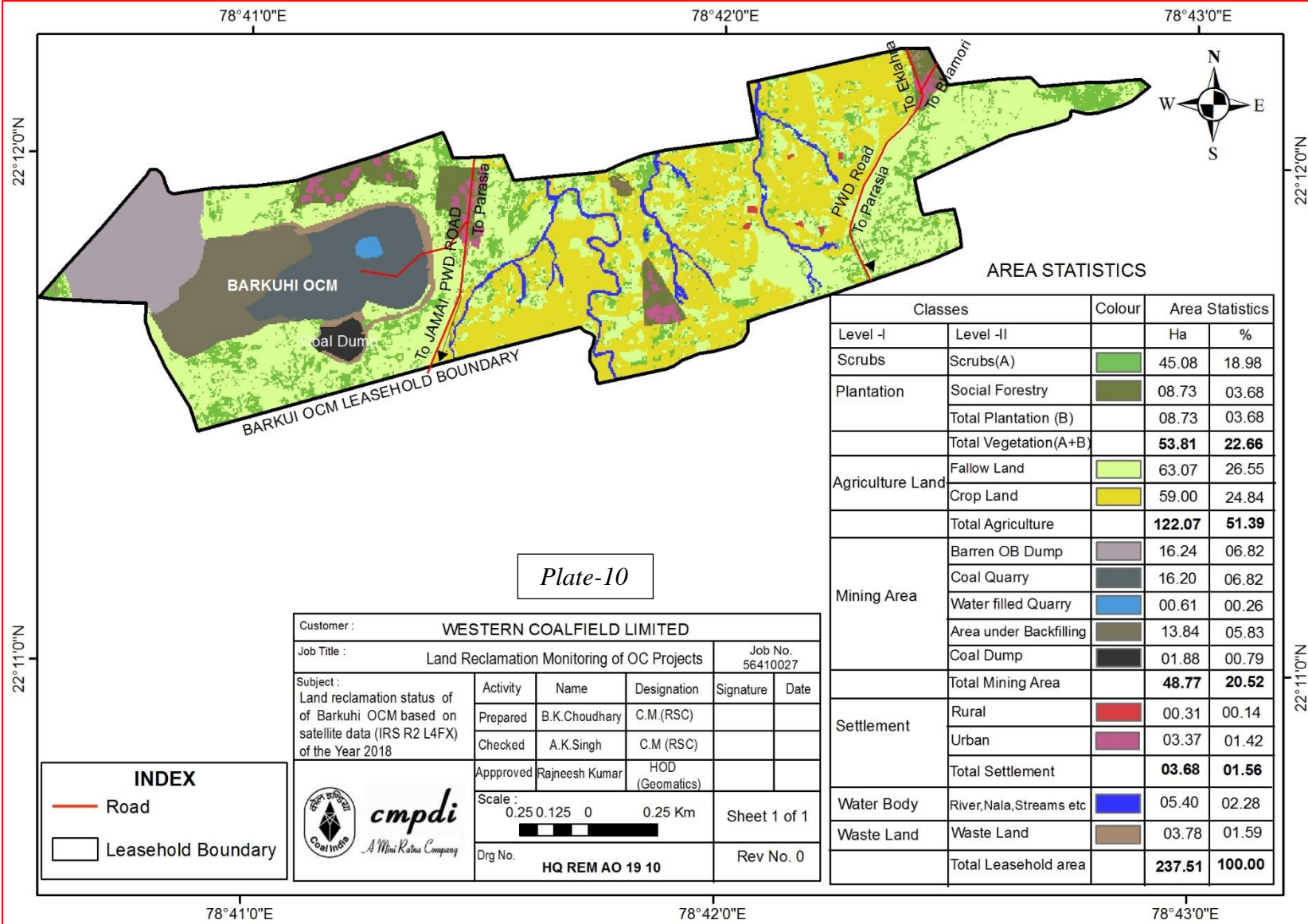
Plate-8

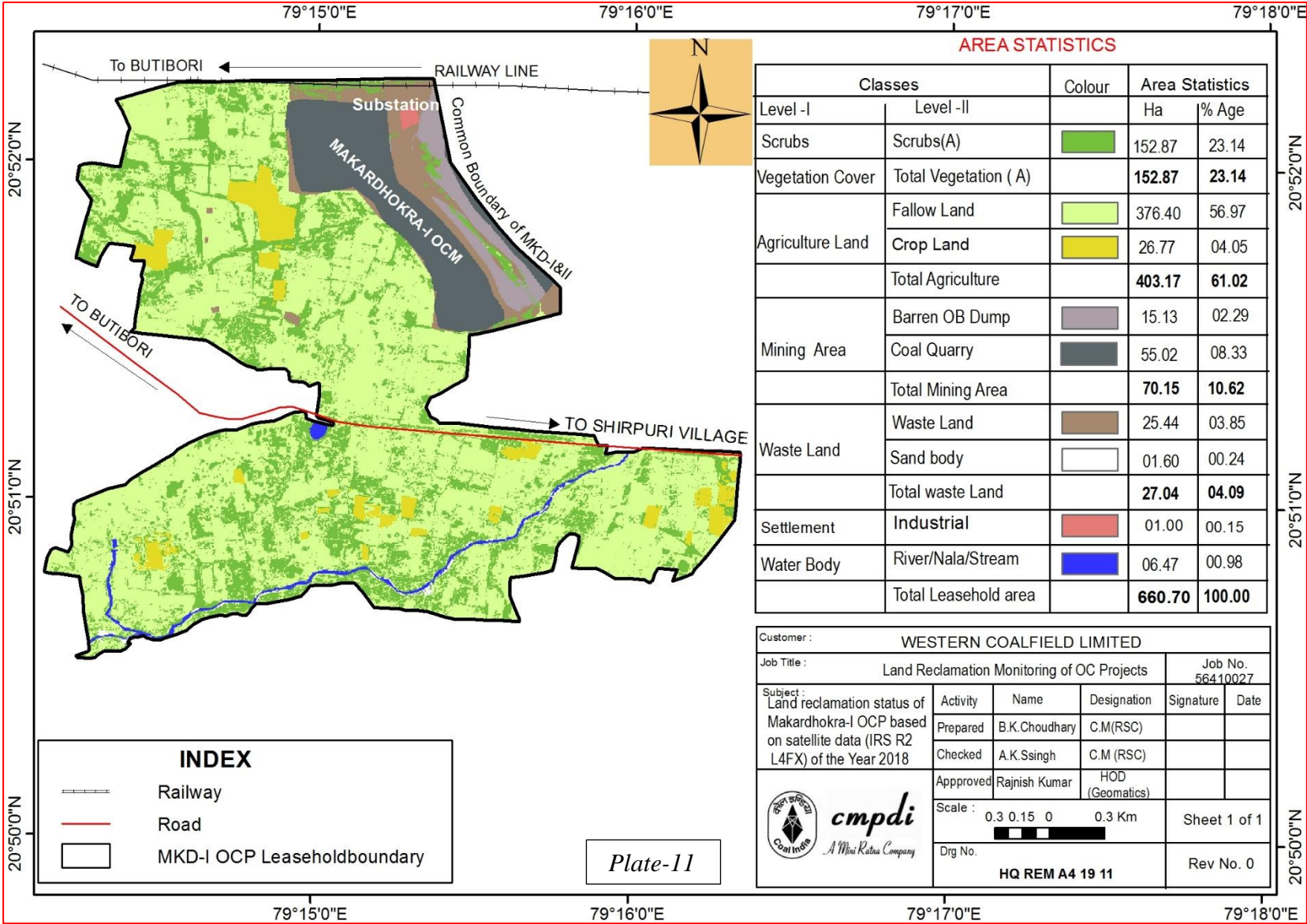
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Customer : WESTERN COALFIELD LIMITED					
Job Title : Land Reclamation Monitoring of OC Projects				Job No. 56410027	
Subject : Land reclamation status of Dhorwasa OCP based on satellite data (IRS R2 L4FX) of the Year 2018	Activity	Name	Designation	Signature	Date
	Prepared	B.K.Choudhary	C.M(RSC)		
	Checked	A.K.Singh	C.M (RSC)		
	Approved	Rajneesh Kumar	HOD (Geomatics)		
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Dwg No. HQ REMAO 19 08		Rev No. 0			









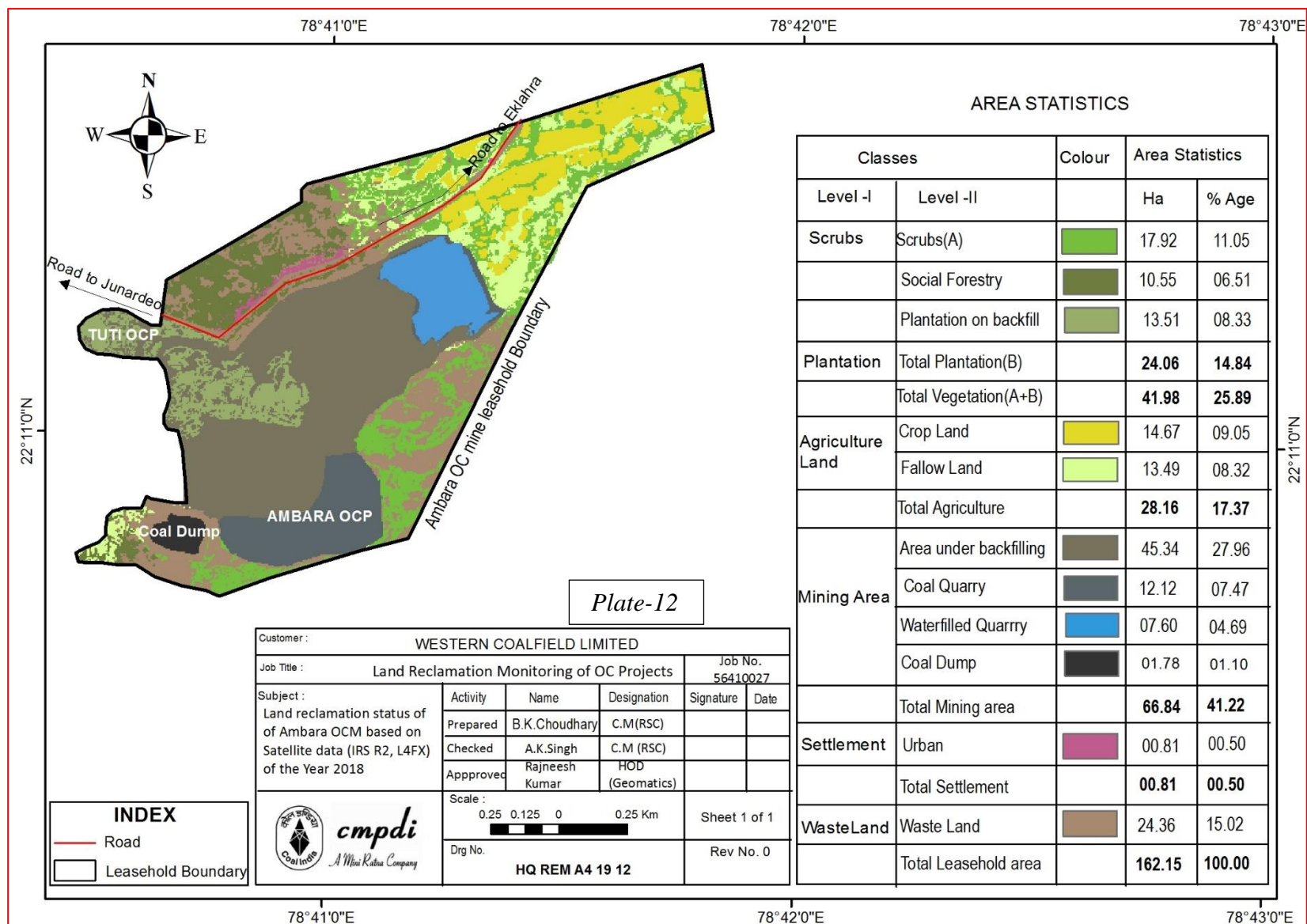


Plate-12

Customer : WESTERN COALFIELD LIMITED					
Job Title : Land Reclamation Monitoring of OC Projects				Job No. 56410027	
Subject : Land reclamation status of of Ambara OCM based on Satellite data (IRS R2, L4FX) of the Year 2018	Activity	Name	Designation	Signature	Date
	Prepared	B.K.Choudhary	C.M(RSC)		
	Checked	A.K.Singh	C.M (RSC)		
	Approved	Rajneesh Kumar	HOD (Geomatics)		
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Drg No. HQ REM A4 19 12			Rev No. 0		

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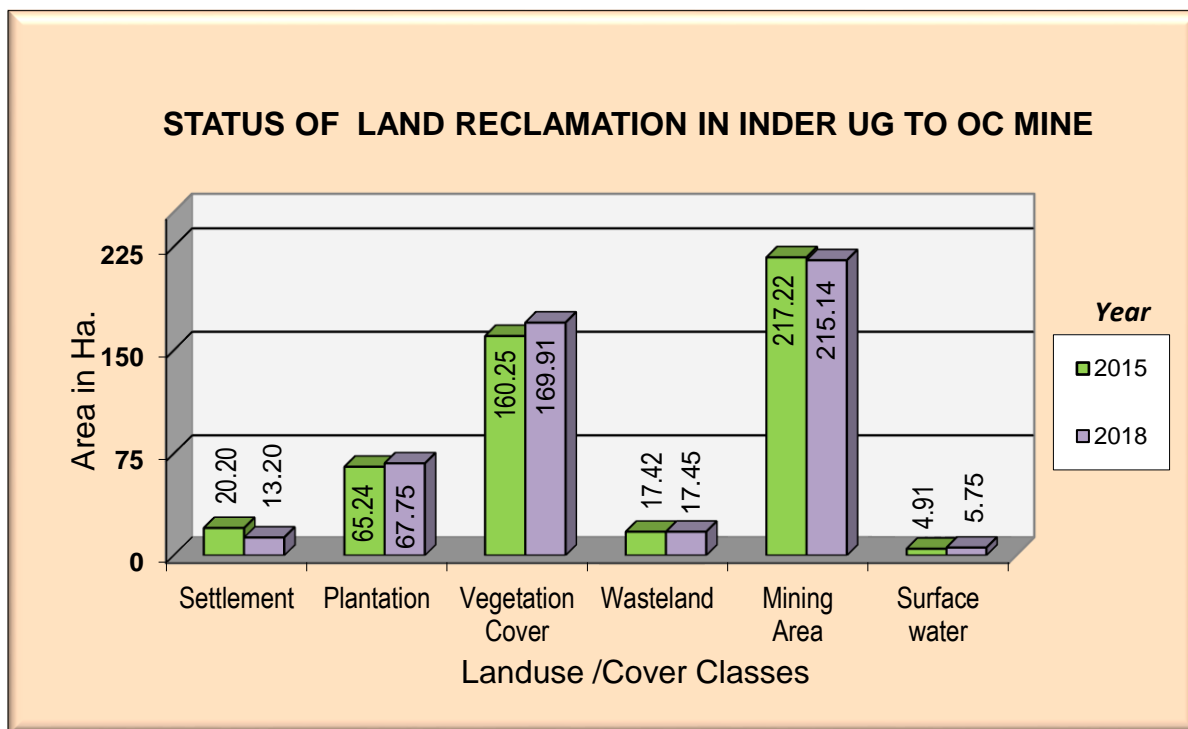


Figure-3

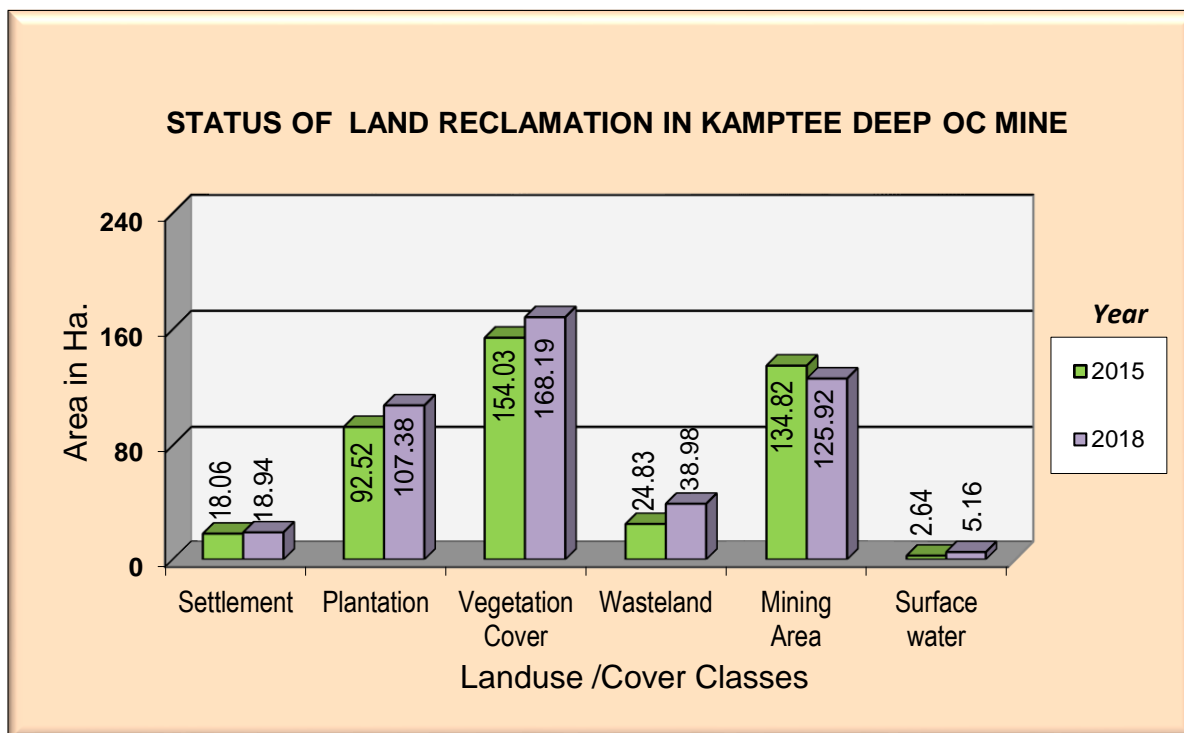


Figure-4

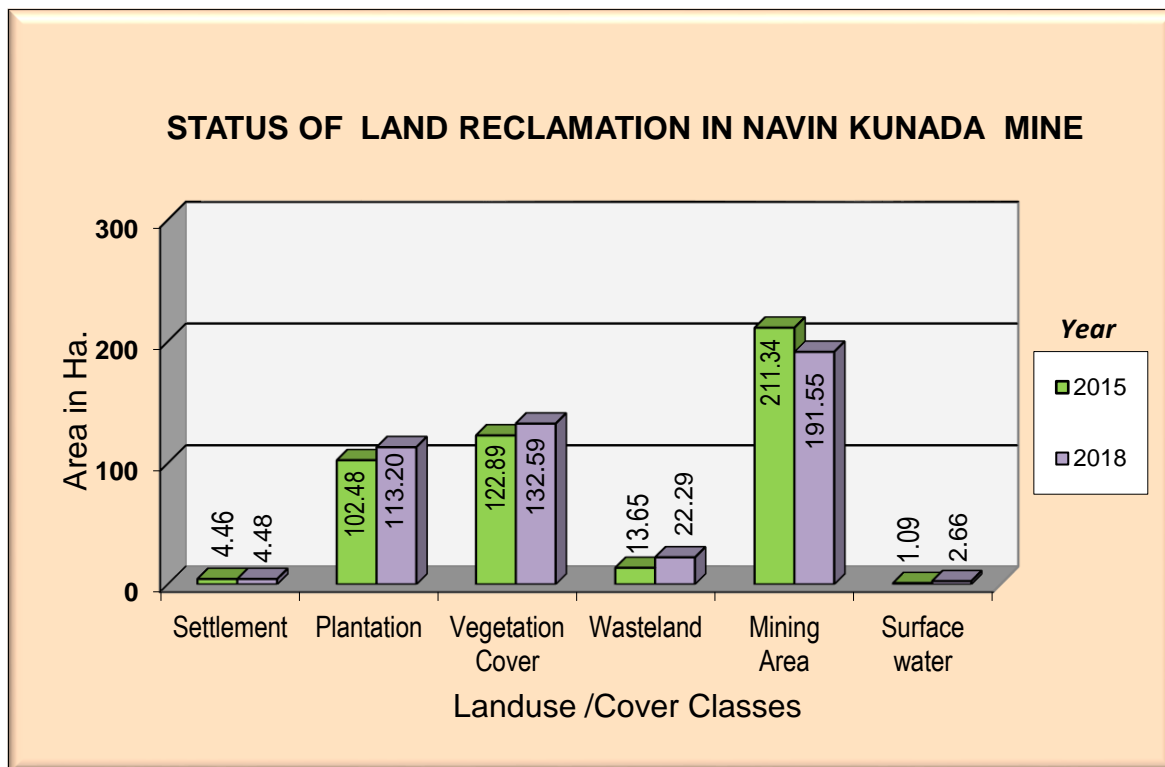


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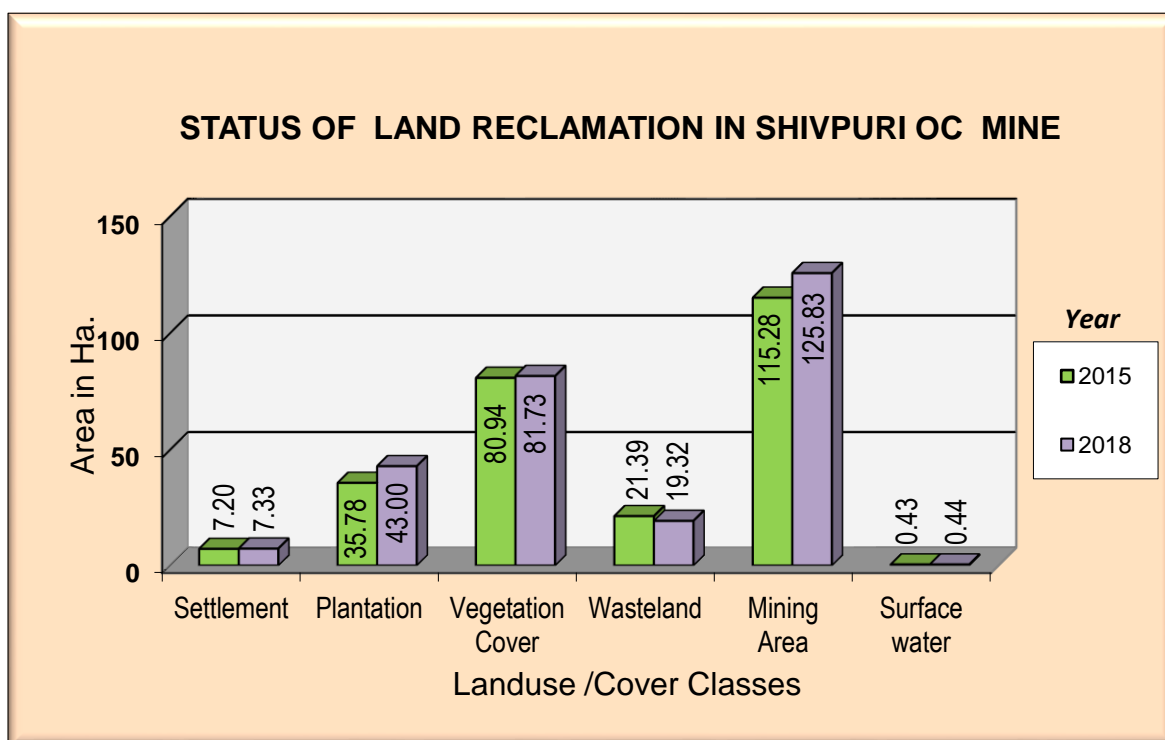


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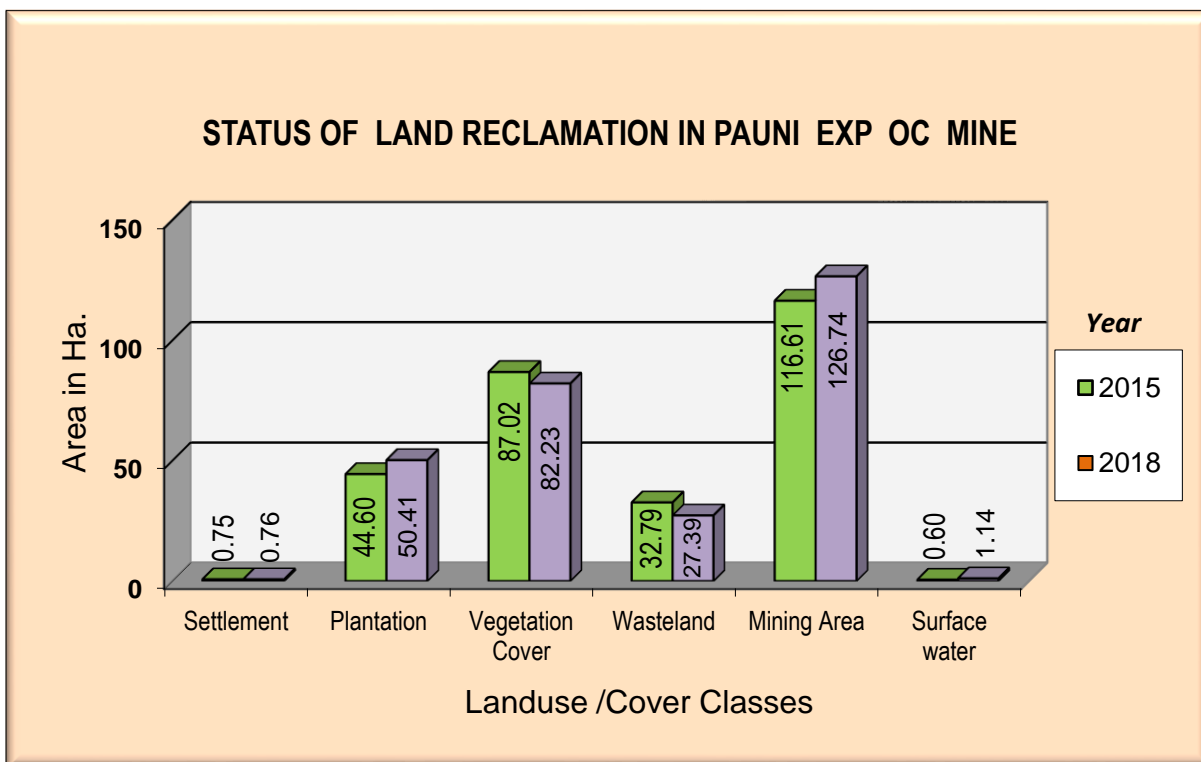


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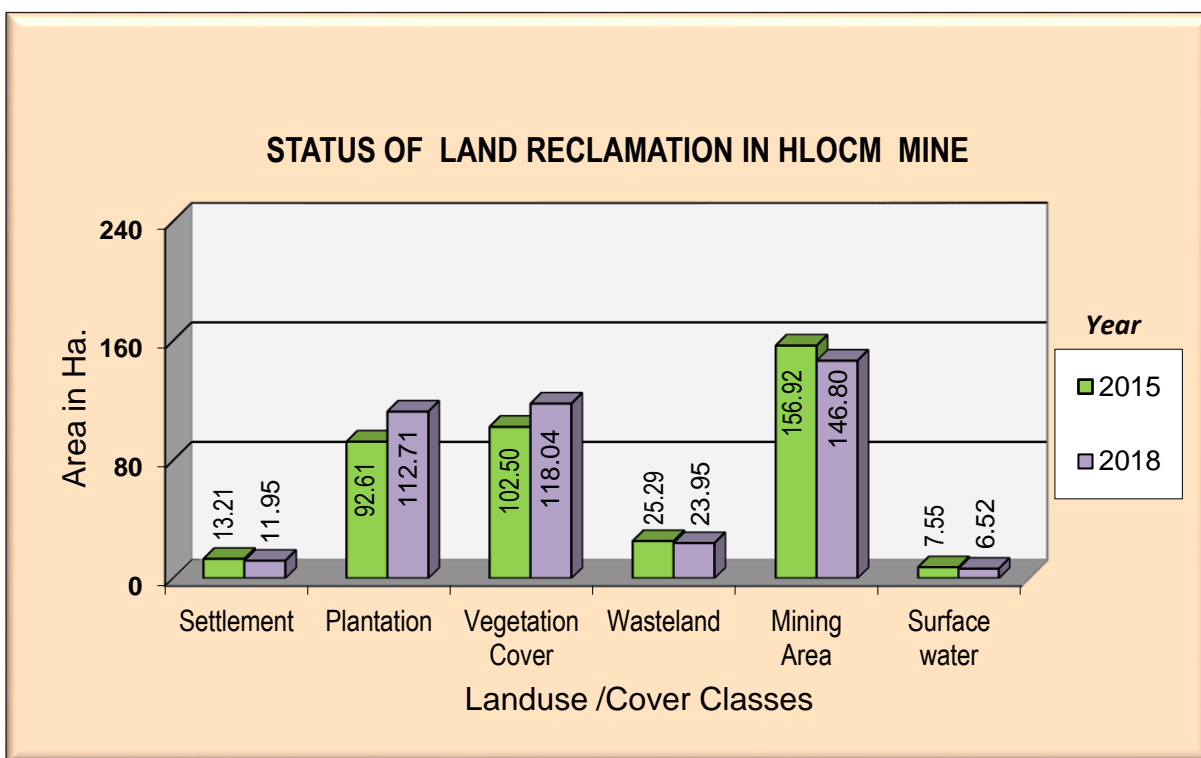


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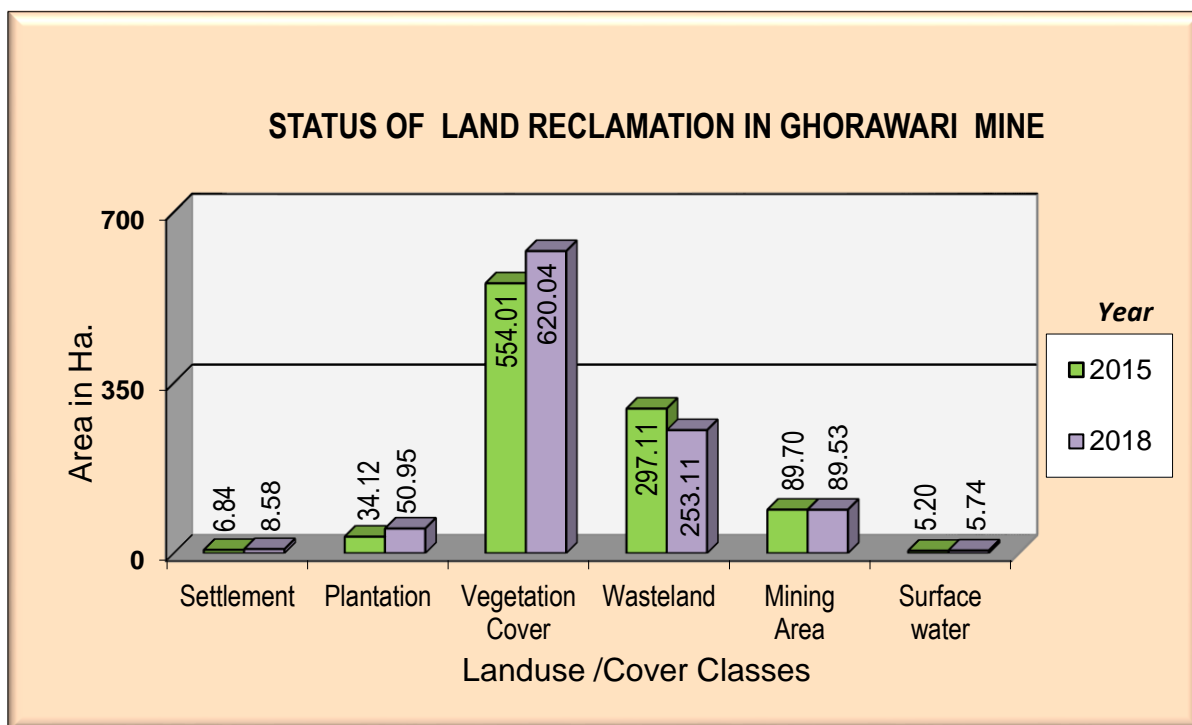


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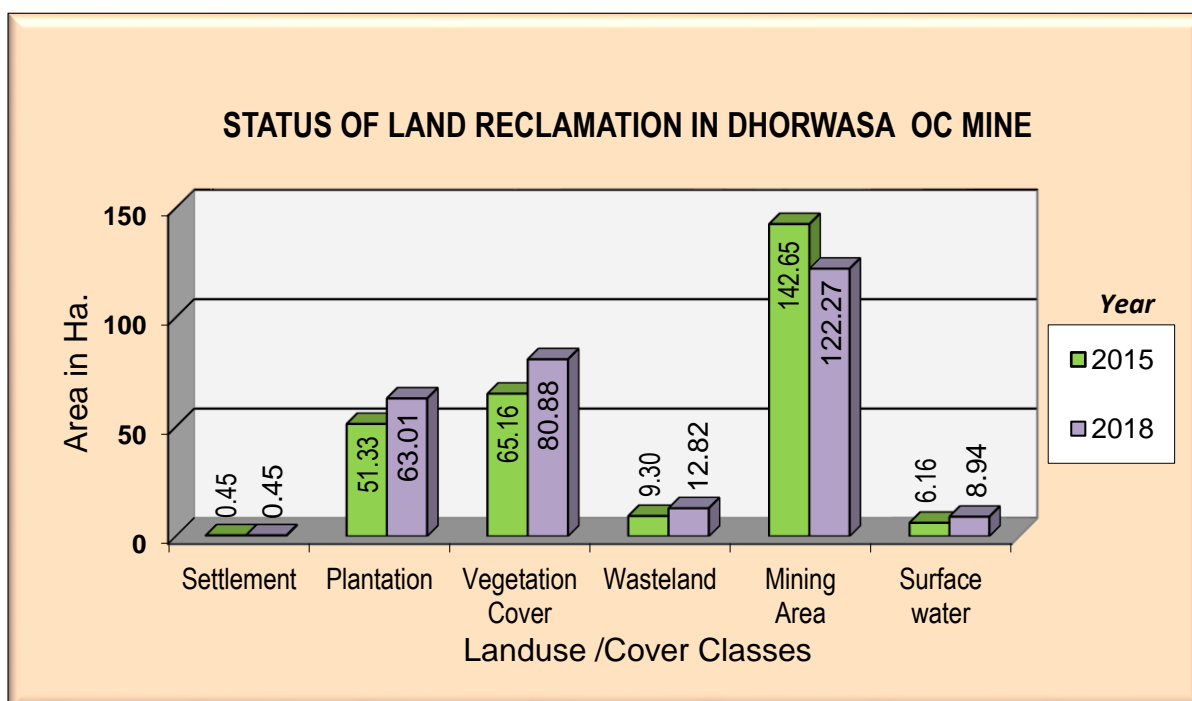


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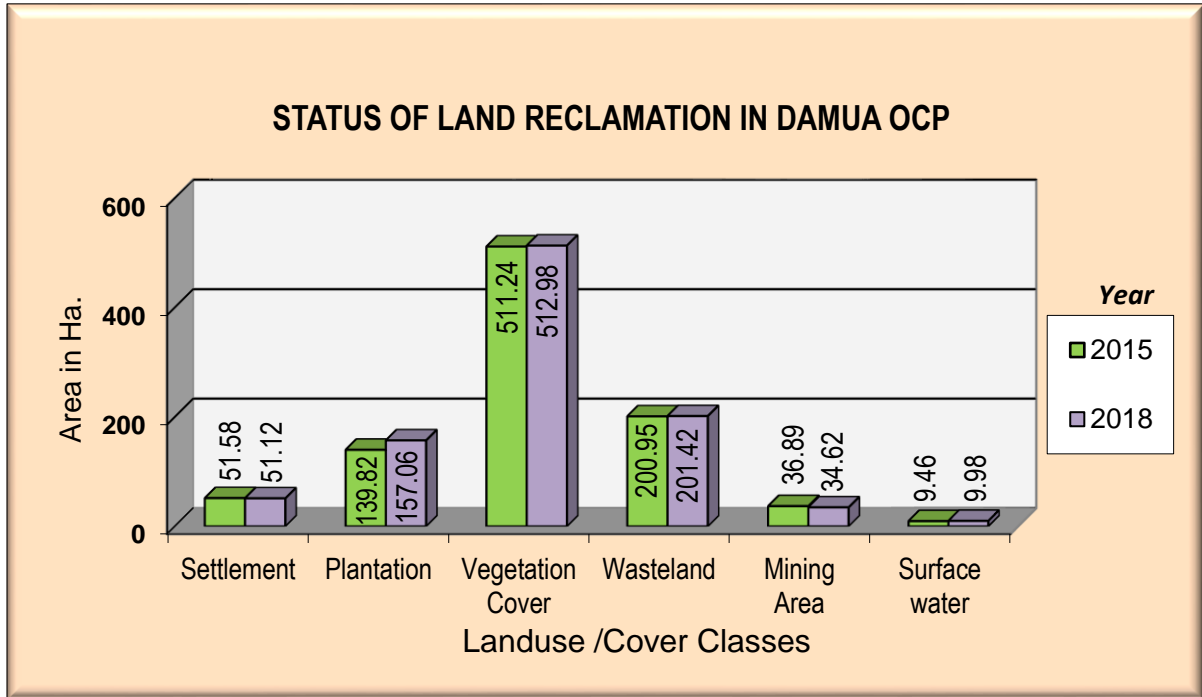


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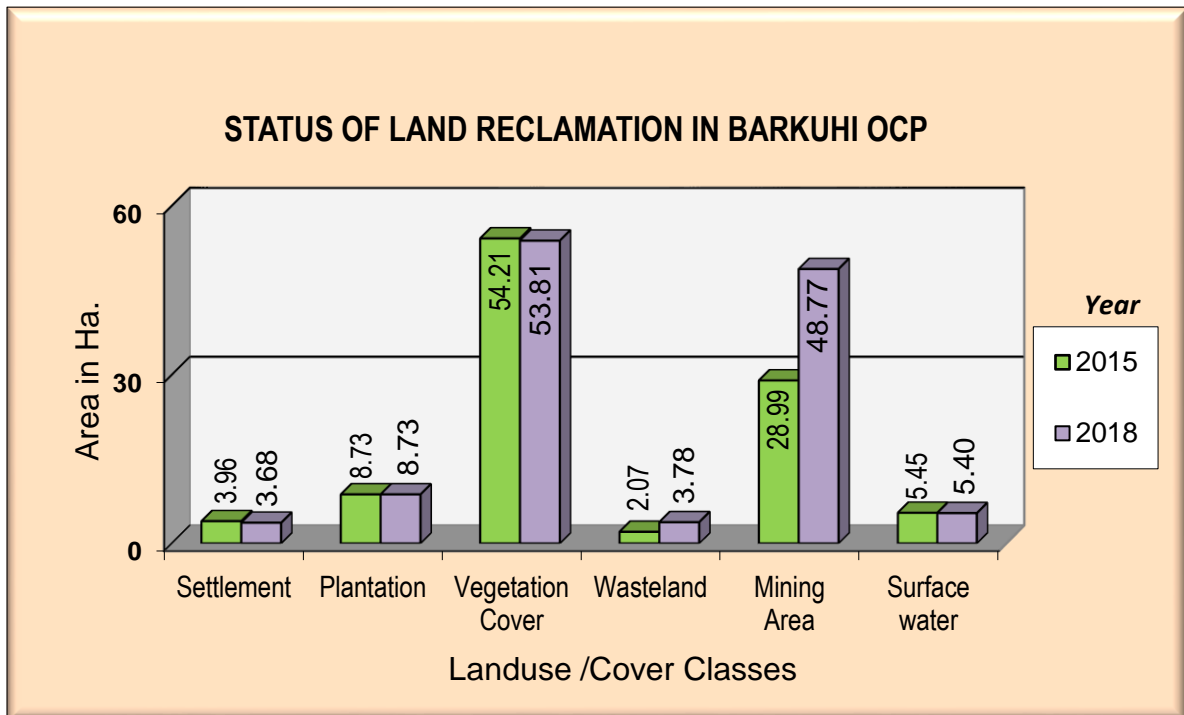


Figure -12

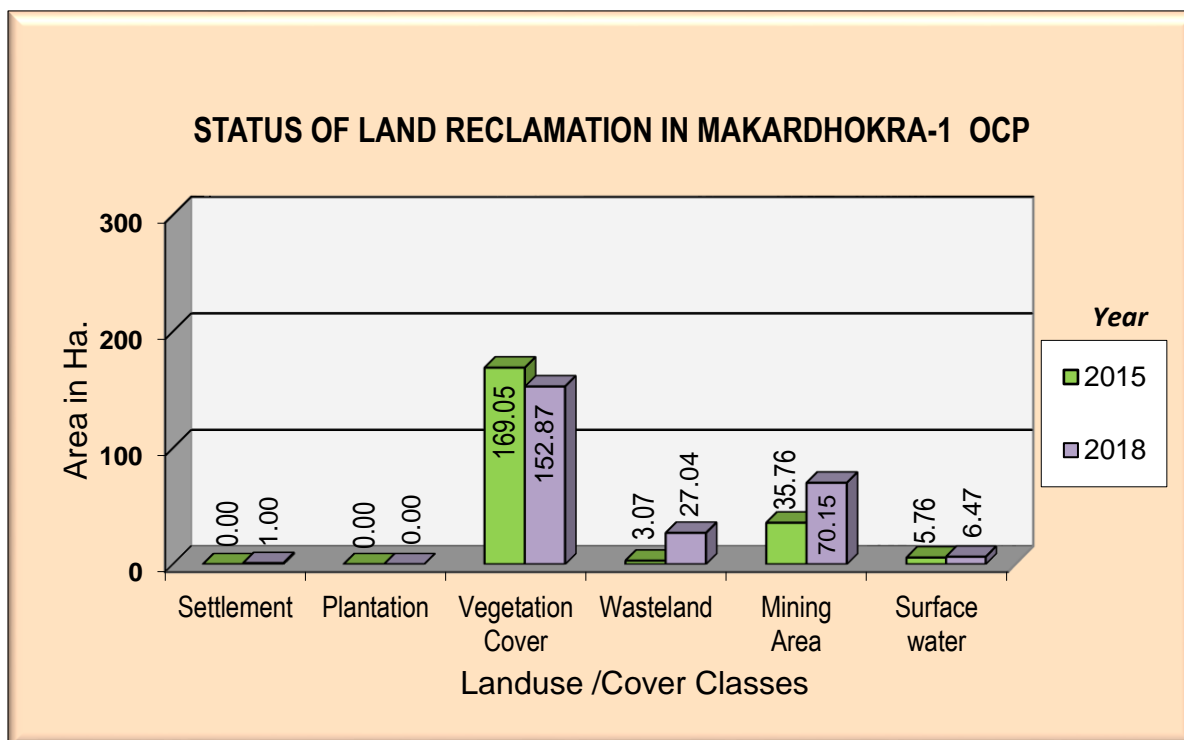


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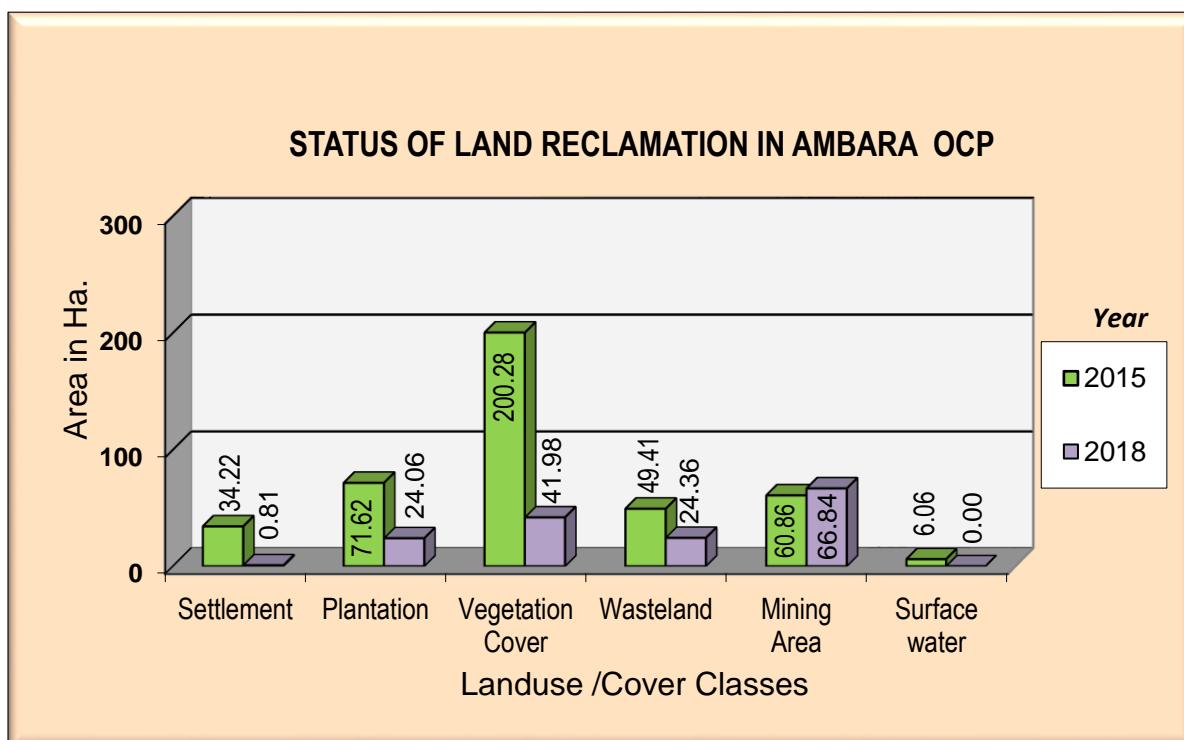


Figure -14



Photograph -1: Plantation under Social Forestry in Kamptee Deep OCP



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Longitude	79.256898	79°15'24" E

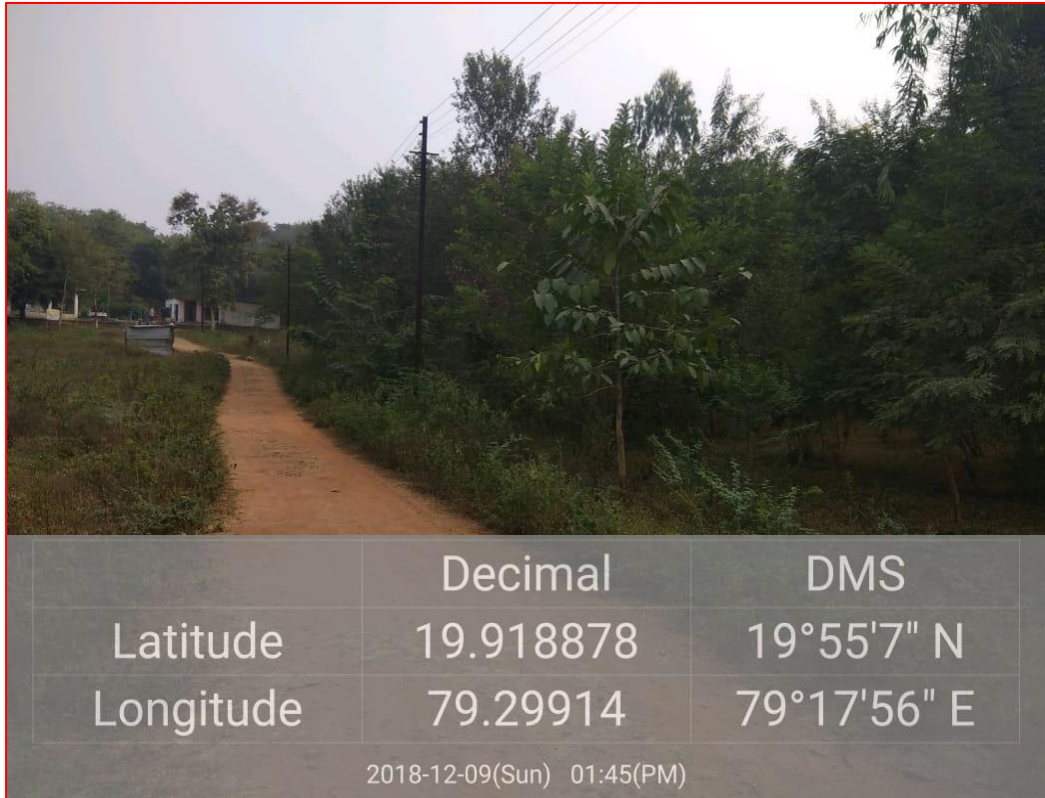
Photograph -2 Plantation under Social Forestry in Pauni Expn OC mine



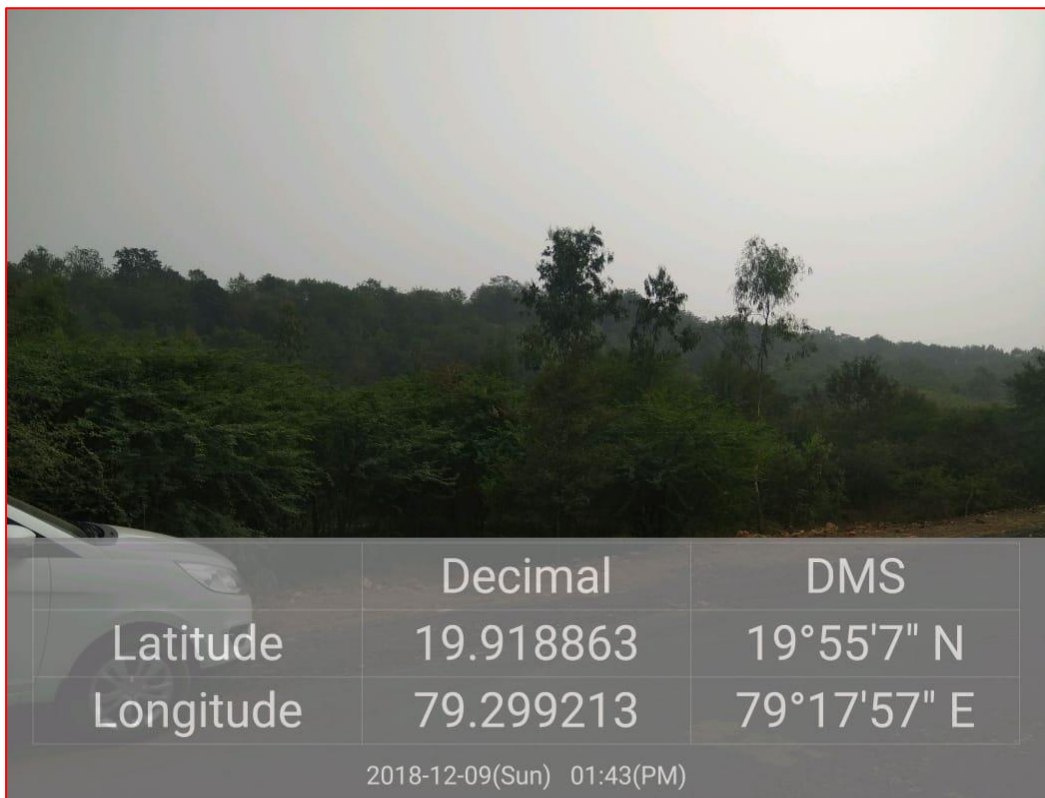
Photograph 3- Plantation on OB in MKD-1 open cast mine



Photograph 4- Plantation on OB in MKD-1 open cast mine



Photograph 5- Plantation under Social Forestry in HLOCM



Photograph 6- Plantation on Barren OB Dump in HLOCM



Photograph 7- Plantation on OB in Dhorwasa opencast mine



Photograph 8- Plantation under social forestry in Dhorwasa opencast mine



Photograph 9- Tree plantation on OB Dump in Navin Kunada OCP



Photograph 10- Tree plantation around pit office in Navin Kunada OCP



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