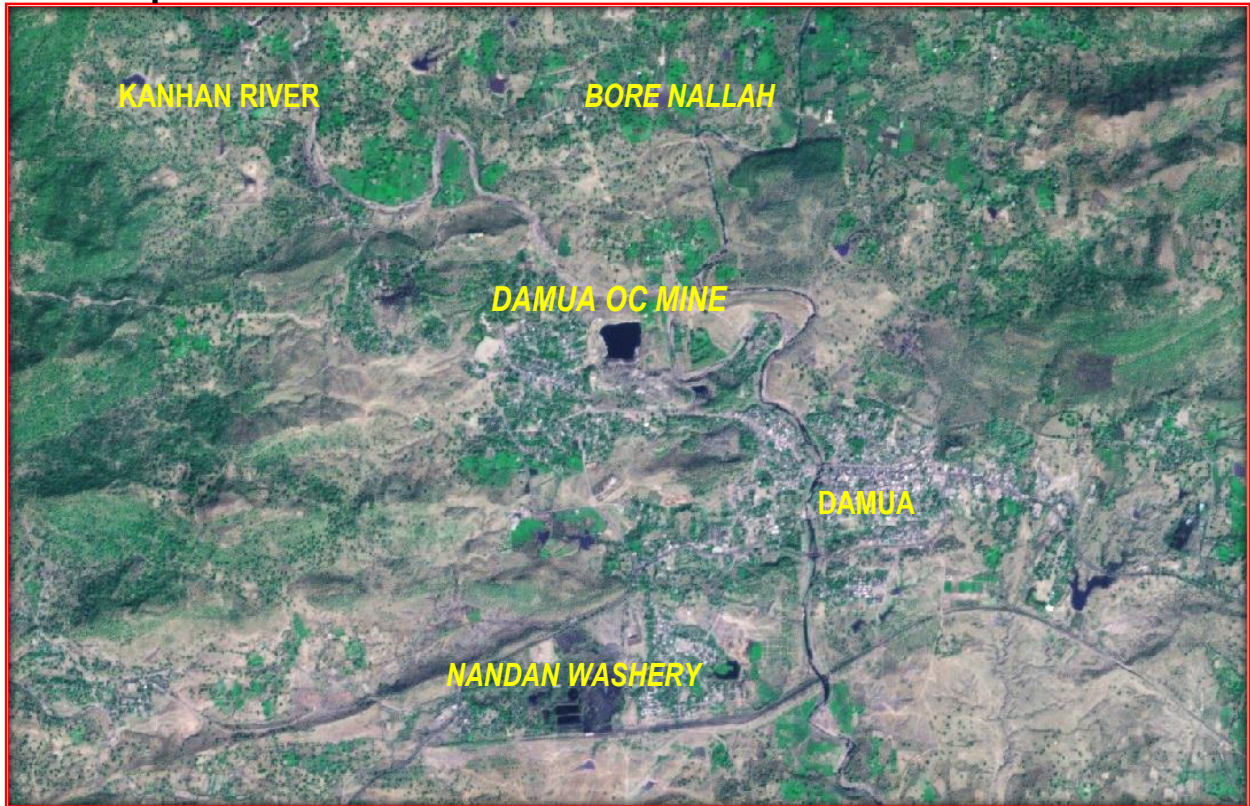


**Land Restoration / Reclamation Monitoring of 11 Opencast Coal Mines
of Western Coalfield Limited producing less than 5 mcm (Coal+ OB)
per annum based on Satellite Data of the Year 2021**



Submitted to
WESTERN COALFIELDS LIMITED

March 2022



cmpdi
A Mini Ratna Company

Land Restoration / Reclamation Monitoring of 11 Opencast Coal Mines of Western Coalfield Limited producing less than 5 mcm (Coal+ OB) per annum based on Satellite Data of the Year 2021

MARCH-2022



**Remote Sensing Cell
Geomatics Division
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Executive Summary

- 1.0 Project** Land restoration/ reclamation monitoring of 11 opencast mine in WCL producing less than 5 million cu.m. (Coal+OB) annually based on satellite data of the year 2021 on regular 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 projects. 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 12 nos OC mine viz Inder UG to OC, Kamptee Deep, Navin Kunada, Shivpuri, Pauni Expn OC, HLOCM, Ghorawari, Dhorwasa, Damua, Barkuhi, ,Ambara OC and MKD-1 OC mine producing less than 5mcm (Coal+OB) annually were considered for monitoring in the year 2018-19, 11nos of OC mine of WCL has been taken up for land reclamation monitoring in the year 2021-22. One no mine named as MKD-1 OC mine which was considered for monitoring under category of mine producing less than 5mcm (Coal+OB) till the year 2018-19. has now been considered under category of those OC mines which have capacity of producing more than 5 mcm (Coal+OB) annually. Therefore, land restoration /reclamation monitoring of MKD-1 mine will be carried out annually along with those OC mine which has capacity of producing more than 5mcm (Coal+OB) from the year 2021 onward and report of the MKD-1OC mine for the year 2021 will be submitted accordingly.
- Out of the total mine leasehold area of 5407.55 Hectare of the 11 OC projects Viz.Inder UG to OC, Kamptee Deep, Navin Kunada, Shivpuri, Pauni Expn OC, HLOCM, Ghorawari, Dhorwasa, Damua, Barkuhi, ,Ambara OC mine taken up for monitoring during year-2021-22; total excavated area is 1088.57 Ha (20.13%). Out of this excavated area, 114.54 Ha area (10.52%) has been planted on backfill, 522.15 Ha area (47.97%) is under backfilling and balance 451.88 Ha area (41.51%) is under active mining. It is evident from the analysis that 636.69 Ha (58.49%) area of the above OC projects have already been reclaimed (biologically and technically) and balance 451.88 Ha (41.51%) area is under active mining. Project wise details are given in Table-1 & Bar chart (Fig-1).

- On comparing the status of land reclamation for 11 nos of opencast projects in WCL carried out in the year 2021-22 with respect to previous cycle study done in the year 2018-19 in these projects of WCL, it is evident from the analysis that area under land reclamation has increased from 563.07 hectares (Yr. 2018) to 636.69 hectares (Yr. 2021) which includes both plantation on backfill (Biological Reclamation) and area under backfilling (Technical Reclamation) .
- It has been observed that area under plantation on backfill (Biological Reclamation) has increased from 86.81 Ha (8.72%) in the Yr. 2018 to 114.54 Ha (10.52%) in the year 2021 whereas area of technical reclamation (area under backfilling) has increased from 476.26 Ha (47.85%) in the year Yr.2018 to 522.15 Ha (47.97%) in the Year 2021.This increase of 27.73 Ha in area of plantation on backfill and 45.89 Ha area under backfilling is the result of the sincere efforts made by Western Coalfields Ltd towards total land reclamation in all OC mines.
- The leasehold boundary of Inder UG to OC has been updated as per EC this year resulting which area of leasehold boundary of this mine has increased from 617.84Ha (Yr.2018) to 661.65 Ha(Yr.2021).whereas shape of leasehold boundary of Ghorawari I&II OC has been modified also as per EC without changing the area of leasehold boundary which remains same as in the year 2018-19 (Refer table-1). Although minor change in the area of lease hold boundary as per EC has been made also in the project like Kamptee Deep, Dhorwasa OC as indicated in Table-1.
- Overall, the area under green cover has gone up from 798.26 Ha in the year 2018 to 865.22 Ha in the year 2021 which shows the sincere effort made by WCL towards environmental protection in their OC projects.
- Total area under reclamation in WCL has gone up from 563.07 Hectares (56.57%) in the year 2018-19 to 636.69 Hectares (58.49%) in the year 2021-22.

Table-1
Project wise Land Reclamation Status in OC mine of WCL producing less than 5 million Cu.M of (Coal+OB) based on Satellite Data of the year 2021

(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											
						Area under Backfilling	Plantation on Excavated / Backfilled Area	Plantation on External Over Burden Dumps	Social Forestry, Avaneue Plantation Etc.										
1	2	3		4		5		6		7		8		9 (=4+5+8)		10 (=5+6+7)		11(=4+5)	
		2018	2021	2018	2021	2018	2021	2018	2021	2018	2021	2018	2021	2018	2021	2018	2021	2018	2021
1	Inder UG to OC	617.84	661.65	57.29	60.01	0.00	0.00	29.79	36.49	37.96	40.81	80.66	79.00	137.95	139.01	67.75	77.30	57.29	60.01
				41.53%	43.17%	0.00%	0.00%					58.47%	56.83%			10.97%	11.68%	41.53%	43.17%
2	kamptee deep	471.44	463.80	51.23	51.53	8.11	8.87	61.39	39.91	37.88	43.57	61.99	67.76	121.33	128.16	107.38	92.35	59.34	60.40
				42.22%	40.21%	6.68%	6.92%					51.09%	52.87%			22.78%	19.91%	48.91%	47.13%
3	Navin kunda OC Expn	373.00	373.00	87.46	79.97	19.71	30.35	88.44	93.26	5.05	4.19	58.17	55.44	165.34	165.76	113.20	127.80	107.17	110.32
				52.90%	48.24%	11.92%	18.31%					35.18%	33.45%			30.35%	34.26%	64.82%	66.55%
4	Shivpuri OC Expn	336.29	336.29	17.98	44.97	6.06	10.15	20.41	20.93	16.53	23.91	47.31	35.14	71.35	90.26	43.00	54.99	24.04	55.12
				25.20%	49.82%	8.49%	11.25%					66.31%	38.93%			12.79%	16.35%	33.69%	61.07%
5	Pauni Expn	255.00	255.00	47.37	57.30	3.83	6.59	36.64	50.66	9.94	10.16	43.76	38.72	94.96	102.61	50.41	67.41	51.20	63.89
				49.88%	55.84%	4.03%	6.42%					46.08%	37.74%			19.77%	26.44%	53.92%	62.26%
6	HLOCM	311.66	311.66	63.64	63.64	6.31	6.35	72.86	73.84	33.54	30.96	35.42	48.24	105.37	118.23	112.71	111.15	69.95	69.99
				60.40%	53.83%	5.99%	5.37%					33.61%	40.80%			36.16%	35.66%	66.39%	59.20%
7	Ghorawari I&II	1296.01	1296.01	32.06	42.76	8.92	16.24	27.60	27.68	14.43	14.84	23.07	38.10	64.05	97.10	50.95	58.76	40.98	59.00
				50.05%	44.04%	13.93%	16.73%					36.02%	39.24%			3.93%	4.53%	63.98%	60.76%
8	Damua	1080.92	1080.92	8.98	8.98	8.51	8.51	9.97	12.83	138.58	144.28	5.51	5.51	23.00	23.00	157.06	165.62	17.49	17.49
				39.04%	39.04%	37.00%	37.00%					23.96%	23.96%			14.53%	15.32%	76.04%	76.04%
9	Dhorwasa	232.91	229.56	51.07	51.68	11.85	13.64	39.69	53.62	11.47	9.02	36.12	39.41	99.04	104.73	63.01	76.28	62.92	65.32
				51.57%	49.35%	11.96%	13.02%					36.47%	37.63%			27.05%	33.23%	63.53%	62.37%
10	Barkuhi	237.51	237.51	13.84	15.64	0.00	0.00	0.00	0.00	8.73	8.81	18.69	18.01	32.53	33.65	8.73	8.81	13.84	15.64
				42.55%	46.48%	0.00%	0.00%					57.45%	53.52%			3.68%	3.71%	42.55%	46.48%
11	Ambara	162.15	162.15	45.34	45.67	13.51	13.84	0.00	0.00	10.55	10.91	21.50	26.55	80.35	86.06	24.06	24.75	58.85	59.51
				56.43%	53.07%	16.81%	16.08%					26.76%	30.85%			14.84%	15.26%	73.24%	69.15%
	TOTAL	5374.73	5407.55	476.26	522.15	86.81	114.54	386.79	409.22	324.66	341.46	432.20	451.88	995.27	1088.57	798.26	865.22	563.07	636.69
				47.85%	47.97%	8.72%	10.52%					43.43%	41.51%	18.52%	20.13%	14.85%	16.00%	56.57%	58.49%

(% is calculated with respected 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.% dcalulated in respect to total excavated area except for "Total area under plantation" where % has been calculated in terms of leasehold area.
6. In the Year 21-22 , MKD-1 OC mine has been included in those category of mines of WCL which produce more than 5 mcm(Coal+OB).

PROJECTWISE STATUS OF LAND RECLAMATION IN WCL FOR THE YEAR 2021

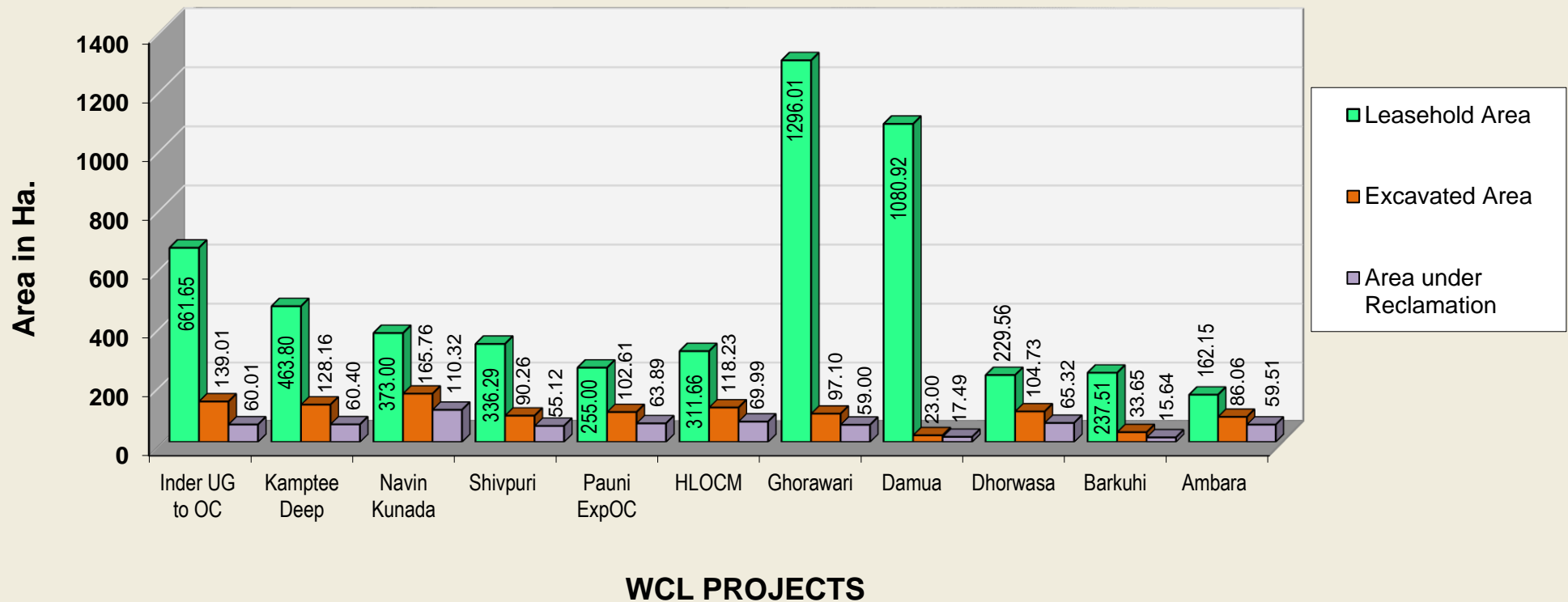


Figure: 1 Land Reclamation status in OC projects producing (less than 5 m.cm (Coal+ OB)) of WCL in the year-2021

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 2021 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:

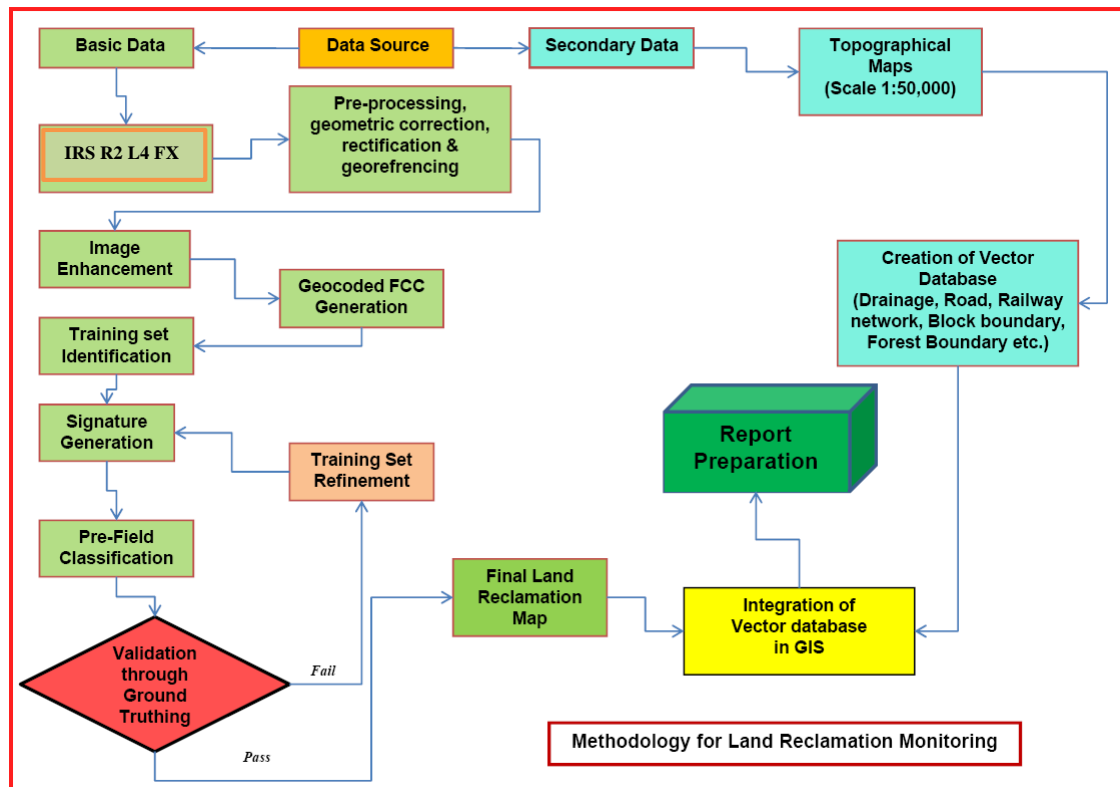


Figure :2 Methodology for Land Reclamation Monitoring

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 area arranged from respective subsidiaries/RIs and 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 of respective mines is determined by 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 status database is created on GIS platform to identify the temporal changes identified from satellite data of different cut-of dates like year 2015, 2018 and 2021.

4.0 Land Reclamation Status in Western Coalfields Ltd.

4.01 Following eleven 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 2021-22:

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

4.02 Area statistics of different land use class present in the mine leasehold of the above projects for the year 2021 are shown in the Table - 2. Land use maps derived from satellite data are shown in Plate 1– 11. Status of land reclamation monitoring for the above mentioned 11 opencast projects were also prepared for the year 2015, 2018. Year wise changes in the different land use classes based on satellite data of the year 2015, 2018 and 2021 are depicted in Bar Charts in Fig. 3 – 13.

4.03 Study reveals that out of total mine leasehold area of 5407.55 Ha of 11 OC projects in WCL Viz Inder Ug to OC, Kamptee Deep , Navin Kunada ,Shivpuri Pauni Expn ,HLOCM Ghorawari ,Dhorwasa , Damua , Barkuhi and Ambara considered for monitoring during year 2021-22 ; total excavated area is 1088.57 Ha(20.13%) ,out of which 114.54 Ha (10.52%) area has been revegetated (Biologically reclaimed) and 522.15 Ha (47.97%) area is under backfilling (Technically reclaimed) and balance 451.88 Hectare (41.51%) area is under active mining. It is evident from analysis that

636.69 Hectare (58.49%) area of above OC projects are under total reclamation in WCL. Project wise details are given in Table-8.1

- 4.04** Study indicates that overall all the projects of WCL considered for this study in the year 2021 indicate increase or static trend in Biological reclamation (plantation on backfill) with respect to the year 2018.
- 4.05** It is evident from analysis that area under land reclamation has increased from 563.07 Ha(Yr.2018) to 636.69 Ha (Yr.2021) which includes both plantation on backfill (Biological Reclamation) and area under backfilling (Technical Reclamation) .This increase of 73.62 Ha area under total reclamation for eleven opencast mine of WCL in the period of three year is due to increase in area under Technical reclamation and Biological Reclamation to the tune of 45.89 Ha and 27.73 Ha respectively. Projectwise status of Land reclamation for eleven OC mines area are shown in bar chart (Figure-1)
- 4.06** There has been overall increase in area under Technical reclamation (area under backfilling) in all projects of WCL except in Navin Kunada OCP where area under technical reclamation has decreased from 87.46 Ha (Yr.2018) to 79.97 Ha (Yr.2021). This decrease of 7.49 Ha area under backfilling in the year 2021 as compared to the year 2018 is due to more area of backfilling has come under area of plantation on backfill in this mine as indicated in Table:1
- 4.07** After analyzing the satellite data of year 2018 vs. 2021, it is evident that total area under plantation (Green Cover) carried out on backfilled area, OB dumps as well as area under social forestry in all the mines of WCL has increased from 798.26 Ha area (Yr.2018) to 865.22 Hectare area (Yr.2021) in span of three year. This increase of 66.96 Hectare area under total plantation (Green Cover) during three year is due to more plantation has been carried out within leasehold area of the mines .
- 4.08** The production in Damua OC mine is temporarily discontinued since 20017 , hence there is no change in area under technical reclamation and biological reclamation

with respect to the year 2018 resulting which area under total reclamation in Damua OC this year is also same as in the year 2018. It is also observed that there is no change in area of active mining and excavated area also with respect to the year 2018 as shown in Table-1.

- 4.09** In Kamptee Deep OC mine, the area under plantation on OB has decreased from 61.39 Ha (Yr.2018) to 39.91 Ha (Yr.2021) due to dumping of barren OB on planted area of overburden. This decrease of 21.48 Ha area in plantation on OB has resulted in decrease in area of green cover in its leasehold boundary of Kamptee Deep OC mine from 107.38 Ha (Yr.2018) to 92.35 Ha (Yr.2021) and percentage green cover generated has also decreased from 22.78 % (Yr.2018) to 19.91% (Yr.2021).
- 4.10** The leasehold boundary of Ghorawari I&II OC has been updated as per EC this year which has resulted in significant change in shape not in area of leasehold boundary i.e 1296.01 Ha which is same as in the year 2018. Area under plantation on backfill has increased from 8.92 Ha (13.93%) in the year 2018 to 16.24 Ha (16.73%) in the year 2021 and area under backfilling has increased from 32.06 Ha (50.05%) to 42.76 Ha (44.04%) resulting which there is an increase in area of total reclamation i.e from 40.98 Ha (63.98%) (Yr.2018) to 59.00 Ha (60.76%) (Yr.2021).
- 4.11** Out of 11 projects of WCL, maximum land reclamation has been carried out in Damua OC projects (76.04%) followed by Ambara (69.15%), Navin Kunada (66.55%), Dhorwasa OC (62.37%), Pauni OC Exn (62.26%), Shivpuri (61.07%), Ghorawari (60.76%), HLOCM (59.20%), Kamptee Deep (47.13%), Barkuhi OC (46.48%) and Inder UG to OC (43.17%) respectively.
- 4.12** Land reclamation monitoring of above set of opencast mines of WCL will be carried out again with the help of satellite data of the year 2024 and comparison for status of the same will be made also with respect to the satellite data of the year 2021.

TABLE 2 : PROJECTWISE AREA STATISTICS OF LANDUSE/COVER CLASSES IN OC MINES OF WCL PRODUCING (<5M.CM (COAL +OB)) BASED ON SATELLITE DATA OF THE YEAR 2021

(Area in Hectare)

CLASSES (RGB COLOUR)			Inder UG to OC		Kamptee Deep		Navin Kunada		Shivpuri		Pauni Expn OC		HLOCM		Ghorawari I&I		Damua		Dhorwasa		Barkuhi		Ambara		Total		
			Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	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	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	53.42	4.12	61.62	5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.04	2.13
	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	115.04	2.13
SCRUBS	Scrubs		110.18	16.65	33.48	7.22	21.69	5.82	23.15	6.88	21.63	8.48	5.25	1.69	315.59	24.35	283.26	26.21	16.22	7.07	26.73	11.25	18.98	11.71	876.16	16.20	
	Total Scrubs		110.18	16.65	33.48	7.22	21.69	5.82	23.15	6.88	21.63	8.48	5.25	1.69	315.59	24.35	283.26	26.21	16.22	7.07	26.73	11.25	18.98	11.71	876.16	16.20	
PLANTATION	Social Forestry		40.81	6.17	43.57	9.39	4.19	1.12	23.91	7.11	10.16	3.98	30.96	9.94	14.84	1.15	144.28	13.35	9.02	3.93	8.81	3.71	10.91	6.73	341.46	6.31	
	Plantation on OB Dump		36.49	5.52	39.91	8.60	93.26	25.00	20.93	6.22	50.66	19.87	73.84	23.69	27.68	2.14	12.83	1.19	53.62	23.36	0.00	0.00	0.00	0.00	409.22	7.57	
	Plantation on Backfill		0.00	0.00	8.87	1.91	30.35	8.14	10.15	3.02	6.59	2.58	6.35	2.04	16.24	1.25	8.51	0.79	13.64	5.94	0.00	0.00	13.84	8.54	114.54	2.12	
	Total Plantation on backfill		0.00	0.00	8.87	1.91	30.35	8.14	10.15	3.02	6.59	2.58	6.35	2.04	16.24	1.25	8.51	0.79	13.64	5.94	0.00	0.00	13.84	8.54	114.54	2.12	
Total Green Cover Generated		77.30	11.69	92.35	19.90	127.80	34.26	54.99	16.35	67.41	26.43	111.15	35.67	58.76	4.54	165.62	15.33	76.28	33.23	8.81	3.71	24.75	15.27	865.22	16.00		
Total Vegetation Cover		187.48	28.34	125.83	27.12	149.49	40.08	78.14	23.23	89.04	34.91	116.40	37.36	427.77	33.01	510.50	47.24	92.50	40.30	35.54	14.96	43.73	26.98	1856.42	34.33		
ACTIVE MINING	Coal Quarry		72.61	10.97	56.85	12.26	27.14	7.28	13.04	3.88	29.68	11.64	42.94	13.78	14.01	1.08	3.12	0.29	14.54	6.33	12.36	5.20	14.83	9.15	301.12	5.57	
	Coal Dump		3.50	0.53	2.41	0.52	3.59	0.96	2.56	0.76	4.03	1.58	1.96	0.63	1.36	0.10	0.00	0.00	2.59	1.13	1.88	0.79	0.86	0.53	24.74	0.46	
	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	
	Quarry Filled With Water		2.89	0.44	8.50	1.83	24.71	6.62	19.54	5.81	5.01	1.96	3.34	1.07	22.73	1.75	2.39	0.22	22.28	9.71	3.77	1.59	10.86	6.70	126.02	2.33	
	Total Area under Active Mining		79.00	11.94	67.76	14.61	55.44	14.86	35.14	10.45	38.72	15.18	48.24	15.48	38.10	2.93	5.51	0.51	39.41	17.17	18.01	7.58	26.55	16.38	451.88	8.36	
RECLAIMED	Barren OB Dump		64.39	9.73	33.76	7.28	38.42	10.30	28.36	8.43	37.49	14.70	21.18	6.80	28.03	2.16	17.75	1.64	25.12	10.94	15.84	6.67	0.00	0.00	310.40	5.74	
	Barren Backfilled Area		60.01	9.07	51.53	11.11	79.97	21.44	44.97	13.37	57.30	22.47	63.64	20.42	42.76	3.30	8.98	0.83	51.68	22.51	15.64	6.58	45.67	28.17	522.15	9.66	
	Total Area under Technical Reclamation		60.01	9.07	51.53	11.11	79.97	21.44	44.97	13.37	57.30	22.47	63.64	20.42	42.76	3.30	8.98	0.83	51.68	22.51	15.64	6.58	45.67	28.17	522.15	9.66	
Total Area Under Mine Operation		203.40	30.74	153.05	33.00	173.83	46.60	108.47	32.25	133.51	52.35	133.06	42.70	108.89	8.39	32.24	2.98	116.21	50.62	49.49	20.83	72.22	44.55	1284.43	23.76		
WASTE LAND	Waste Lands		34.36	5.19	34.50	7.44	23.19	6.22	38.89	11.58	11.98	4.70	40.06	12.85	208.33	16.07	179.70	16.62	12.50	5.45	5.04	2.12	17.93	11.06	606.48	11.22	
	Fly Ash Pond / Sand Body		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.01	1.57	0.00	0.00	0.00	0.00	15.52	1.44	0.97	0.42	0.00	0.00	0.00	0.00	20.50	0.38	
Total Wasteland		34.36	5.19	34.50	7.44	23.19	6.22	38.89	11.58	15.99	6.27	40.06	12.85	208.33	16.07	195.22	18.06	13.47	5.87	5.04	2.12	17.93	11.06	626.98	11.60		
WATERBODIES	Reservoir, nallah, ponds		4.43	0.67	2.80	0.60	6.47	1.73	1.18	0.35	0.00	0.00	6.51	2.09	2.34	0.20	10.98	1.01	0.00	0.00	6.24	2.63	0.00	0.00	40.95	0.75	
	Total Waterbodies		4.43	0.67	2.80	0.60	6.47	1.73	1.18	0.35	0.00	0.00	6.51	2.09	2.34	0.20	10.98	1.01	0.00	0.00	6.24	2.63	0.00	0.00	40.95	0.75	
AGRICULTURE	Crop Lands		12.07	1.82	8.80	1.90	0.00	0.00	18.20	5.41	0.00	0.00	0.00	0.00	87.28	6.73	10.85	1.00	0.00	0.00	79.09	33.30	15.69	9.68	231.98	4.29	
	Fallow Lands		214.77	32.46	114.02	24.58	15.76	4.23	72.51	21.56	15.75	6.20	4.07	1.31	453.65	35.00	273.95	25.34	6.70	2.91	57.92	24.39	11.40	7.03	1240.50	22.94	
	Total Agriculture		226.84	34.28	122.82	26.48	15.76	4.23	90.71	26.97	15.75	6.20	4.07	1.31	540.93	41.73	284.80	26.34	6.70	2.91	137.01	57.69	27.09	16.71	1472.48	27.23	
SETTLEMENTS	Urban Settlement		3.67	0.55	23.83	5.14	0.54	0.14	12.93	3.84	0.38	0.14	10.16	3.26	5.61	0.43	42.46	3.93	0.55	0.24	3.81	1.61	1.18	0.70	105.12	1.94	
	Rural Settlement		1.47	0.23	0.00	0.00	0	0	5.97	1.78	0.00	0.00	0.00	0.00	1.63	0.13	3.76	0.35	0.00	0.00	0.38	0.16	0.00	0.00	13.21	0.24	
	Industrial Settlement		0.00	0.00	0.97	0.22	3.72	1.00	0.00	0.00	0.33	0.13	1.40	0.43	0.51	0.04	0.96	0.09	0.13	0.06	0.00	0.00	0.00	0.00	8.02	0.15	
	Total Settlement		5.14	0.78	24.80	5.36	4.26	1.14	18.90	5.62	0.71	0.27	11.56	3.69	7.75	0.60	47.18	4.37	0.68	0.30	4.19	1.77	1.18	0.70	126.35	2.33	
Grand Total		661.65	100.00	463.80	100.00	373.00	100.00	336.29	100.00	255.00	100.00	311.66	100.00	1296.01	100.00	1080.92	100.00	229.56	100.00	237.51	100.00	162.15	100.00	5407.55	100.00		

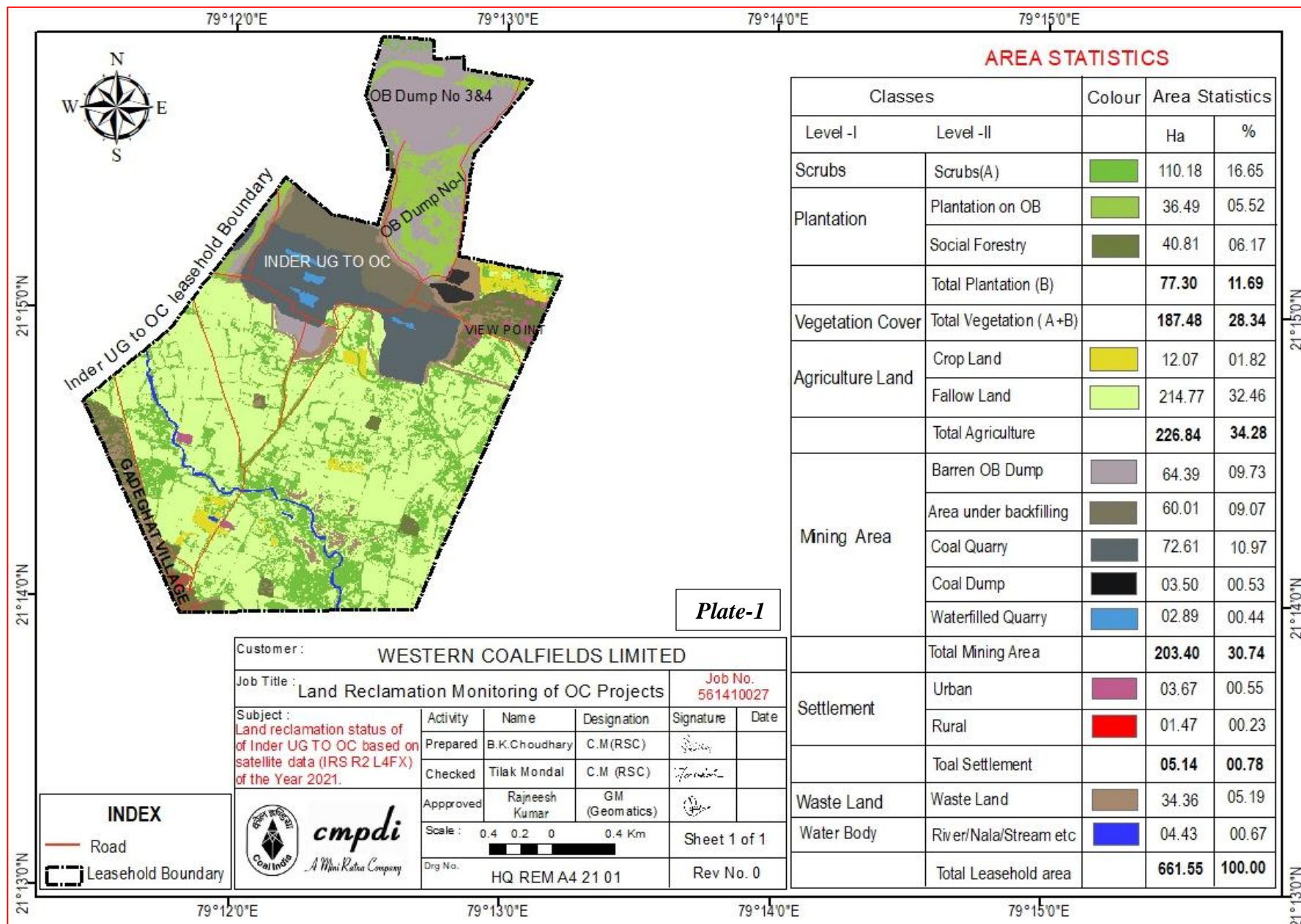


Plate-1

Customer : WESTERN COALFIELDS LIMITED

Job Title : Land Reclamation Monitoring of OC Projects Job No. 561410027

Subject : Land reclamation status of Inder UG TO OC based on satellite data (IRS R2 L4FX) of the Year 2021.

Activity	Name	Designation	Signature	Date
Prepared	B.K.Choudhary	C.M (RSC)		
Checked	Tilak Mondal	C.M (RSC)		
Approved	Rajneesh Kumar	GM (Geomatics)		

Scale : 0.4 0.2 0 0.4 Km

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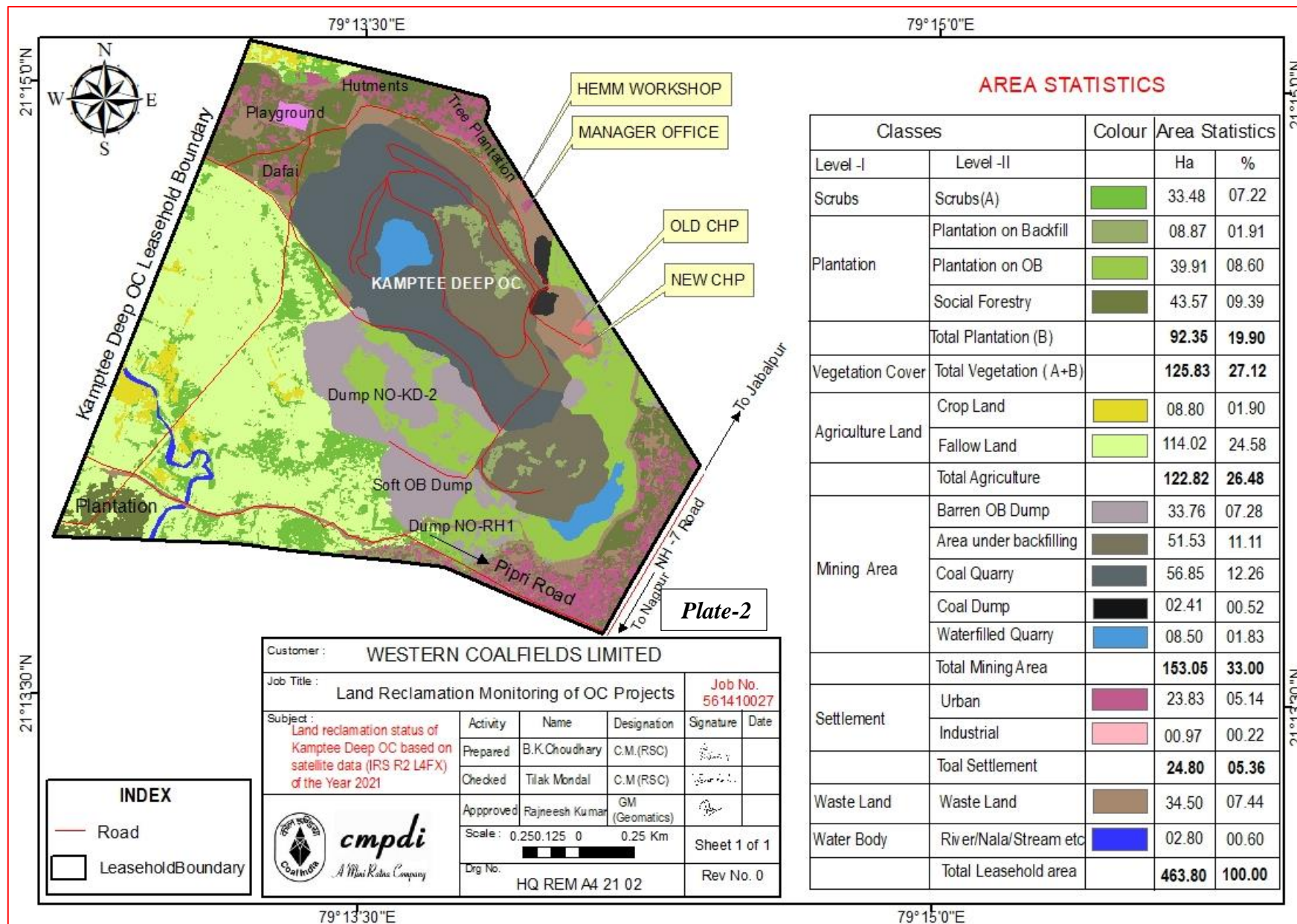
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AREA STATISTICS

Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	Scrubs(A)		33.48	07.22
Plantation	Plantation on Backfill		08.87	01.91
	Plantation on OB		39.91	08.60
	Social Forestry		43.57	09.39
	Total Plantation (B)		92.35	19.90
Vegetation Cover	Total Vegetation (A+B)		125.83	27.12
Agriculture Land	Crop Land		08.80	01.90
	Fallow Land		114.02	24.58
	Total Agriculture		122.82	26.48
Mining Area	Barren OB Dump		33.76	07.28
	Area under backfilling		51.53	11.11
	Coal Quarry		56.85	12.26
	Coal Dump		02.41	00.52
	Waterfilled Quarry		08.50	01.83
	Total Mining Area		153.05	33.00
Settlement	Urban		23.83	05.14
	Industrial		00.97	00.22
	Total Settlement		24.80	05.36
Waste Land	Waste Land		34.50	07.44
Water Body	River/Nala/Stream etc		02.80	00.60
	Total Leasehold area		463.80	100.00

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Customer : WESTERN COALFIELDS LIMITED

Job Title : Land Reclamation Monitoring of OC Projects Job No. 561410027

Subject	Activity	Name	Designation	Signature	Date
Land reclamation status of Kamptee Deep OC based on satellite data (IRS R2 L4FX) of the Year 2021	Prepared	B.K.Choudhary	C.M.(RSC)		
	Checked	Tilak Mondal	C.M.(RSC)		
	Approved	Rajneesh Kumar	GM (Geomatics)		

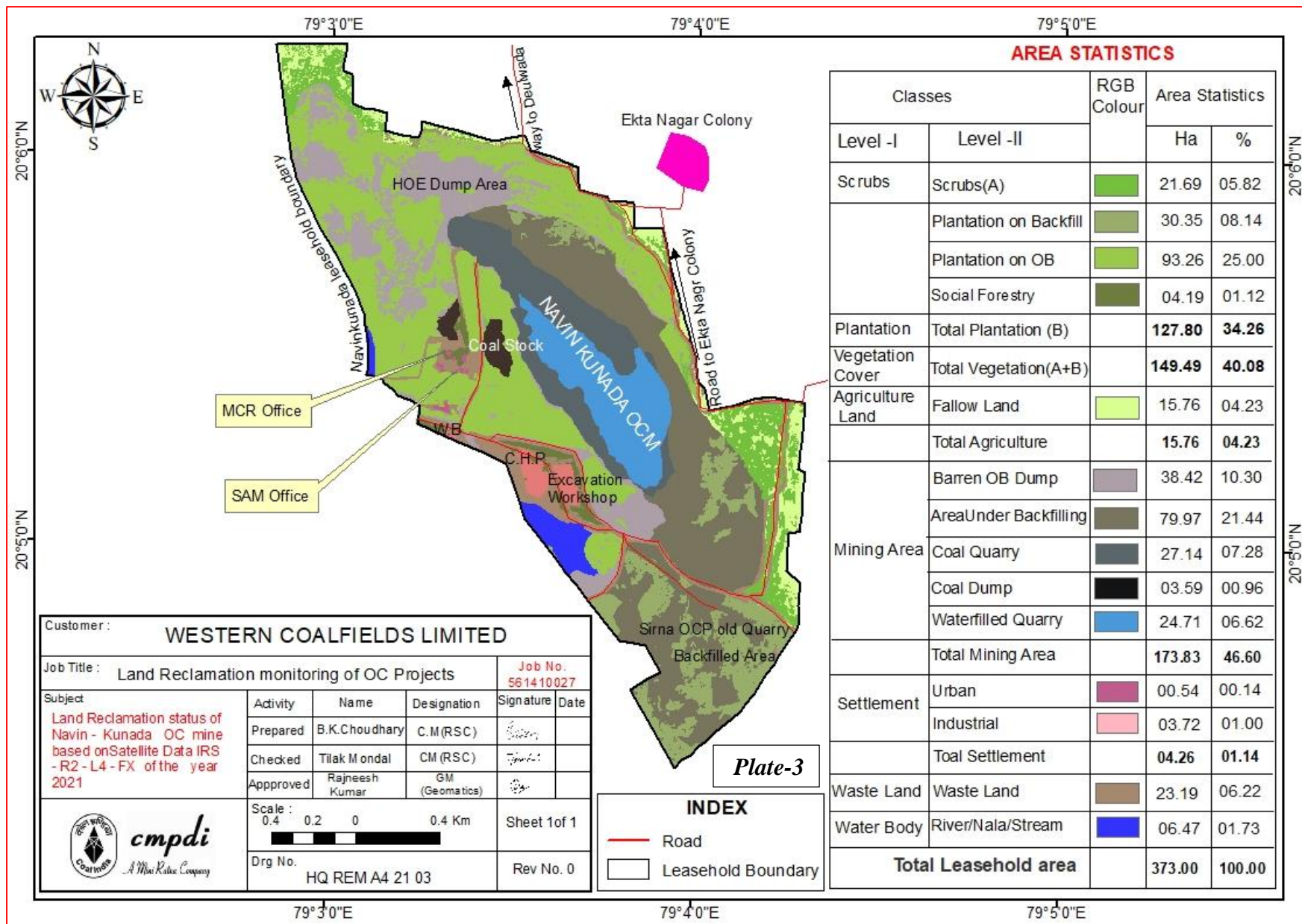
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AREA STATISTICS

Classes		RGB Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrub	Scrub(A)		21.69	05.82
	Plantation on Backfill		30.35	08.14
	Plantation on OB		93.26	25.00
	Social Forestry		04.19	01.12
Plantation	Total Plantation (B)		127.80	34.26
Vegetation Cover	Total Vegetation(A+B)		149.49	40.08
Agriculture Land	Fallow Land		15.76	04.23
	Total Agriculture		15.76	04.23
Mining Area	Barren OB Dump		38.42	10.30
	Area Under Backfilling		79.97	21.44
	Coal Quarry		27.14	07.28
	Coal Dump		03.59	00.96
	Waterfilled Quarry		24.71	06.62
	Total Mining Area		173.83	46.60
Settlement	Urban		00.54	00.14
	Industrial		03.72	01.00
	Total Settlement		04.26	01.14
Waste Land	Waste Land		23.19	06.22
Water Body	River/Nala/Stream		06.47	01.73
Total Leasehold area			373.00	100.00

Customer: **WESTERN COALFIELDS LIMITED**

Job Title: Land Reclamation monitoring of OC Projects Job No. 561410027

Subject	Activity	Name	Designation	Signature	Date
Land Reclamation status of Navin - Kunada OC mine based on Satellite Data IRS - R2 - L4 - FX of the year 2021	Prepared	B.K.Choudhary	C.M(RSC)		
	Checked	Tilak Mondal	CM (RSC)		
	Approved	Rajneesh Kumar	GM (Geomatics)		
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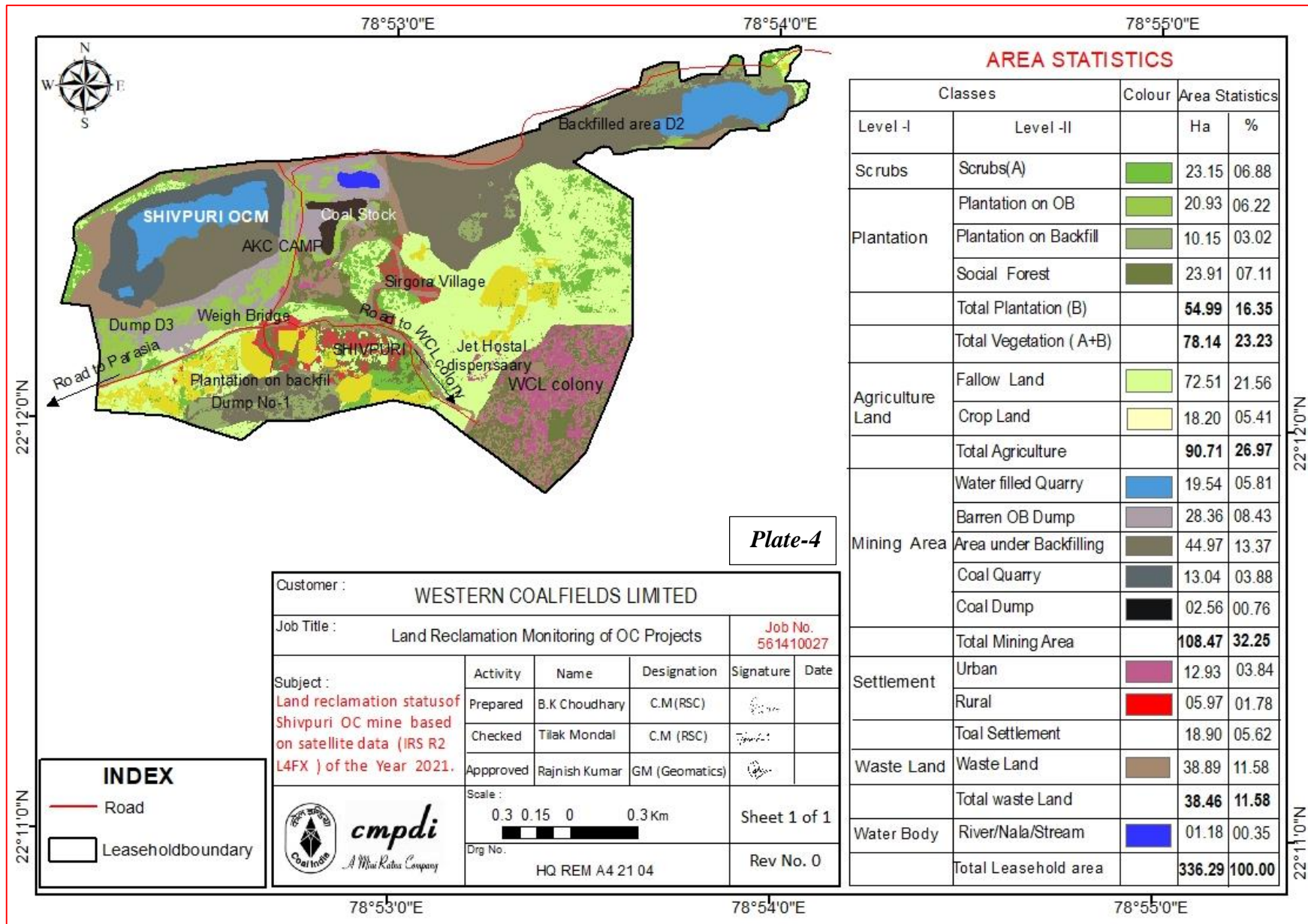


Plate-4

Customer : WESTERN COALFIELDS LIMITED

Job Title : Land Reclamation Monitoring of OC Projects Job No. 561410027

Subject :	Activity	Name	Designation	Signature	Date
Land reclamation status of Shivpuri OC mine based on satellite data (IRS R2 L4FX) of the Year 2021.	Prepared	B.K Choudhary	C.M(RSC)		
	Checked	Tilak Mondal	C.M (RSC)		
	Approved	Rajnish Kumar	GM (Geomatics)		

Scale : 0.3 0.15 0 0.3 Km

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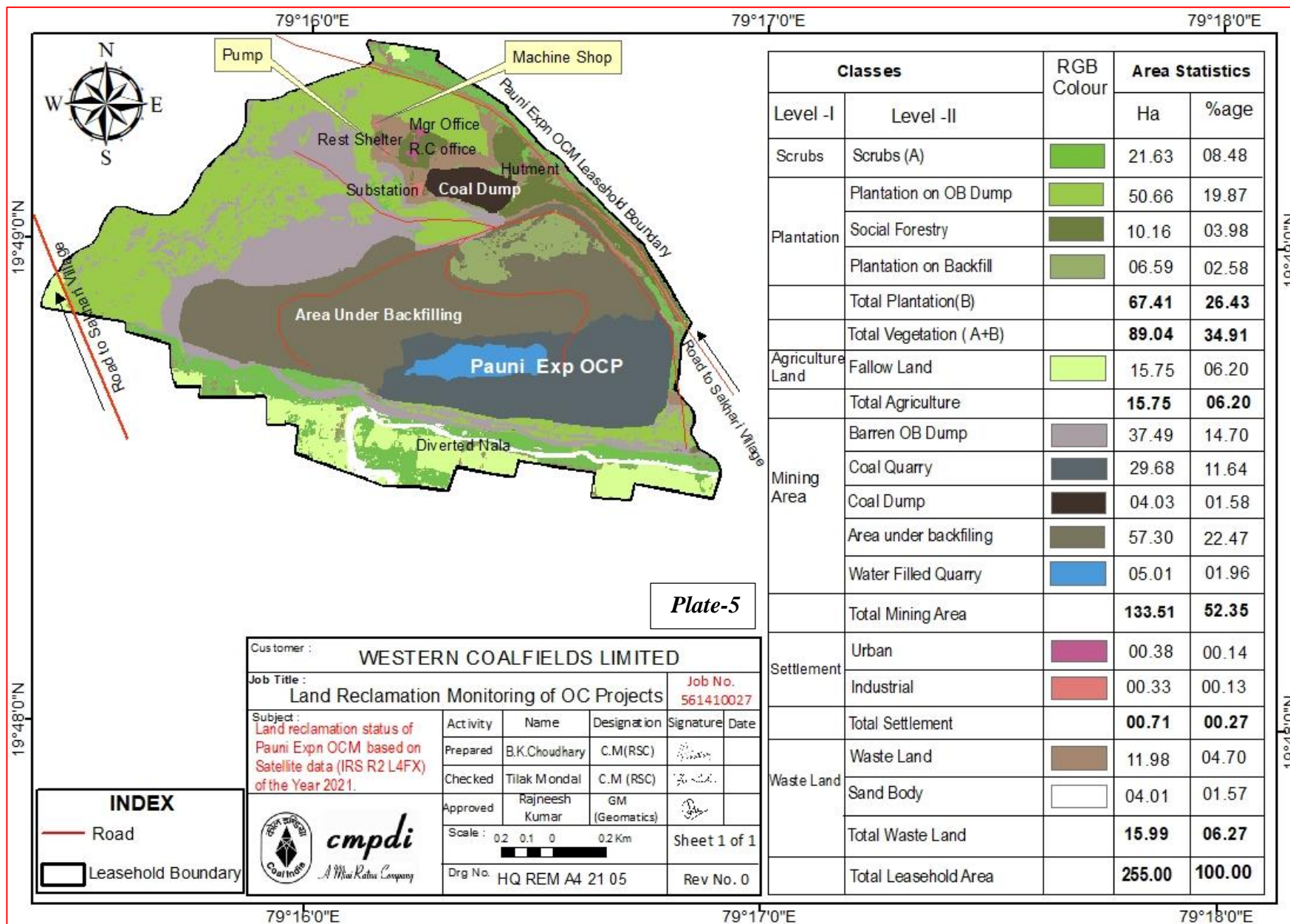
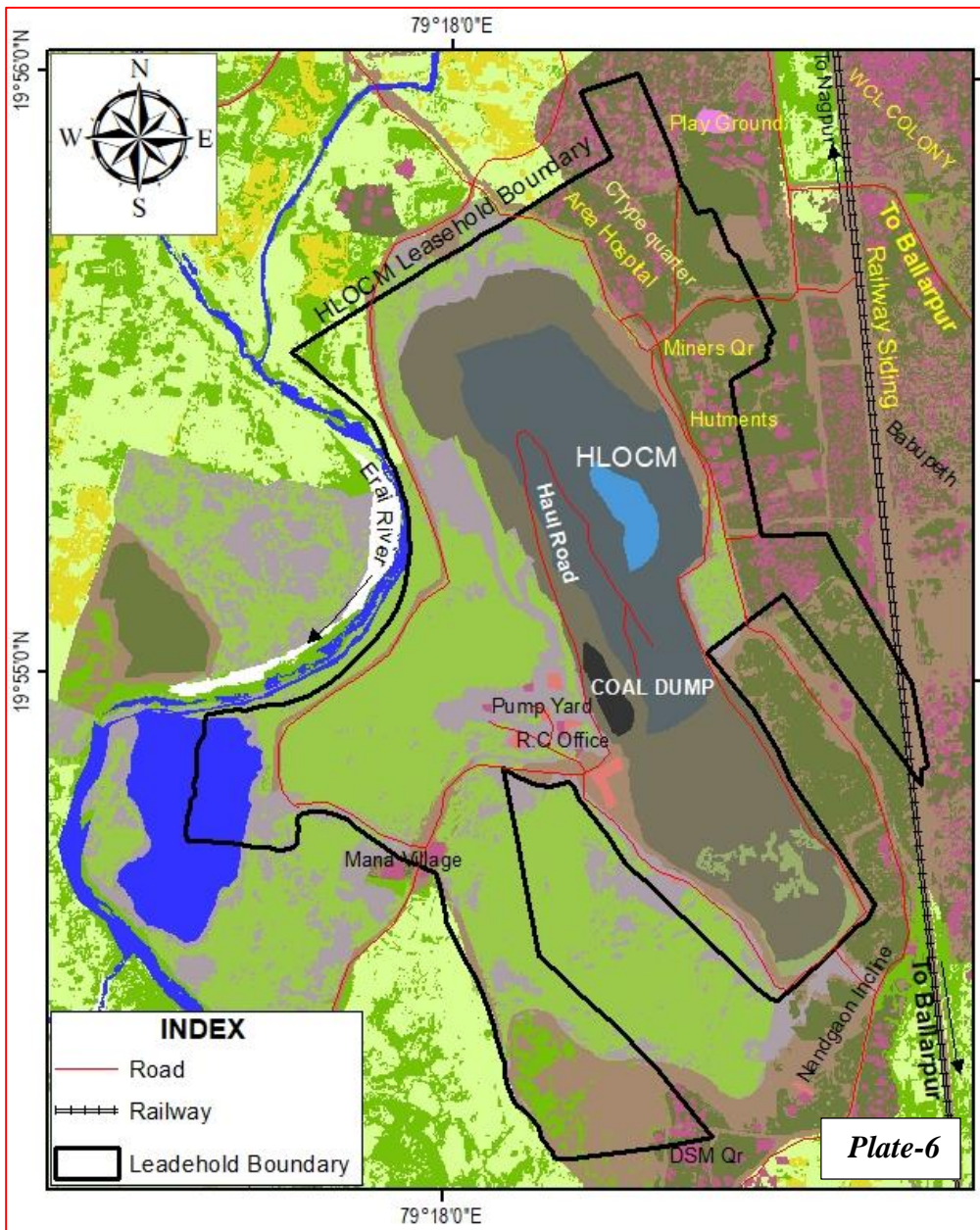


Plate-5

Customer : WESTERN COALFIELDS LIMITED					
Job Title : Land Reclamation Monitoring of OC Projects				Job No. 561410027	
Subject : Land reclamation status of Pauni Expn OCM based on Satellite data (IRS R2 L4F3) of the Year 2021.					
Activity	Name	Designation	Signature	Date	
Prepared	B.K.Choudhary	C.M(RSC)	<i>[Signature]</i>		
Checked	Tilak Mondal	C.M (RSC)	<i>[Signature]</i>		
Approved	Rajneesh Kumar	GM (Geomatics)	<i>[Signature]</i>		
Scale : 0 0.1 0.2 Km			Sheet 1 of 1		
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Classes		RGB Colour	Area Statistics	
Level -I	Level -II		Ha	%age
Scrub	Scrub (A)		21.63	08.48
Plantation	Plantation on OB Dump		50.66	19.87
	Social Forestry		10.16	03.98
	Plantation on Backfill		06.59	02.58
Total Plantation(B)			67.41	26.43
Total Vegetation (A+B)			89.04	34.91
Agriculture Land	Fallow Land		15.75	06.20
Total Agriculture			15.75	06.20
Mining Area	Barren OB Dump		37.49	14.70
	Coal Quarry		29.68	11.64
	Coal Dump		04.03	01.58
	Area under backfilling		57.30	22.47
	Water Filled Quarry		05.01	01.96
Total Mining Area			133.51	52.35
Settlement	Urban		00.38	00.14
	Industrial		00.33	00.13
	Total Settlement			00.71
Waste Land	Waste Land		11.98	04.70
	Sand Body		04.01	01.57
	Total Waste Land			15.99
Total Leasehold Area			255.00	100.00



AREA STATISTICS

Classes		Colour	Area Statistics	
Level -I	Level -II	R G B	Ha	% age
Scrubs	Scrubs(A)		05.25	01.69
Plantation	Plantation on Backfill		06.35	02.04
	Plantation on OB		73.84	23.69
	Social Forestry		30.96	09.94
	Total Plantation (B)		111.15	35.67
Vegetation Cover	Total Vegetation (A+B)		116.40	37.36
Agriculture Land	Fallow Land		04.07	01.31
	Total Agriculture Land		04.07	01.31
Mining Area	Barren OB Dump		21.18	06.80
	Area under backfilling		63.64	20.42
	Coal Quarry		42.94	13.78
	Coal Dump		01.96	00.63
	Waterfilled Quarry		03.34	01.07
	Total Mining Area		133.06	42.70
Settlement	Urban		10.16	03.26
	Industrial		01.40	00.43
	Toal Settlement		11.56	03.69
Waste Land	Waste Land		40.06	12.85
Water Body	River/Nala/Stream		06.51	02.09
	Total Leasehold area		311.66	100.00

Customer : **WESTERN COALFIELDS LIMITED**

Job Title : **Land Reclamation Monitoring of OC Projects** Job No. **561410027**

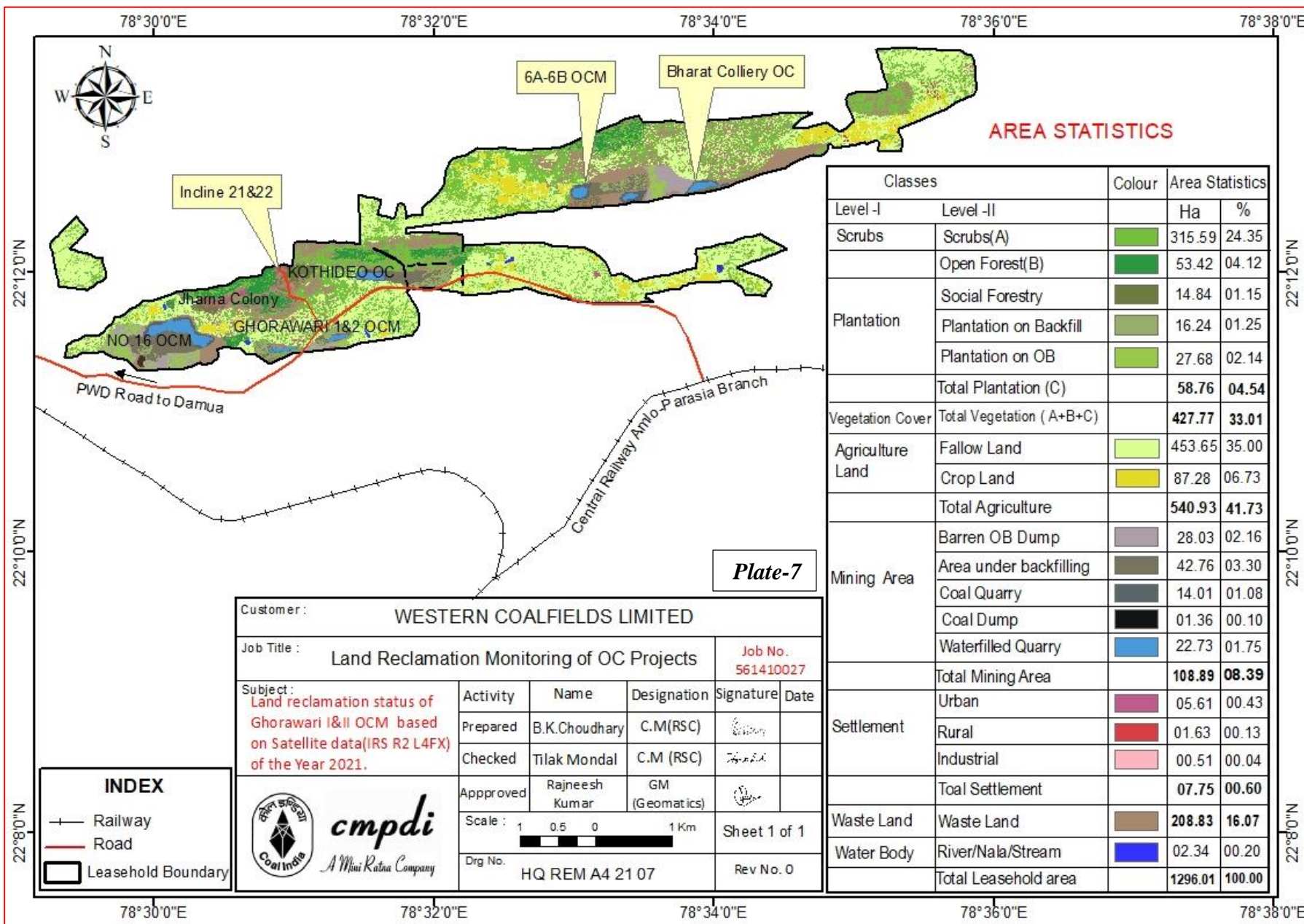
Subject : **Land reclamation status of HLOCM based on satellite data (IRS R2 L4 FX) of the Year 2021**

Activity	Name	Designation	Signature	Date
Prepared	B.K. Choudhary	C.M (RSC)		
Checked	Tilak Mondal	C.M (RSC)		
Approved	Rajneesh Kumar	GM (Geomatics)		

Scale : 0 0.125 0.25 Km

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AREA STATISTICS

Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	Scrubs(A)		315.59	24.35
	Open Forest(B)		53.42	04.12
Plantation	Social Forestry		14.84	01.15
	Plantation on Backfill		16.24	01.25
	Plantation on OB		27.68	02.14
	Total Plantation (C)		58.76	04.54
Vegetation Cover	Total Vegetation (A+B+C)		427.77	33.01
Agriculture Land	Fallow Land		453.65	35.00
	Crop Land		87.28	06.73
	Total Agriculture		540.93	41.73
Mining Area	Barren OB Dump		28.03	02.16
	Area under backfilling		42.76	03.30
	Coal Quarry		14.01	01.08
	Coal Dump		01.36	00.10
	Waterfilled Quarry		22.73	01.75
	Total Mining Area		108.89	08.39
Settlement	Urban		05.61	00.43
	Rural		01.63	00.13
	Industrial		00.51	00.04
	Total Settlement		07.75	00.60
Waste Land	Waste Land		208.83	16.07
Water Body	River/Nala/Stream		02.34	00.20
	Total Leasehold area		1296.01	100.00

Plate-7

Customer : WESTERN COALFIELDS LIMITED

Job Title : Land Reclamation Monitoring of OC Projects Job No. 561410027

Subject : Land reclamation status of Ghorawari I&II OCM based on Satellite data(IRS R2 L4FX) of the Year 2021.

Activity	Name	Designation	Signature	Date
Prepared	B.K.Choudhary	C.M(RSC)		
Checked	Tilak Mondal	C.M (RSC)		
Approved	Rajneesh Kumar	GM (Geomatics)		

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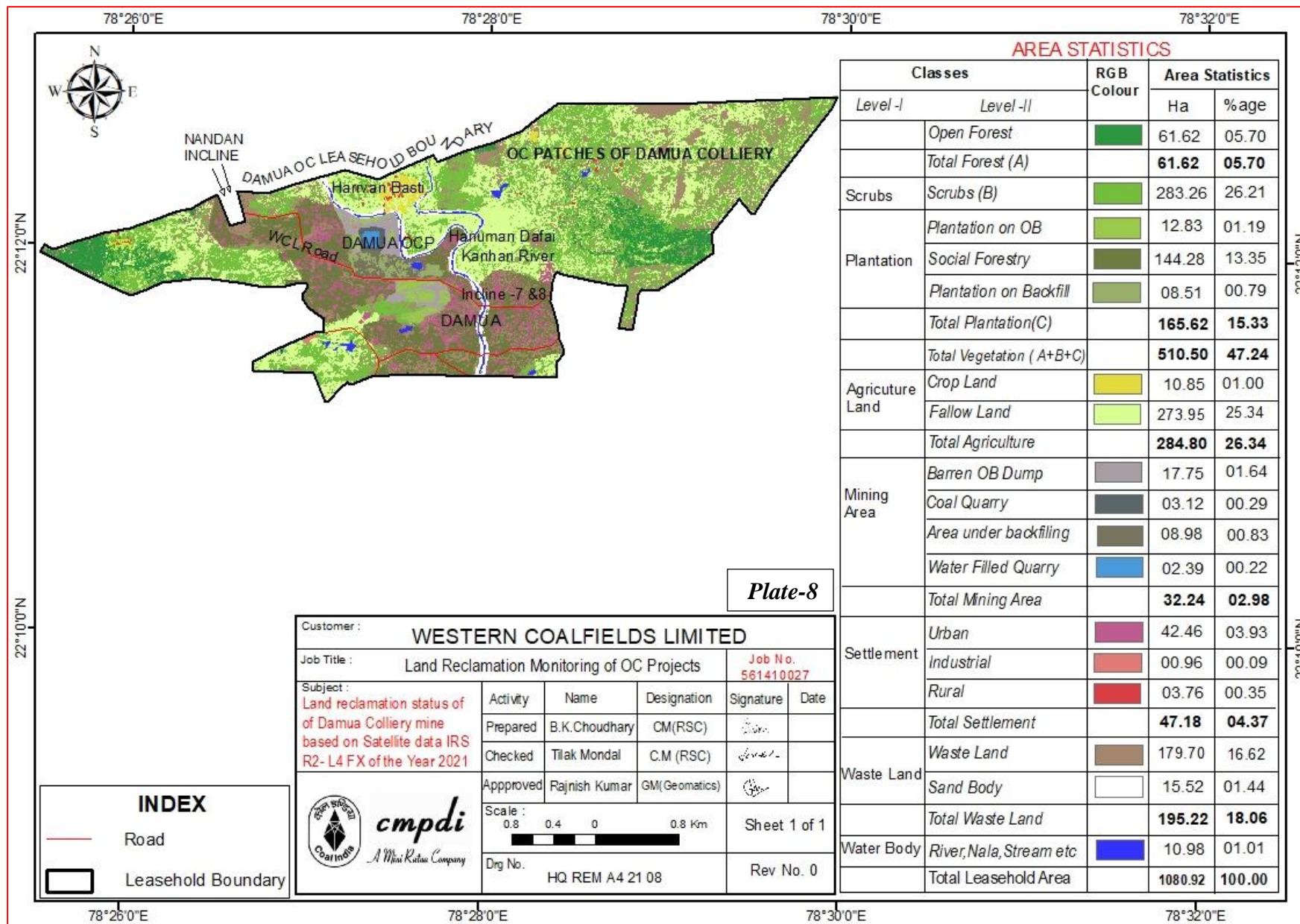


Plate-8

Customer : **WESTERN COALFIELDS LIMITED**

Job Title : Land Reclamation Monitoring of OC Projects Job No. 561410027

Subject :	Activity	Name	Designation	Signature	Date
Land reclamation status of Damua Colliery mine based on Satellite data IRS R2- L4 FX of the Year 2021	Prepared	B.K.Choudhary	CM(RSC)	<i>[Signature]</i>	
	Checked	Tilak Mondal	C.M (RSC)	<i>[Signature]</i>	
	Approved	Rajnish Kumar	GM(Geomatics)	<i>[Signature]</i>	
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Drg No. HQ REM A4 21 08		Rev No. 0			

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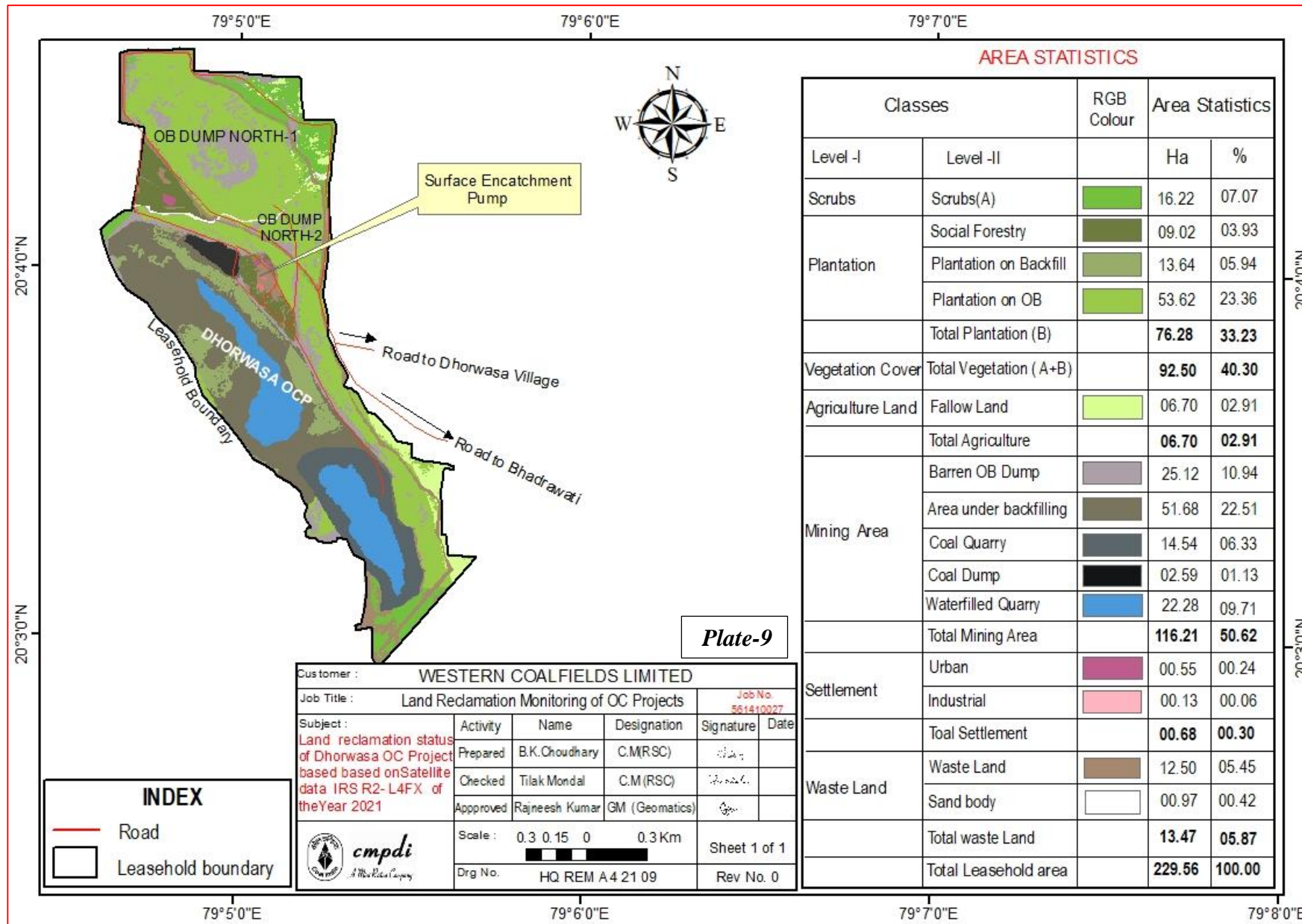
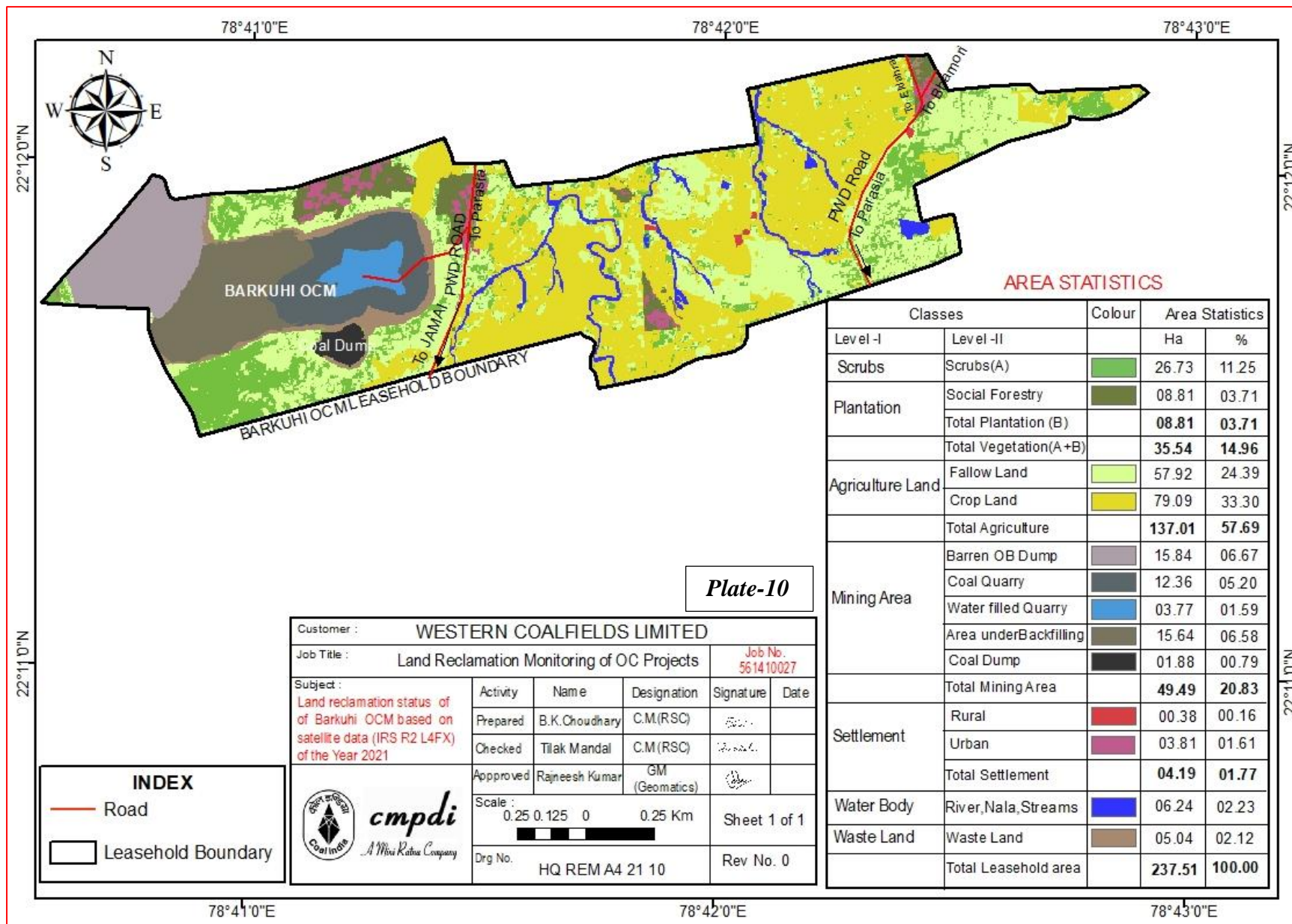


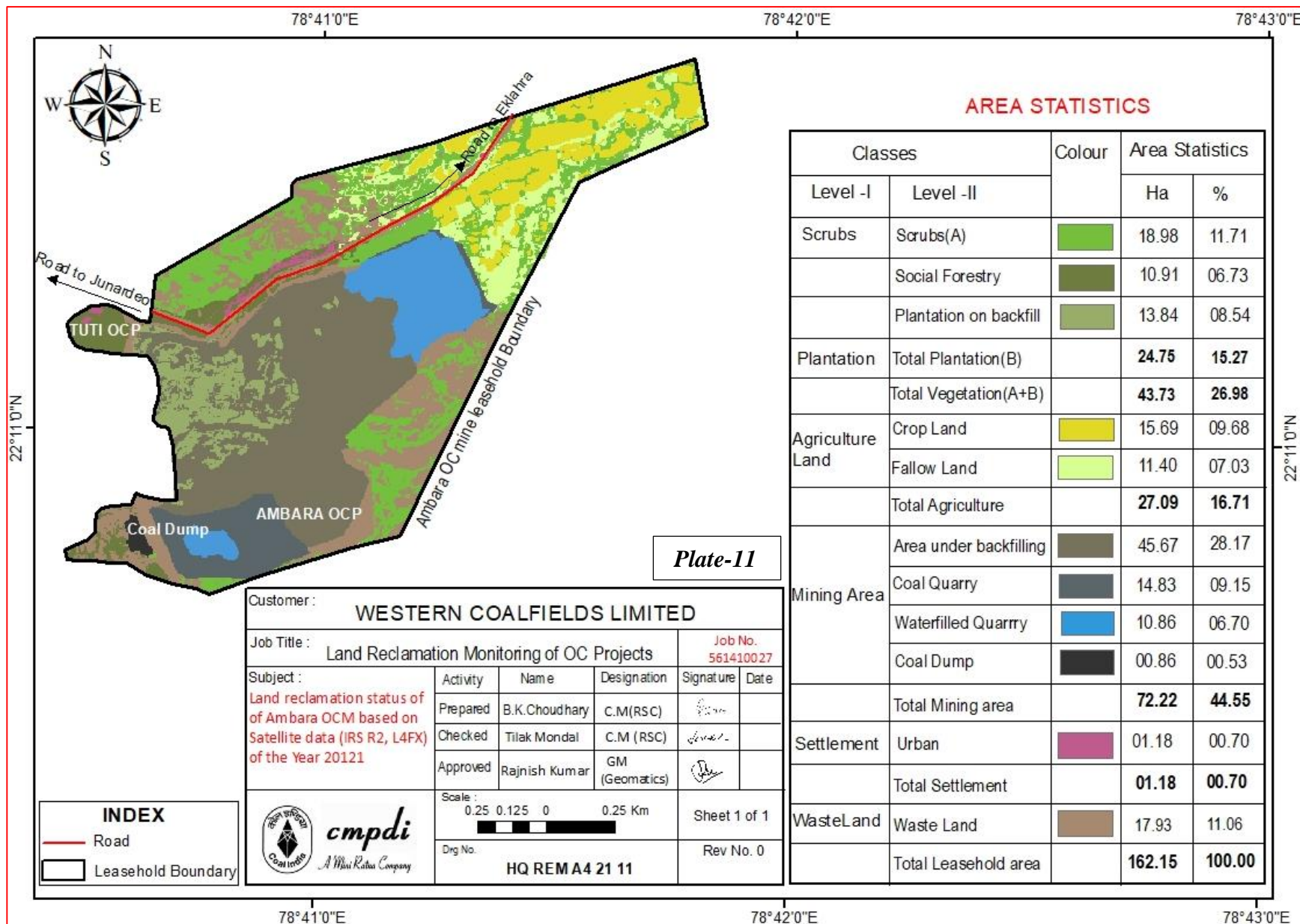
Plate-9

Customer : WESTERN COALFIELDS LIMITED					
Job Title : Land Reclamation Monitoring of OC Projects			Job No. 561410027		
Subject : Land reclamation status of Dhorwasa OC Project based on Satellite data IRS R2- L4FX of the Year 2021	Activity	Name	Designation	Signature	Date
	Prepared	B.K.Choudhary	C.MRSC		
	Checked	Tilak Mondal	C.M(RSC)		
Approved	Rajneesh Kumar	GM (Geomatics)			
Scale : 0.3 0.15 0 0.3 Km		Sheet 1 of 1			
Drg No. HQ REM A 4 21 09		Rev No. 0			

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	Leasehold boundary

AREA STATISTICS				
Classes		RGB Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrub	Scrub(A)		16.22	07.07
Plantation	Social Forestry		09.02	03.93
	Plantation on Backfill		13.64	05.94
	Plantation on OB		53.62	23.36
	Total Plantation (B)		76.28	33.23
Vegetation Cover	Total Vegetation (A+B)		92.50	40.30
Agriculture Land	Fallow Land		06.70	02.91
	Total Agriculture		06.70	02.91
Mining Area	Barren OB Dump		25.12	10.94
	Area under backfilling		51.68	22.51
	Coal Quarry		14.54	06.33
	Coal Dump		02.59	01.13
	Waterfilled Quarry		22.28	09.71
	Total Mining Area		116.21	50.62
Settlement	Urban		00.55	00.24
	Industrial		00.13	00.06
	Total Settlement		00.68	00.30
Waste Land	Waste Land		12.50	05.45
	Sand body		00.97	00.42
	Total waste Land		13.47	05.87
	Total Leasehold area		229.56	100.00





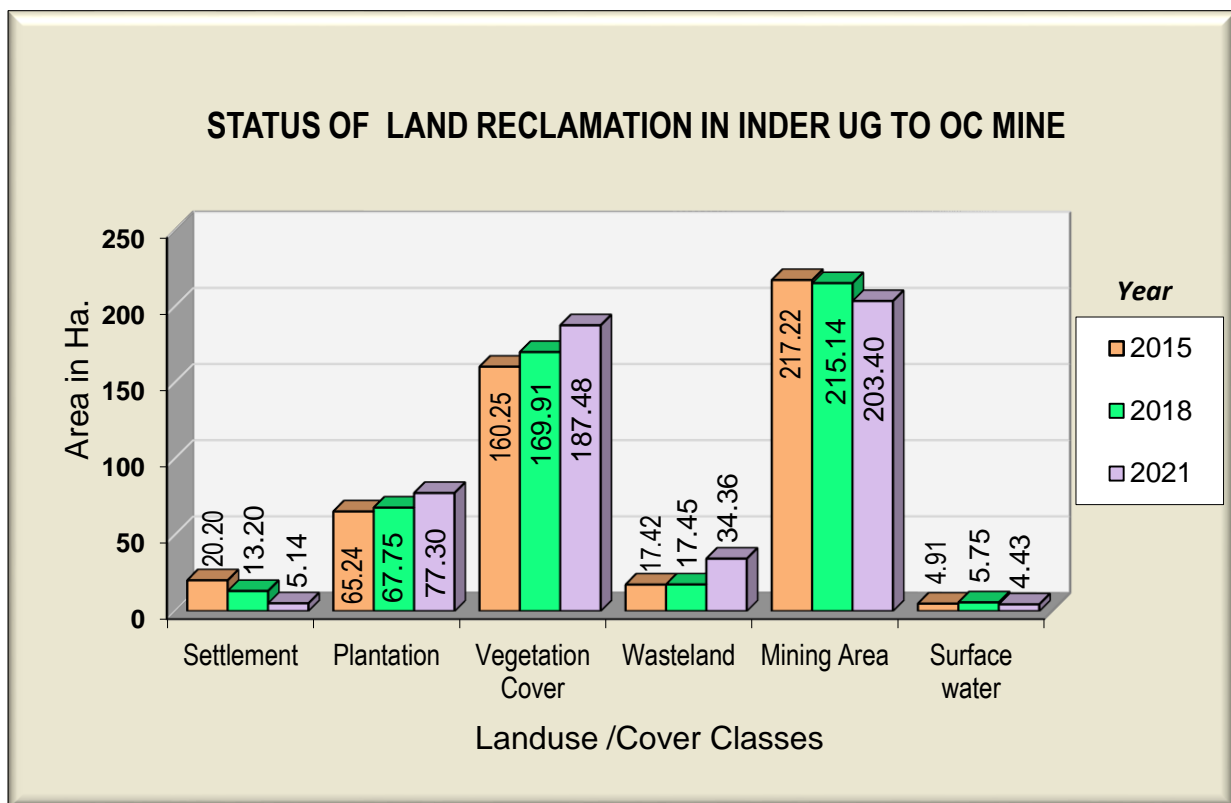


Figure-3

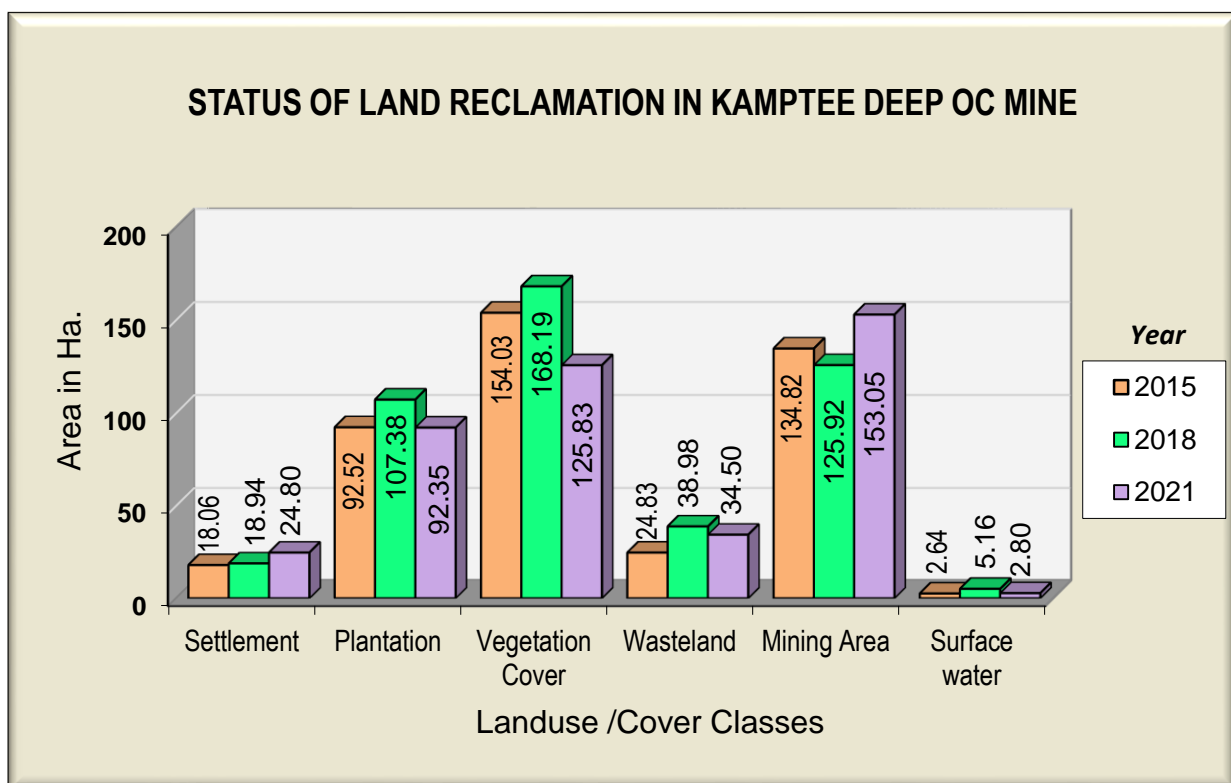


Figure-4

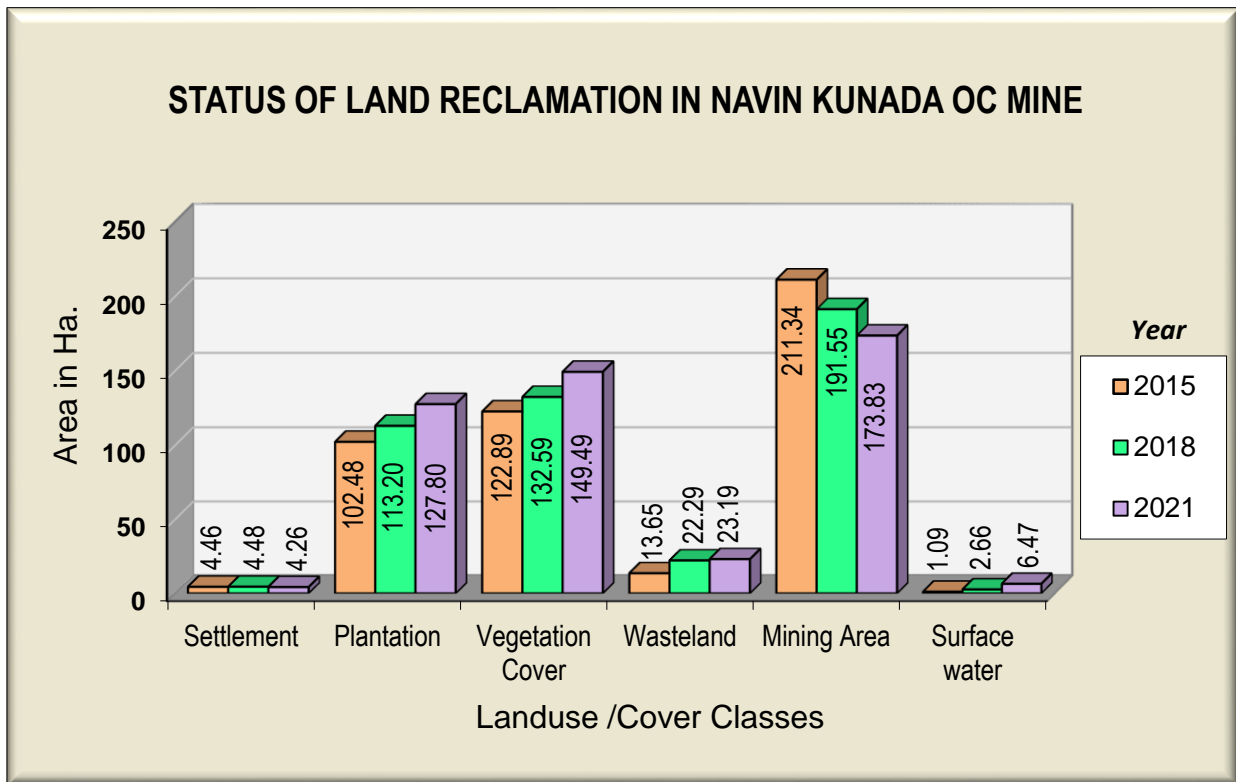


Figure-5

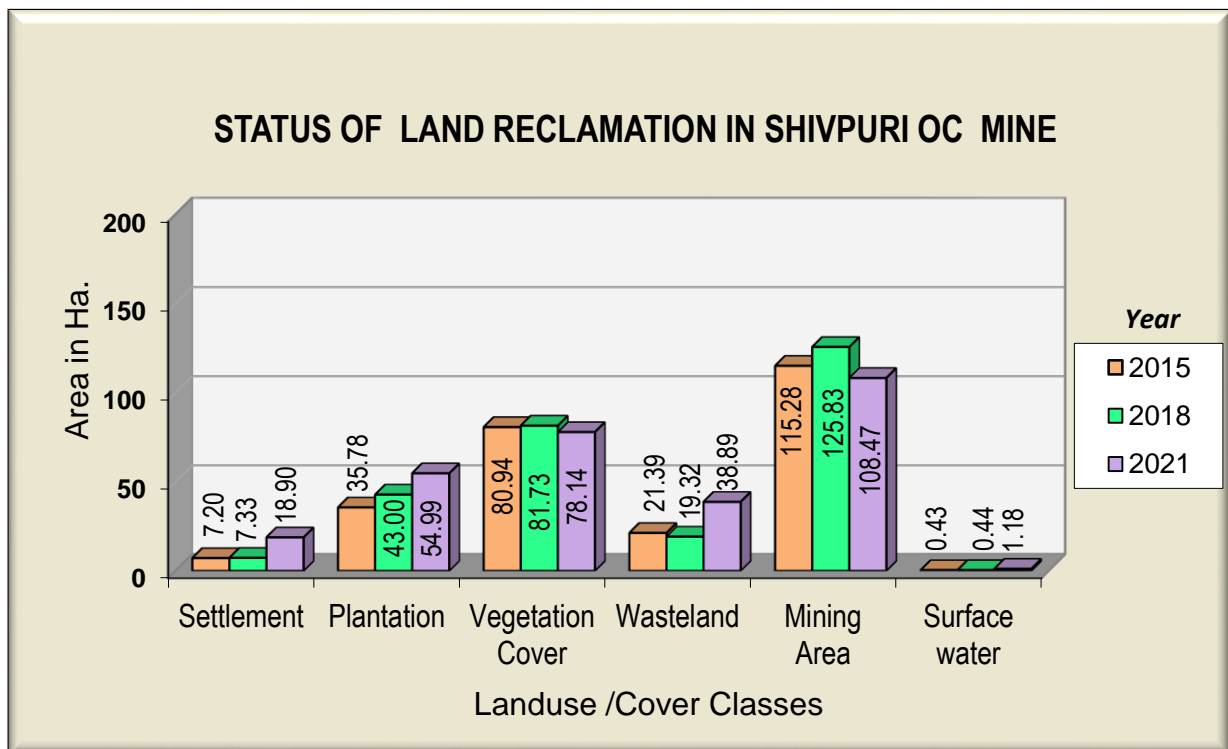


Figure -6

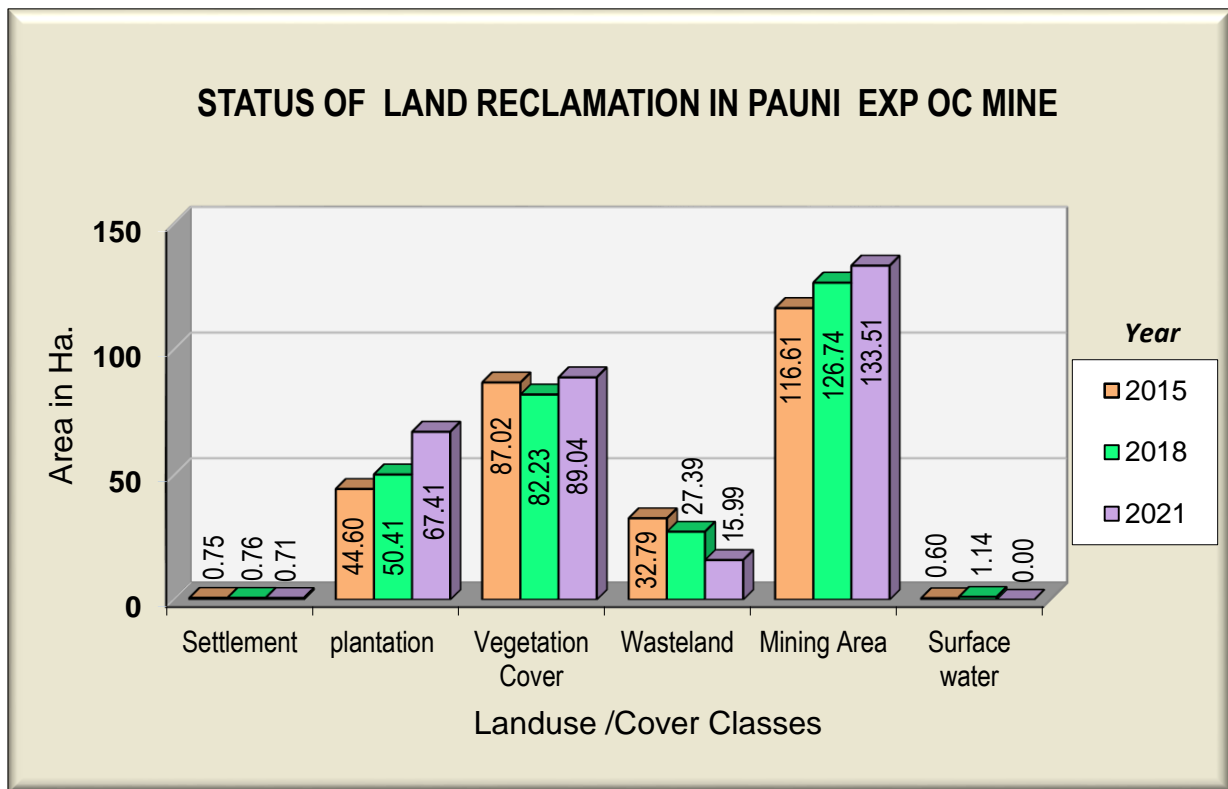


Figure-7

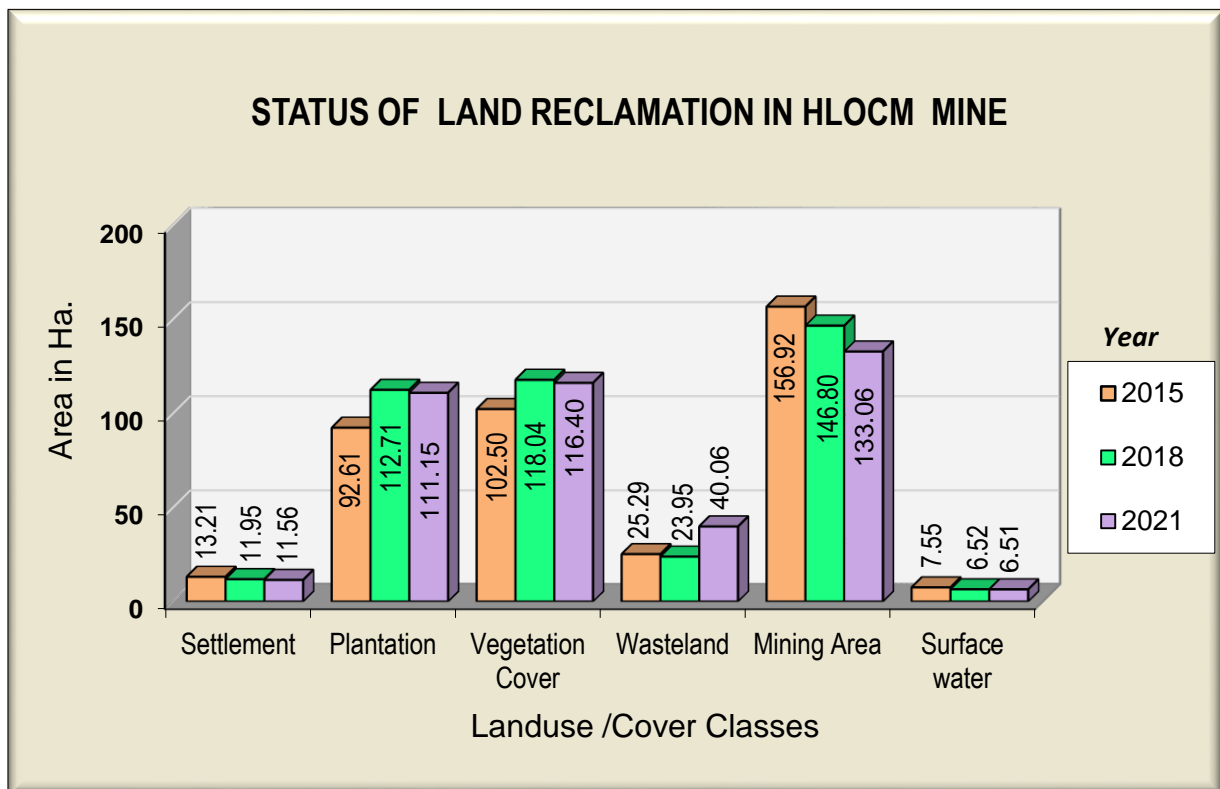


Figure-8

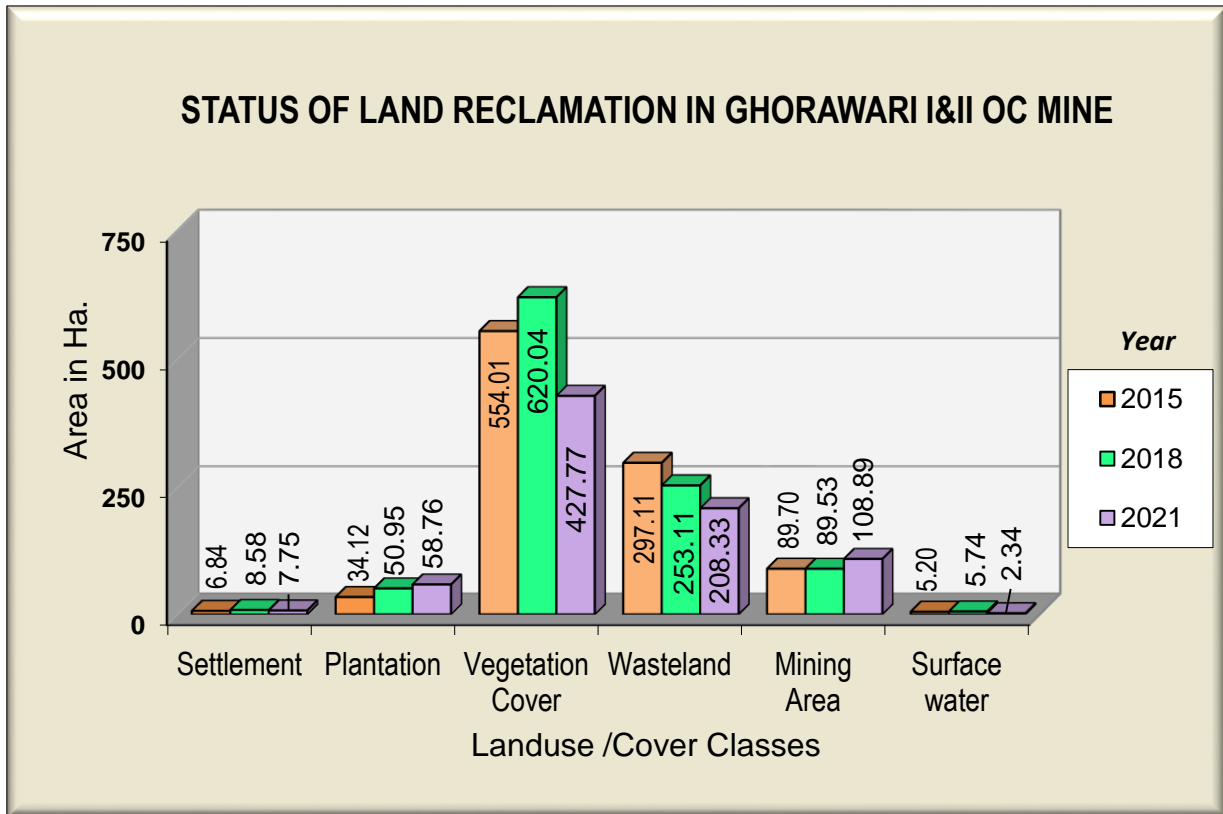


Figure -9

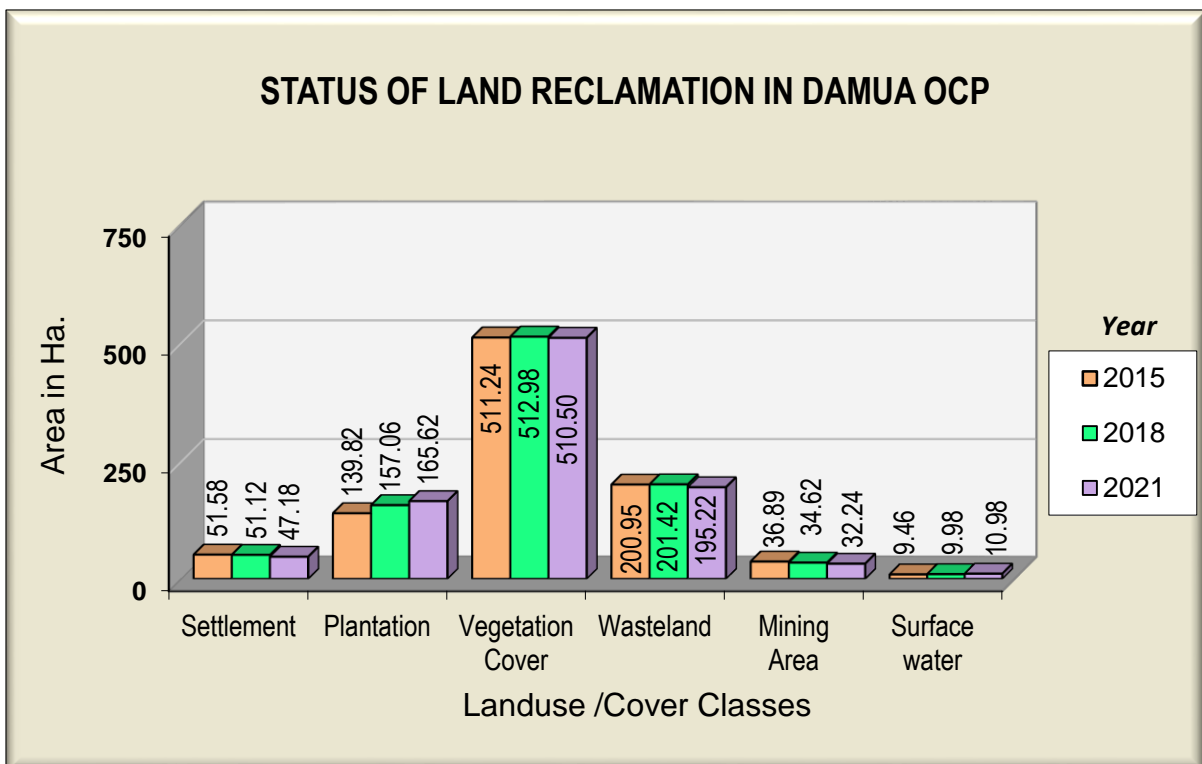


Figure-10

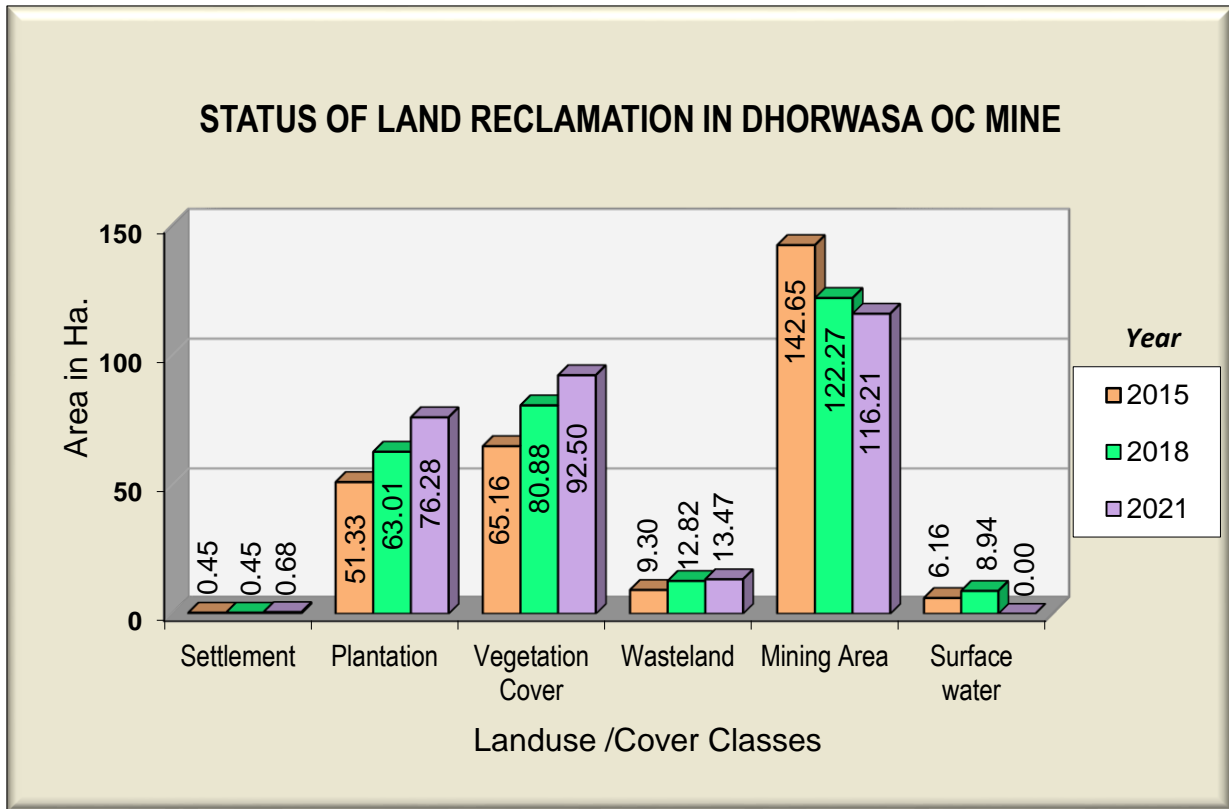


Figure-11

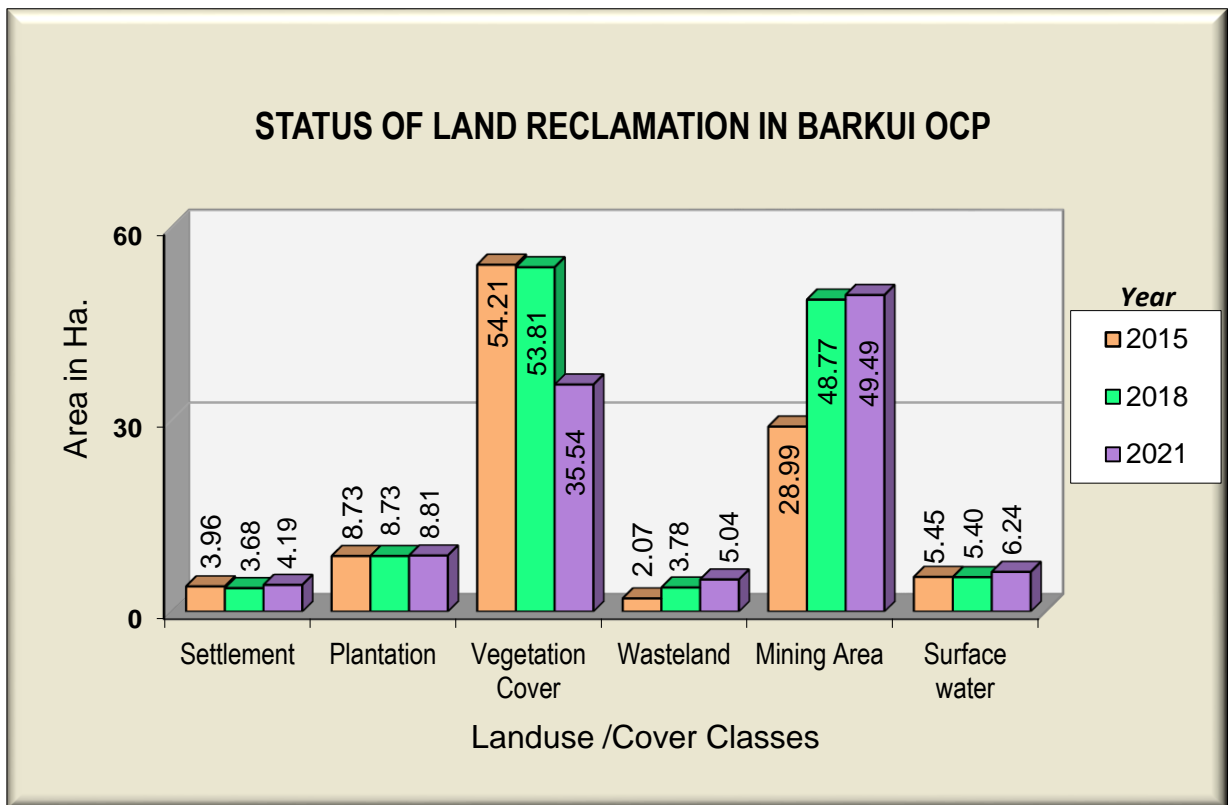


Figure-12

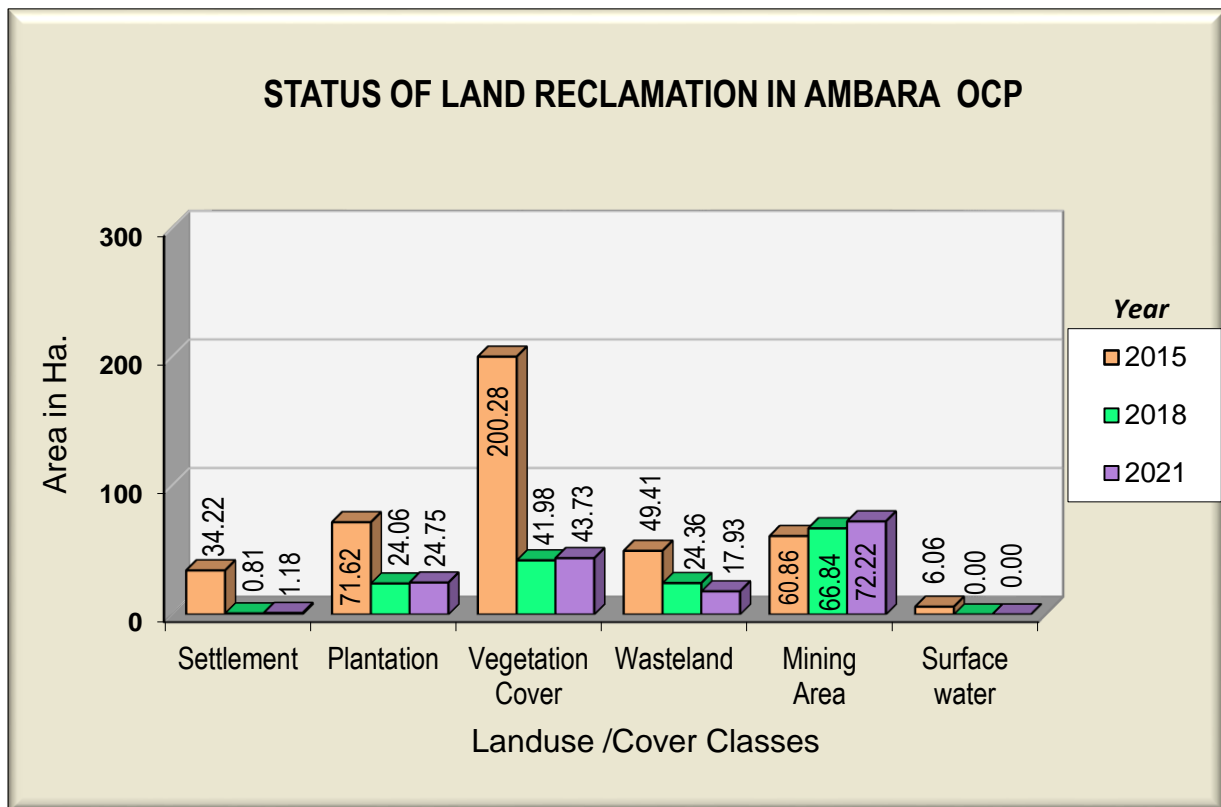


Figure -13



Photograph1: Plantation under Social Forestry in Kamptee Deep OC mine.



Photograph2 :Plantation on barren OB in Kamptee Deep OC mine.



Photograph3: Plantation under social Forestry in Navin Kunda OC mine.



Photograph 4: Plantation on embankment in Navin Kunda OC mine.



Photograph 5: Plantation on barren OB in Navin Kunda OC mine.



Photograph 6: Plantation on backfill in Shivpuri OC mine



Photograph 7: Plantation on Barren OB in Pauni OC mine



Photograph 8: Plantation on Barren OB in Hindustan Lalpeth OCM



Photograph 9: Plantation under social Forestry in Hindustan Lalpeth OCM



Photograph 10: Plantation on backfill in Ghorawari OC



Photograph 11: Plantation on Barren OB in Damua OC mine



Photograph 12: Plantation on embankment in Dhorwasa OC mine



Photograph 13: Plantation on Barren OB Dump in Dhorwasa OC mine



Photograph 14: Plantation on Backfill in Ambara OC mine



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