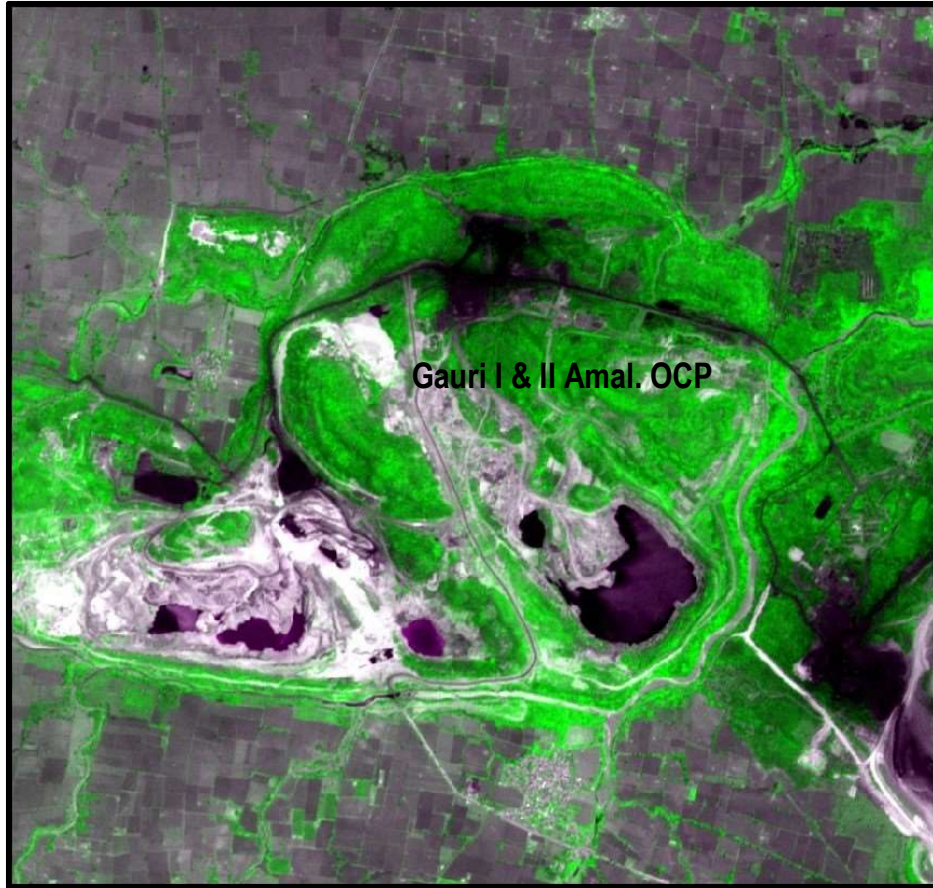


वेस्टर्न कोल्फील्ड्स लिमिटेड के ५ मिलियन घन मीटर (कोल + अधिभार) से कम उत्पादन क्षमतावाले १३ खुली खदानों का भूमि पुनरुद्धार हेतु २०२३ के उपग्रह डाटा के आधार पर निगरानी का प्रतिवेदन

Land Restoration / Reclamation Monitoring of 13 opencast projects of Western Coalfield Limited producing less than 5 million Cu. M. (Coal+OB) per annum based on Satellite Data of the Year 2023



Submitted to  
**WESTERN COALFIELDS LIMITED**



वेस्टर्न कोल्फील्ड्स लिमिटेड के ५ मिलियन घन मीटर (कोल + अधिभार) से कम उत्पादन क्षमतावाले १३ खुली खदानों का भूमि पुनरुद्धार हेतु २०२३ के उपग्रह डाटा के आधार पर निगरानी का प्रतिवेदन

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**March-2024**

Remote Sensing Cell  
Geomatics Division  
CMPDI, Ranchi



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## कार्यकारी सारांश

**१.० परियोजना** वेस्टर्न कोल्फील्ड्स लिमिटेड के ५ मिलियन घन मीटर (कोल+ अधिभार) से कम उत्पादन क्षमतावाले १३ खुली खदानों के पुनरुद्धार हेतु वर्ष २०२३ के उपग्रह डाटा पर आधारित तीन साल के अन्तराल पर सलाना नियमित निगरानी।

**२.० उद्देश्य** भूमि पुनरुद्धार (लैंड रिक्लेमेशन) का उद्देश्य कुल पट्टाक्षेत्र में बैकफील, वृक्षारोपण, सामाजिक वानिकी, सक्रिय खनन क्षेत्र, जल निकाय (वाटर ट्रेनेज), बंजर भूमि, कृषि भूमि और जंगल के विभिन्न प्रकार के वितरण प्रणाली के क्षेत्र का आकलन करने के लिए है। यह अध्ययन उपरोक्त सभी खुली खदानों के भूमि पुनरुद्धार (लैंड रिक्लेमेशन) का निगरानी के प्रगति का आकलन करने में मदद करेगा तथा इसके अतिरिक्त पर्यावरण संरक्षण के लिए आवश्यक उपचारात्मक उपायों को क्रियान्वित करने में भी सहायता करेगा।

### ३.० मुख्य निष्कर्ष

- वर्ष २०२०-२१ के कुल १५ परियोजनाओं की तुलना में वर्ष २०२३-२४ में कुल १३ खुली खदान परियोजनाओं में भूमि सुधार की स्थिति की निगरानी पर विचार किया गया है। डब्ल्यूसीएल के अनुरोध पर तेलवासा खुली खदान और जूना कुनाडा खुली खदान परियोजनाओं को वर्ष २०२३-२४ में भूमि सुधार निगरानी से हटा दिया गया है।
- वर्ष २०२३-२४ में भूमि पुनरुद्धार (लैंड रिक्लेमेशन) हेतु चयन किये गए कुल १३ खुली खदान परियोजनाओं यथा: कोलेगांव, बेलोरा-नयिगांव, घोंसा, बल्लारपुर, जुनाद एक्सटेंशन, उर्धन, गौरी। और ॥ एकीकृत, भटाडी, गोंडेगांव, कोलारपिंपरी, छिंदा, गौरी डीप और अदासा यूजी से ओसी के कुल पट्टाक्षेत्र अथवा माइन लीज होल्ड एरिया ७१६२.१७ हेक्टेयर है जिसमें १५७४.८१ हेक्टेयर उत्खनन क्षेत्र के अंतर्गत है तथा इस उत्खनन क्षेत्र में से ११५.४६ हेक्टेयर (७.३३%) क्षेत्र में जैविक पुनरुद्धार (बैकफील पर बृक्षारोपण) किया गया है तथा ४०१.६८ हेक्टेयर (२५.५१%) क्षेत्र में तकनीकी पुनरुद्धार (बैकफीलिंग) का कार्य प्रगति पर है और

शेष १०५७.६७ हेक्टेयर (६७.१६%) क्षेत्र सक्रिय खनन के अन्तर्गत है। विश्लेषण से स्पष्ट है कि वर्ष २०२३-२४ के अध्ययन के लिए ली गई १३ खुली खदान परियोजनाओं का ५१७.१४ हेक्टेयर (३२.८४%) क्षेत्र भूमि पुनरुद्धार के अधीन है और शेष १०५७.६७ हेक्टेयर (६७.१६%) क्षेत्र सक्रिय खनन के अन्तर्गत है। परियोजनावार भूमि पुनरुद्धार (लैंड रिक्लेमेशन) के निगरानी का वर्णन विस्तार रूप से तालिका संख्या ०१, बार चार्ट चित्र संख्या ०१ में दर्शाया गया है।

- डब्ल्यूसीएल में पिछले चक्र अध्ययन के संबंध में वर्ष २०२३-२४ में १३ ओसी परियोजनाओं के लिए किए गए भूमि सुधार की स्थिति की तुलना करने पर यह स्पष्ट है कि भूमि पुनरुद्धार (लैंड रिक्लेमेशन) के तहत आनेवाले क्षेत्र का क्षेत्रफल वर्ष २०२०-२१ के ४२२.८६ हेक्टेयर की तुलना में वर्ष २०२३-२४ में बढ़कर ५१७.१४ हेक्टेयर हो गया है जिसमें बैकफ़िल पर वृक्षारोपण) जैविक पुनरुद्धार (और बैकफ़िलिंग के तहत क्षेत्र) तकनीकी पुनरुद्धार (दोनों शामिल हैं)। तीन वर्षों की अवधि में भूमि पुनरुद्धार क्षेत्र में ९४.२८ हेक्टेयर की यह वृद्धि डब्ल्यूसीएल द्वारा भूमि पुनरुद्धार की दिशा में किए गए प्रयासों का परिणाम है। विभिन्न ओसी परियोजनाओं में भूमि सुधार की वर्षवार तुलना तालिका-१ में दी गई है।
- कुल वृक्षारोपण अथवा हरित आवरण सामाजिक वानिकी के तहत) वृक्षारोपण, बैकफ़िल पर किए गए वृक्षारोपण, बंजर अधिभार डंप पर किए गए वृक्षारोपण के तहत आने वाले क्षेत्र का क्षेत्रफल वर्ष २०२०-२१ में १०४३.२६ हेक्टेयर से बढ़कर वर्ष २०२३-२४ में १२२७.०० हेक्टेयर हो गया है।

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## Executive Summary

**1.0 Project** Land restoration / reclamation monitoring of 13 opencast coal mines of Western Coalfields Ltd. (WCL) producing less than 5 million cu.m. (Coal+OB) per year based on satellite data, at an interval of three years.

**2.0 Objective** Objective of land restoration / reclamation monitoring is to assess the area of backfilled, plantation, social forestry, active mining area, water bodies, 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

- Total 13 no. of OC projects have been considered for monitoring the status of land reclamation in the year 2023-24 as compared to 15 no. of OC projects in the year 2020-21. Telwasa OC and Juna kunada OC projects are removed from land reclamation monitoring in the year 2023-24 on request of WCL.
- Out of the total mine leasehold area of 7162.17 Hectare of the 13 projects Viz. Kolegaon, Bellora-Naigaon, Ghonsa, Ballarpur, Junad Extn., Urdhan, Gauri I & II Amal., Bhatadi, Gondegaon, Kolarpimpri, Chhinda, Gauri deep and Adasa UG to OC considered for monitoring during the year 2023-24; total excavated area is only 1574.81 Ha (21.99%) out of which 115.46 Ha area (7.33%) has been planted on backfill (Biologically Reclaimed) and 401.68 Ha area (25.51%) is under backfilling (Technically Reclaimed) and 1057.67 Ha (67.16%) area is under active mining. It is evident from the analysis that 517.14 Ha (32.84%) area of the 13 OC projects taken for study for the year 2023-24 is under reclamation and balance 1057.67 Ha (67.16%) area is under active mining. Project wise details are given in Table-1 & bar chart Fig-1.
- On comparing the status of land reclamation carried out for 13 nos of OC projects in year 2023-24 with respect to previous cycle study in WCL, it is evident from analysis that area under land reclamation has increased from 422.86 Hectares (Yr 2020-21) to 517.14 Hectares (Yr 2023-24) which includes both planation on backfill (Biological Reclamation) and area under backfilling (Technical



Reclamation). This increase of 94.28 Hectares area of land reclamation in a period of three years is the result of the efforts made by WCL towards land reclamation. Year wise comparison in land reclamation in different OC projects is given in Table-1.

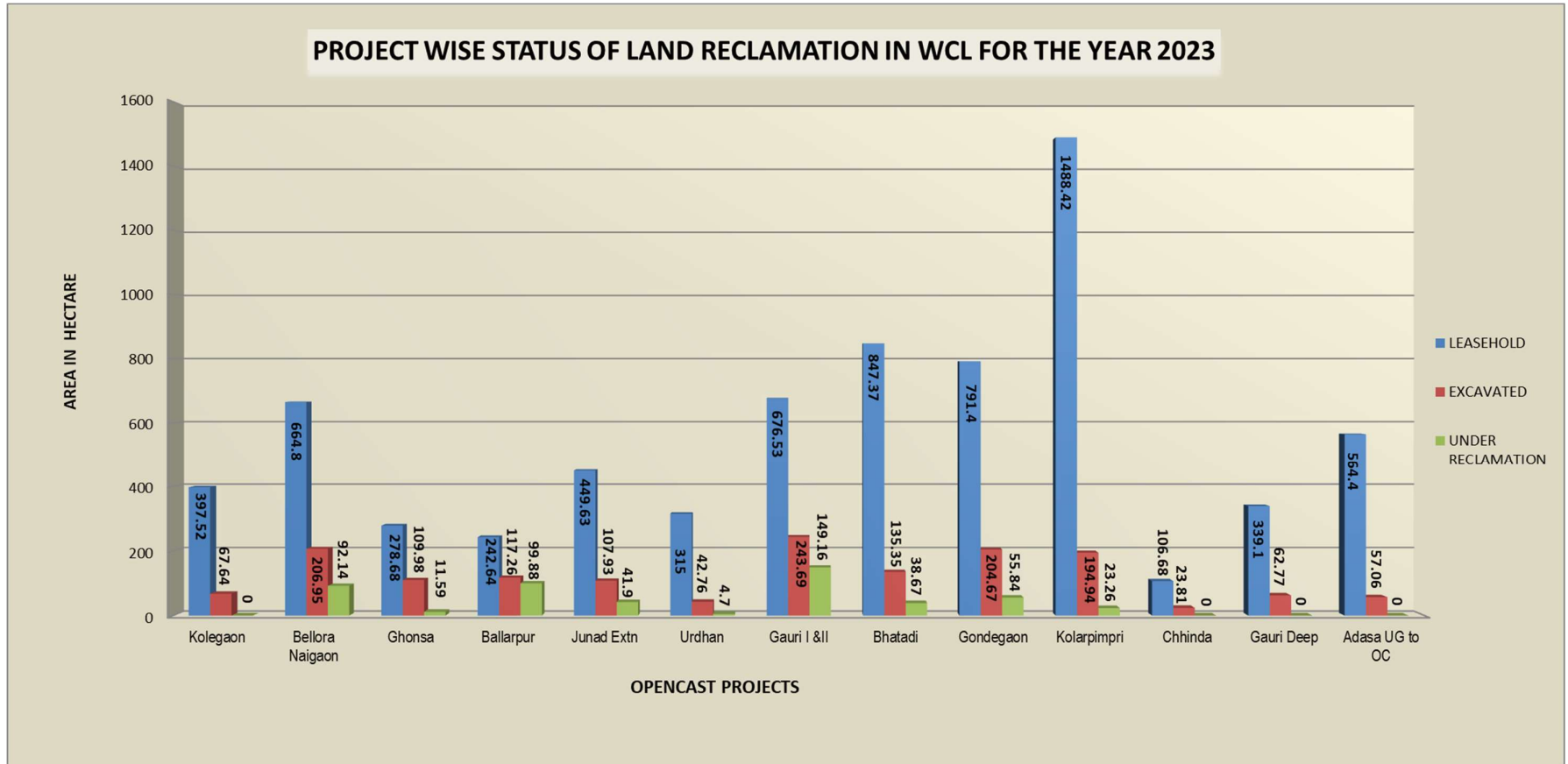
- Overall, total area under plantation (green cover) carried out on backfill, barren OB dump and plantation under social forestry has gone up from 1043.26 Hectares in the year 2020-21 to 1227.00 Hectares in the year 2023-24.

**Table-1**  
**Project wise Land Reclamation Status in Opencast Projects of WCL (<5 MCM Coal+OB) based on Satellite Data of the year 2023-24**  
(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.	2020	2023								
1	2	3	4	5	6	7	8	9 (=4+5+8)	10 (=5+6+7)	11(=4+5)									
		2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023
1	Kolegaon	397.52	397.52	0.00	0.00	0.00	0.00	72.83	83.45	25.63	24.11	48.03	67.64	48.03	67.64	98.46	107.56	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			24.77%	27.06%	0.00%	0.00%
2	Bellora-Naigaon	664.80	664.80	53.02	73.59	12.75	18.55	35.62	48.09	28.94	31.79	91.53	114.81	157.30	206.95	77.31	98.43	65.77	92.14
				33.71%	35.56%	8.11%	8.96%					58.19%	55.48%			11.63%	14.81%	41.81%	44.52%
3	Ghonsa	278.68	278.68	7.28	11.59	0.00	0.00	2.55	5.51	4.65	6.54	60.29	98.39	67.57	109.98	7.20	12.05	7.28	11.59
				10.77%	10.54%	0.00%	0.00%					89.23%	89.46%			2.58%	4.32%	10.77%	10.54%
4	Ballarpur	242.64	242.64	80.79	75.63	15.00	24.25	69.49	73.75	9.74	9.76	17.47	17.38	113.26	117.26	94.23	107.76	95.79	99.88
				71.33%	64.50%	13.24%	20.68%					15.42%	14.82%			38.84%	44.41%	84.58%	85.18%
5	Junad EXTN	449.63	449.63	34.51	37.39	2.46	4.51	65.57	74.65	28.81	33.69	61.54	66.03	98.51	107.93	96.84	112.85	36.97	41.90
				35.03%	34.64%	2.50%	4.18%					62.47%	61.18%			21.54%	25.10%	37.53%	38.82%
6	Urdhan	315.00	315.00	2.36	4.70	0.00	0.00	5.79	10.15	6.87	9.02	19.45	38.06	21.81	42.76	12.66	19.17	2.36	4.70
				10.82%	10.99%	0.00%	0.00%					89.18%	89.01%			4.02%	6.09%	10.82%	10.99%
7	Gouri I & II Amal.	676.53	676.53	106.53	89.42	29.20	59.74	150.98	205.78	96.21	61.57	95.57	94.53	231.30	243.69	276.39	327.09	135.73	149.16
				46.06%	36.69%	12.62%	24.51%					41.32%	38.79%			40.85%	48.35%	58.68%	61.21%
8	Bhatadi	847.37	847.37	21.94	38.67	0.00	0.00	30.86	50.43	46.12	42.58	71.92	96.68	93.86	135.35	76.98	93.01	21.94	38.67
				23.38%	28.57%	0.00%	0.00%					76.62%	71.43%			9.08%	10.98%	23.38%	28.57%
9	Gondegaon	791.40	791.40	42.29	55.84	0.00	0.00	73.47	96.43	62.15	51.26	157.19	148.83	199.48	204.67	135.62	147.69	42.29	55.84
				21.20%	27.28%	0.00%	0.00%					78.80%	72.72%			17.14%	18.66%	21.20%	27.28%
10	Kolarpimpri	1488.42	1488.42	10.71	14.85	4.02	8.41	115.55	134.64	8.21	12.02	140.37	171.68	155.10	194.94	127.78	155.07	14.73	23.26
				6.91%	7.62%	2.59%	4.31%					90.50%	88.07%			8.58%	10.42%	9.50%	11.93%
11	Chhinda	106.68	106.68	0.00	0.00	0.00	0.00	20.44	20.11	2.87	4.30	23.29	23.81	23.29	23.81	23.31	24.41	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			21.85%	22.88%	0.00%	0.00%
12	Gouri deep	339.10	339.10	0.00	0.00	0.00	0.00	0.00	0.00	8.00	8.00	51.04	62.77	51.04	62.77	8.00	8.00	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			2.36%	2.36%	0.00%	0.00%
13	Adasa UG to OC	564.40	564.40	0.00	0.00	0.00	0.00	0.00	0.00	8.48	13.91	0.00	57.06	0.00	57.06	8.48	13.91	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					0.00%	100.00%			1.50%	2.46%	0.00%	0.00%
	<b>TOTAL</b>	<b>7162.17</b>	<b>7162.17</b>	<b>359.43</b>	<b>401.68</b>	<b>63.43</b>	<b>115.46</b>	<b>643.15</b>	<b>802.99</b>	<b>336.68</b>	<b>308.55</b>	<b>837.69</b>	<b>1057.67</b>	<b>1260.55</b>	<b>1574.81</b>	<b>1043.26</b>	<b>1227.00</b>	<b>422.86</b>	<b>517.14</b>
				<b>28.51%</b>	<b>25.51%</b>	<b>5.03%</b>	<b>7.33%</b>					<b>66.45%</b>	<b>67.16%</b>	<b>17.60%</b>	<b>21.99%</b>	<b>14.57%</b>	<b>17.13%</b>	<b>33.55%</b>	<b>32.84%</b>

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

1. Area under Biological Reclamation includes Areas under Plantation done on Backfilled Area Only.
2. Area under Technical Reclamation includes Area under Barren Backfilling only.
3. Area under Active Mining Includes Coal Quarry, Advance Quarry Site and Quarry filled with water etc., if any.
4. Social Forestry and Plantation on External OB Dumps are not included in Biological Reclamation and are put under separate categories as shown in the above Table.
5. (%) calculated in the above Table is in respect to Total Excavated Area except for "Total Area under Plantation" where % is in terms of "Leasehold Area".



**Fig.1: Land Reclamation Status in OC projects producing less than 5mcm (Coal +OB) of WCL in the Year 2023**

## **1.0 Background**

- 1.1** Land is the most important natural resource which embodies soil, water, flora fauna and total ecosystem. All human activities are based on the land which is the most scarce natural resource in our country. Mining is a site specific industry and it could not be shifted anywhere else from the location where mineral occurs. It is a fact that surface mining activities do effect the land environment due to ground breaking. Therefore, there is an urgent need to reclaim and restore the mined out land for its productive use for sustainable development of mining. This will not only mitigate environmental degradation, but would also help in creating a more congenial environment for land acquisition by coal companies in future.
- 1.2** Keeping above in view, Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/Env/2009/2478 dated 29.12.2009 to Central Mine Planning & Design Institute (CMPDI), Ranchi, for monitoring land reclamation status of all the opencast coal mines having production of less than 5 million m<sup>3</sup> per annum (coal + OB taken together per annum) based on remote sensing satellite data regularly on annual basis and less than 5 million m<sup>3</sup> per annum (coal + OB taken together per annum) at interval of three years based on remote sensing satellite data, for sustainable development of mining. A revised work order was issued vide letter no. CIL/WBP/Env/2011/4706 dated 12.10.2012 from Coal India Ltd for the period 2012-13 to 2016-2017. which was subsequently followed by another work order vide letter no: CIL/WBP/Env/2017/DP/8477 dated 21.09.2017 from coal India ltd for period 2017-18 to 2021-22. Further, a revised work order was issued vide letter no. CIL/ENVT/2022-23/W.O/10899 dated 06.07.2022 from Coal India Limited for the period 2022-23 to 2023-24. According to this work order, 76 OC projects having more than 5 million cu. m (coal +OB) per annum capacity shall be monitored every year and also land reclamation monitoring of 33 OCPs having less than 5 million cu. m (coal +OB) per annum capacity, totaling 109 OC mines and vegetation cover mapping of 06 coalfields for 2022-23 & totaling 123 (76+47) OC mines and

vegetation cover mapping of 07 coalfields for 2023-24, covering all the subsidiaries of Coal India Ltd. The result of land reclamation status of all such mines to be put on the website of CIL, ([www.coalindia.in](http://www.coalindia.in)), CMPDI ([www.cmpdi.co.in](http://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 & Climate Change (MoEF & CC). 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 2023 carried out for the 13 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 under backfilling, plantation, OB dumps, social forestry, active mining area, settlements, 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:

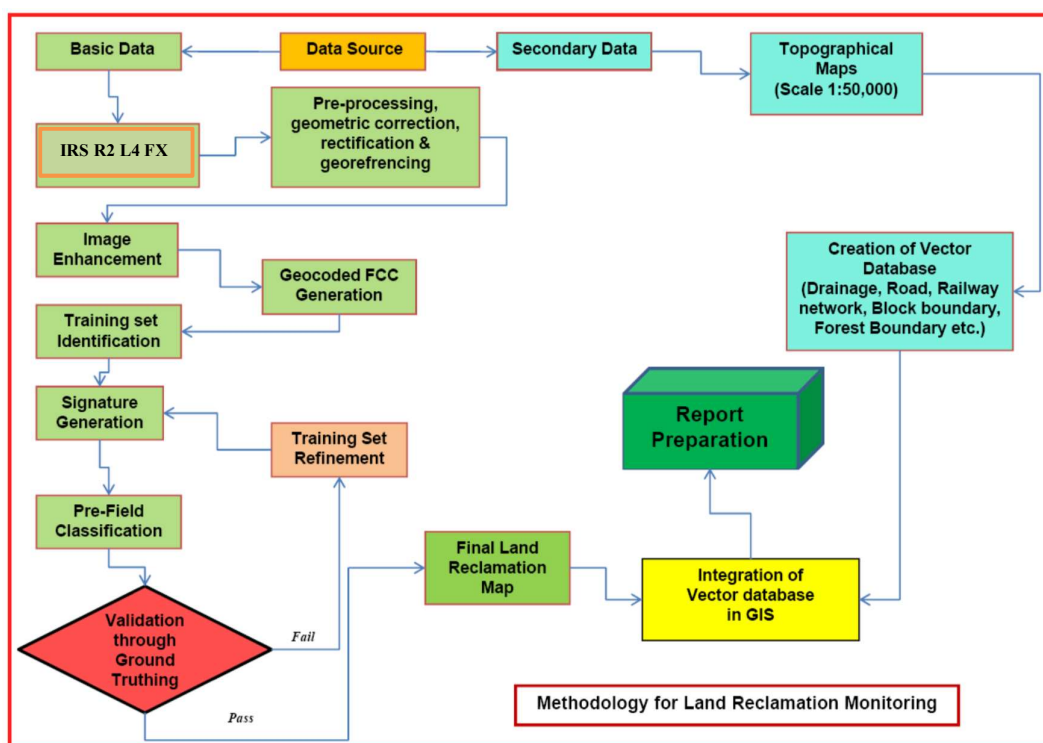


Figure :2 Methodology for Land Reclamation Monitoring

**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 2022 digital image processing s/w. 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 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 2022 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. 2022 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 is 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 13 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 2023-24:

- Kolgaon
- Bellora-Naigaon
- Ghonsa
- Ballarpur
- Junad Extension
- Urdhan
- Gauri I & II Amal.
- Bhatadi
- Gondegaon
- Kolarpimpri
- Chhinda
- Gouri Deep
- Adasa UG to OC

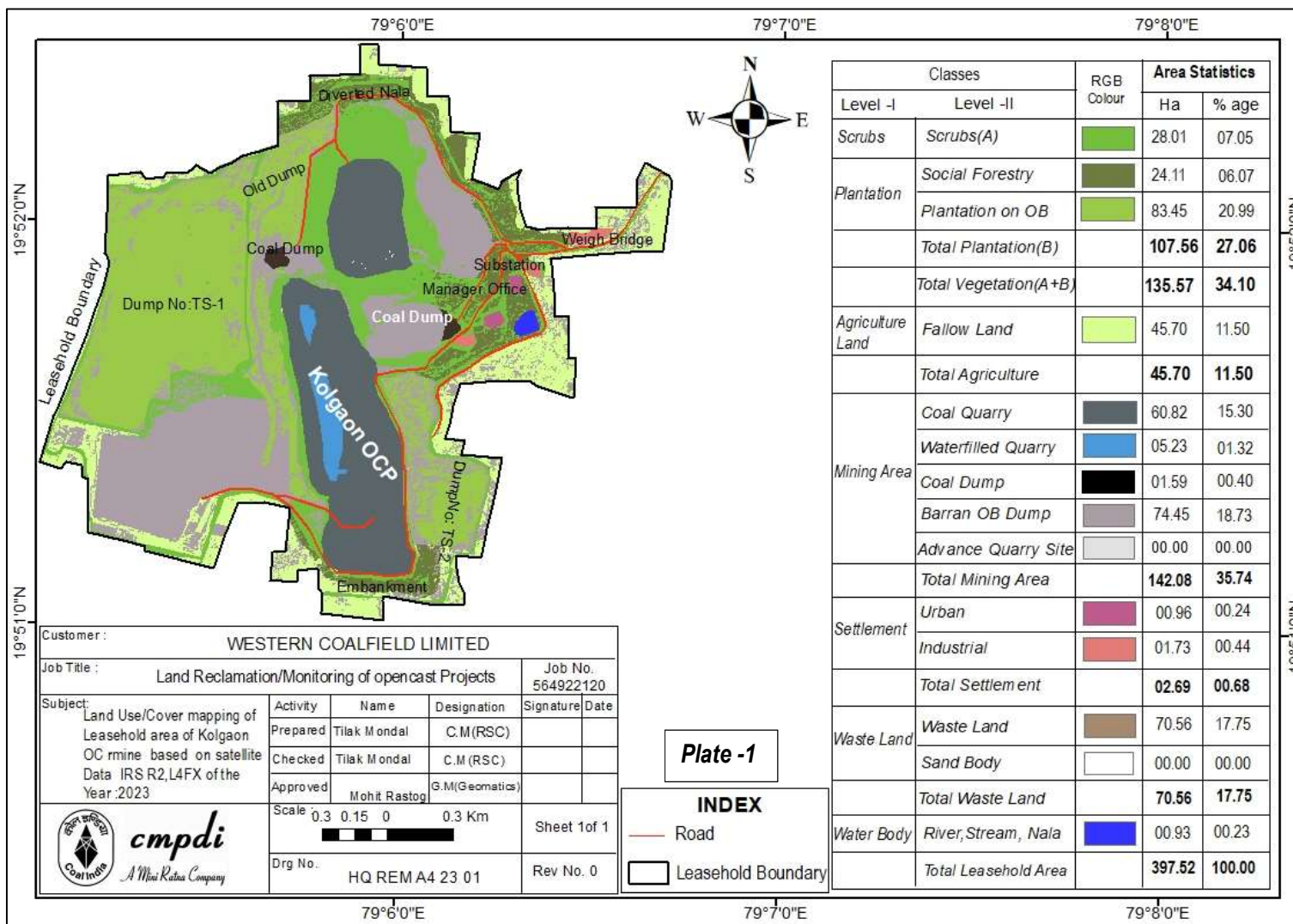
4.2 Area statistics of different land use class present in the mine leasehold of the above projects for the year 2023 are shown in the Table - 2. Land use maps derived from satellite data of year 2023 are shown in Plate 1 - 13. Changes in the different land use classes based on satellite data are depicted in Bar Charts in Fig. 3- 15.

4.3 Study reveals that out of total mine leasehold area of 7162.17 Hectare of the 13 projects Viz, Kolgaon, Bellora-Naigaon, Ghonsa, Ballarpur, Junad Extn, Urdhan, Gauri I & II Amal., Bhatadi, Gondegaon, Kolarpimpri, Chhinda, Gauri deep and Adasa UG to OC considered for monitoring during year 2023-24; total excavated area is 1574.81 Ha (21.99%), out of which 115.46 Ha (7.33%) area has been planted on backfill (Biologically Reclaimed) and 401.68 Ha (25.51%) area is under backfilling (Technically Reclaimed) and balance 1057.67 Ha (67.16%) area is under active

mining. It is evident from analysis that 517.14 Ha (32.84%) area of above projects is under reclamation (Biologically and Technically). Project wise details area given in Table 1.

- 4.4** From analysis it is revealed that total vegetated area (Biological Reclamation) within leasehold of the above projects has increased to 115.46 Ha (7.33%) in the year 2023-24 as compared to 63.43 Ha (5.03%) in the year 2020 and area under technical reclamation (area under backfilling) has also increased from 359.43 Ha (28.51%) in the year 2020 to 401.68 Ha (25.51%) area in the year 2023.
- 4.5** Study indicates that overall the projects of WCL considered for this study indicate increase or static trend in biological reclamation (Plantation on backfill) as well as area under backfilling (Technical reclamation).
- 4.6** After analyzing the satellite data of year 2020 vs. 2023 it is evident that total area under plantation (Green cover) carried out on backfilled area, OB dumps as well as under social forestry in above OC mines of WCL has increased from 1043.26 Ha (Year 2020) to 1227.00 Ha (Year 2023) in the span of three years. This increase of 183.74 Ha area under total plantation in three years' time is due to the sincere efforts made by WCL towards generation of green cover in leasehold area of the 13 opencast projects considered for land reclamation in the year 2023-24.
- 4.7** Out of 13 projects of WCL, maximum land reclamation has been carried out in Ballarpur OCP (85.18%) followed by Gauri I & II Amal. OCP (61.21%), Bellora - Naigaon (44.52%), Junad Extn. OCP (38.82%), Bhatadi OCP (28.57%), Gondegaon OCP (27.28%), Kolarpimpri OCP (11.93%), Urdhan OCP (10.99%) and Ghonsa OCP (10.54%).





Classes		RGB Colour	Area Statistics	
Level -I	Level -II		Ha	% age
Scrubs	Scrubs(A)		28.01	07.05
Plantation	Social Forestry		24.11	06.07
	Plantation on OB		83.45	20.99
Total Plantation(B)			<b>107.56</b>	<b>27.06</b>
Total Vegetation(A+B)			<b>135.57</b>	<b>34.10</b>
Agriculture Land	Fallow Land		45.70	11.50
	Total Agriculture		<b>45.70</b>	<b>11.50</b>
Mining Area	Coal Quarry		60.82	15.30
	Waterfilled Quarry		05.23	01.32
	Coal Dump		01.59	00.40
	Barran OB Dump		74.45	18.73
	Advance Quarry Site		00.00	00.00
Total Mining Area			<b>142.08</b>	<b>35.74</b>
Settlement	Urban		00.96	00.24
	Industrial		01.73	00.44
Total Settlement			<b>02.69</b>	<b>00.68</b>
Waste Land	Waste Land		70.56	17.75
	Sand Body		00.00	00.00
Total Waste Land			<b>70.56</b>	<b>17.75</b>
Water Body	River, Stream, Nala		00.93	00.23
	Total Leasehold Area		<b>397.52</b>	<b>100.00</b>

Customer : WESTERN COALFIELD LIMITED

Job Title : Land Reclamation/Monitoring of opencast Projects Job No. 564922120

Subject:	Activity	Name	Designation	Signature	Date
Land Use/Cover mapping of Leasehold area of Kolgaon OC mine based on satellite Data IRS R2,L4FX of the Year :2023	Prepared	Tilak Mondal	C.M(RSC)		
	Checked	Tilak Mondal	C.M(RSC)		
	Approved	Mohit Rastogi	G.M(Geomatics)		

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Sheet 1 of 1

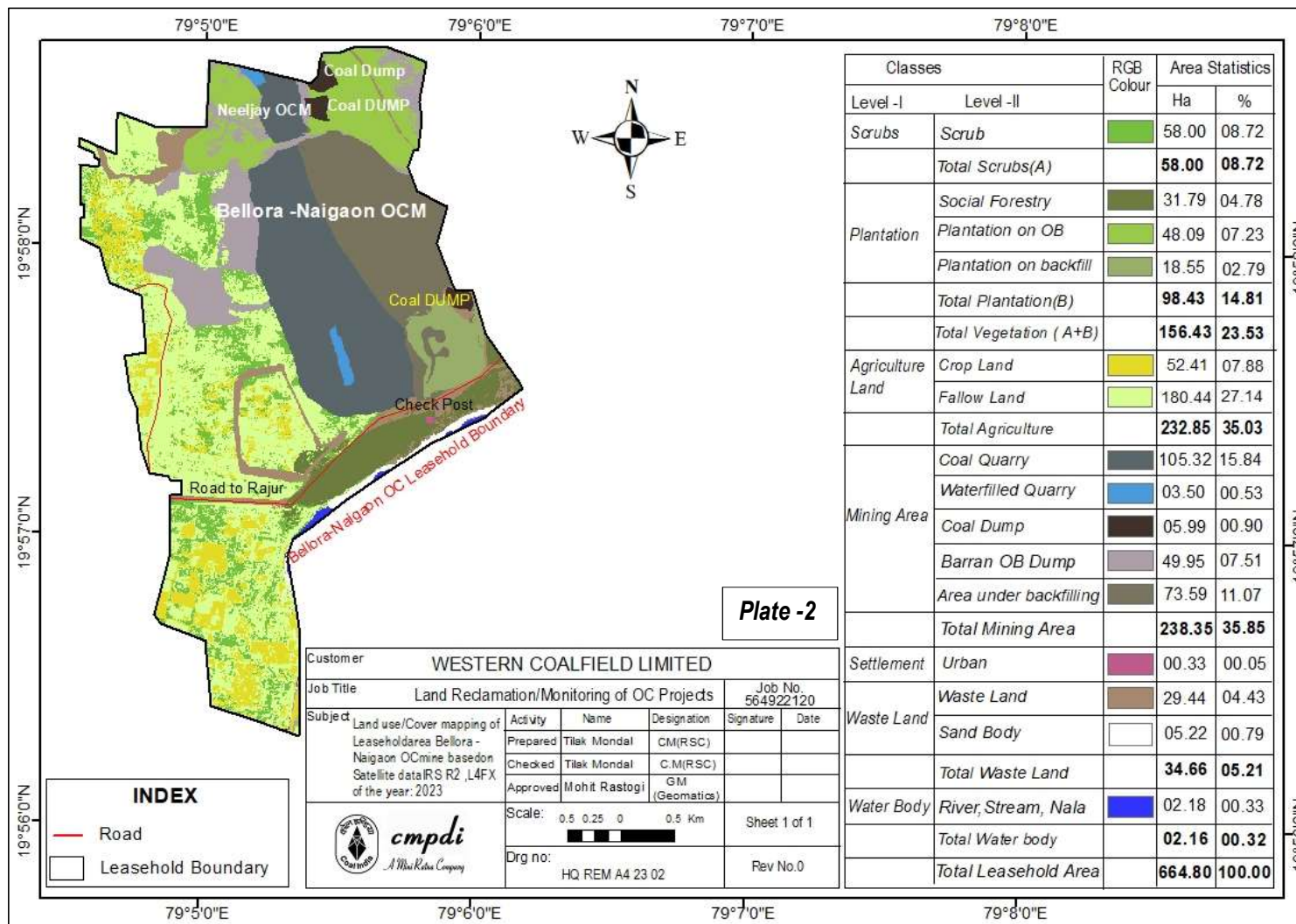
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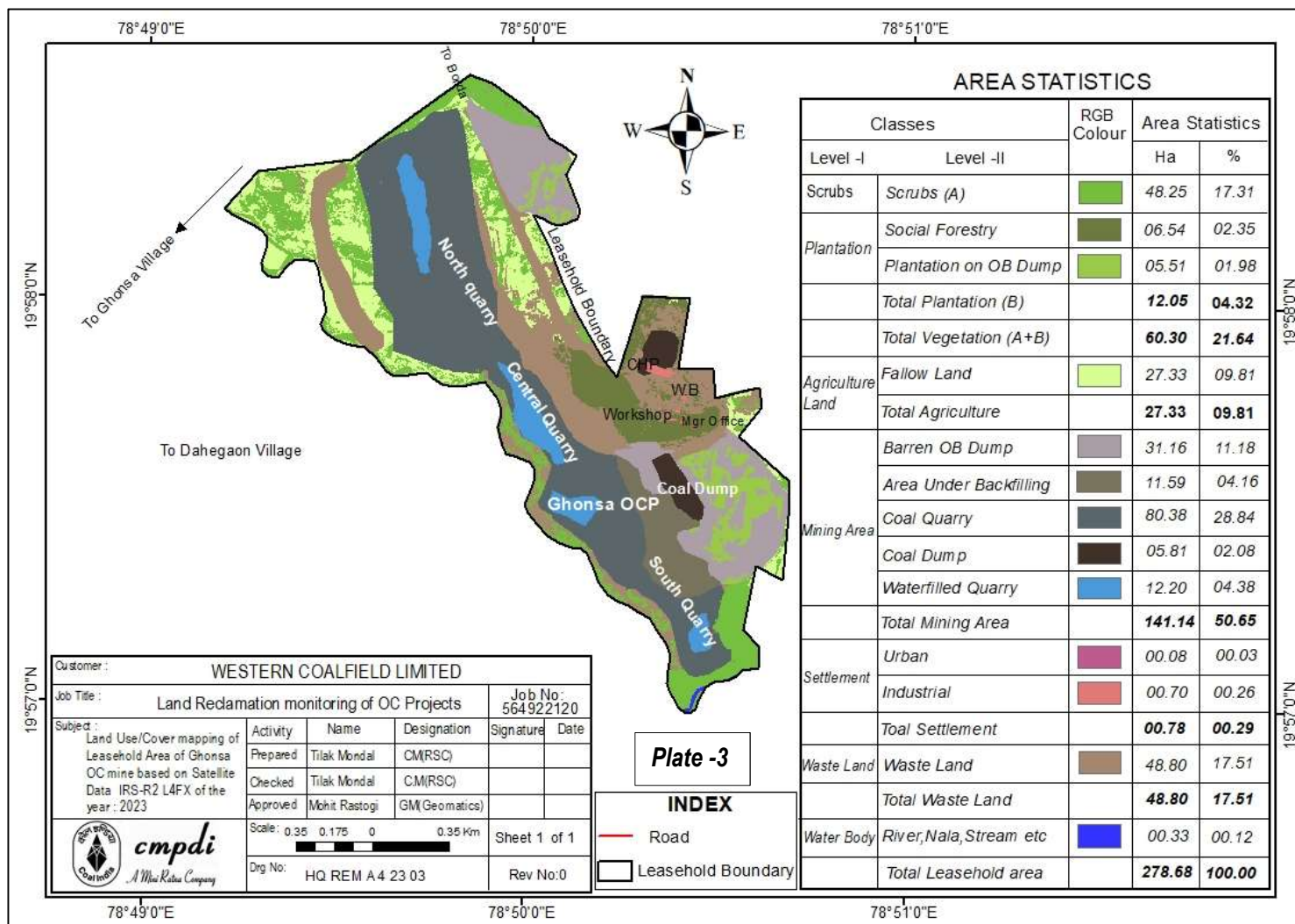
Plate -1

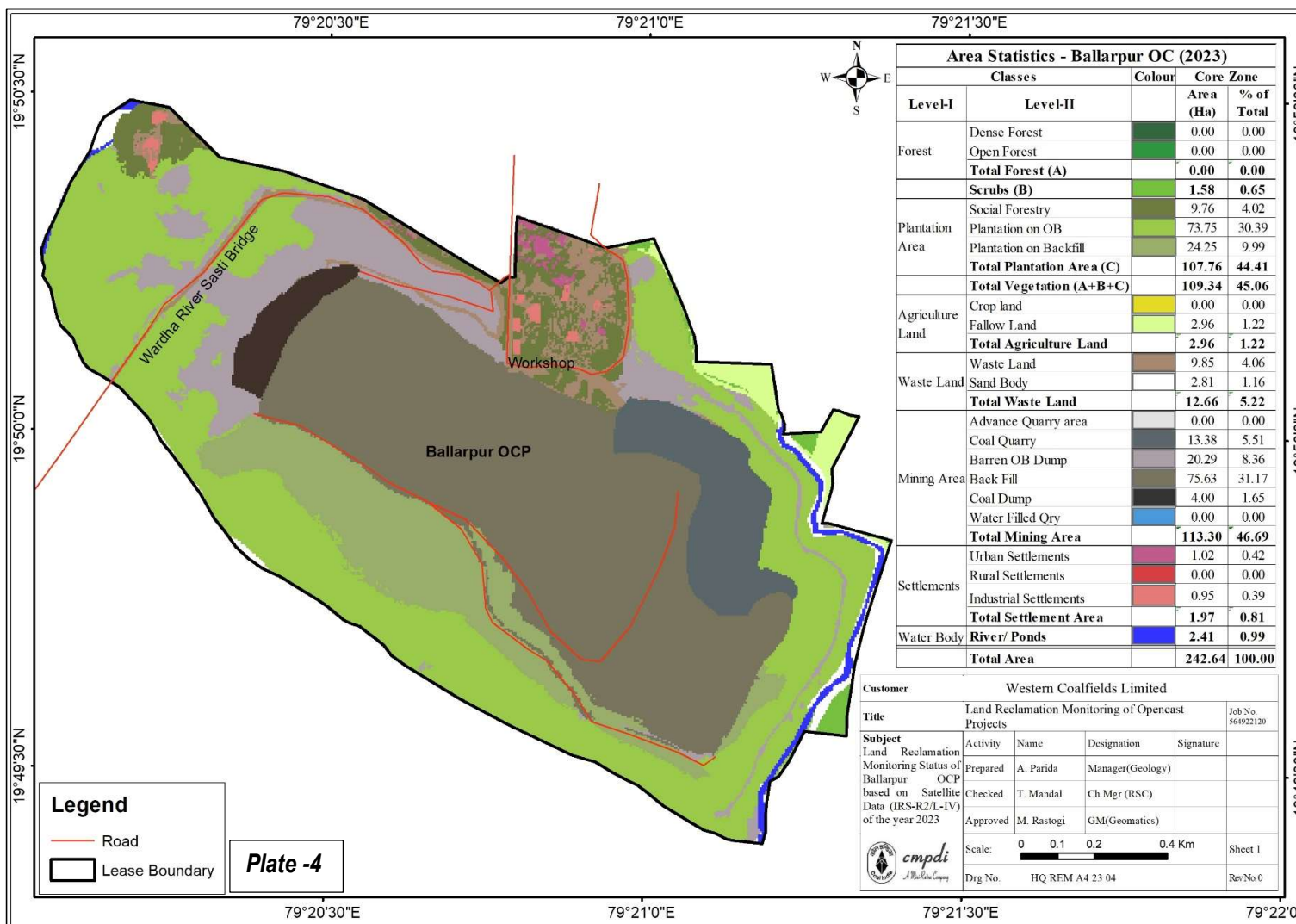
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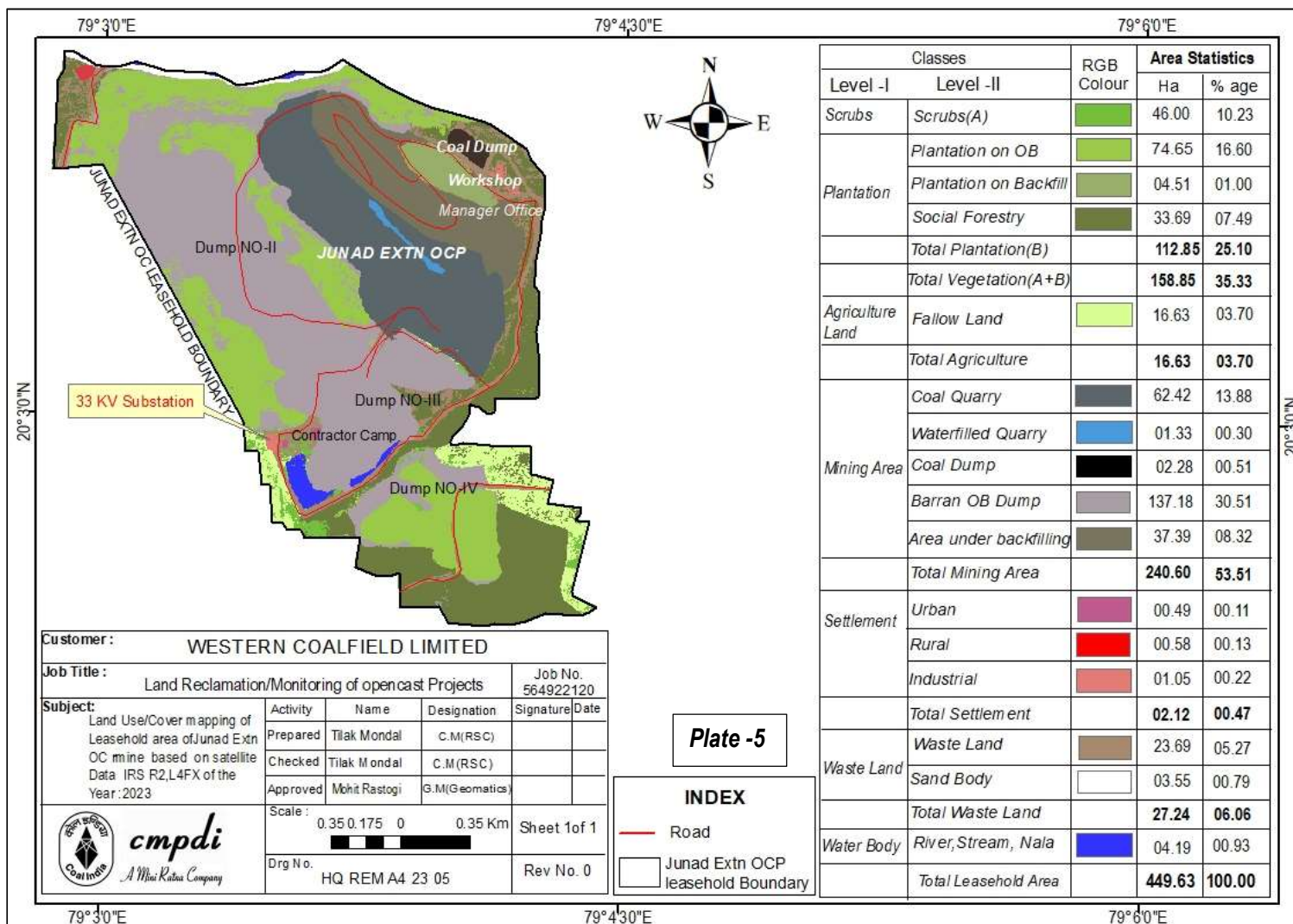
Road

Leasehold Boundary

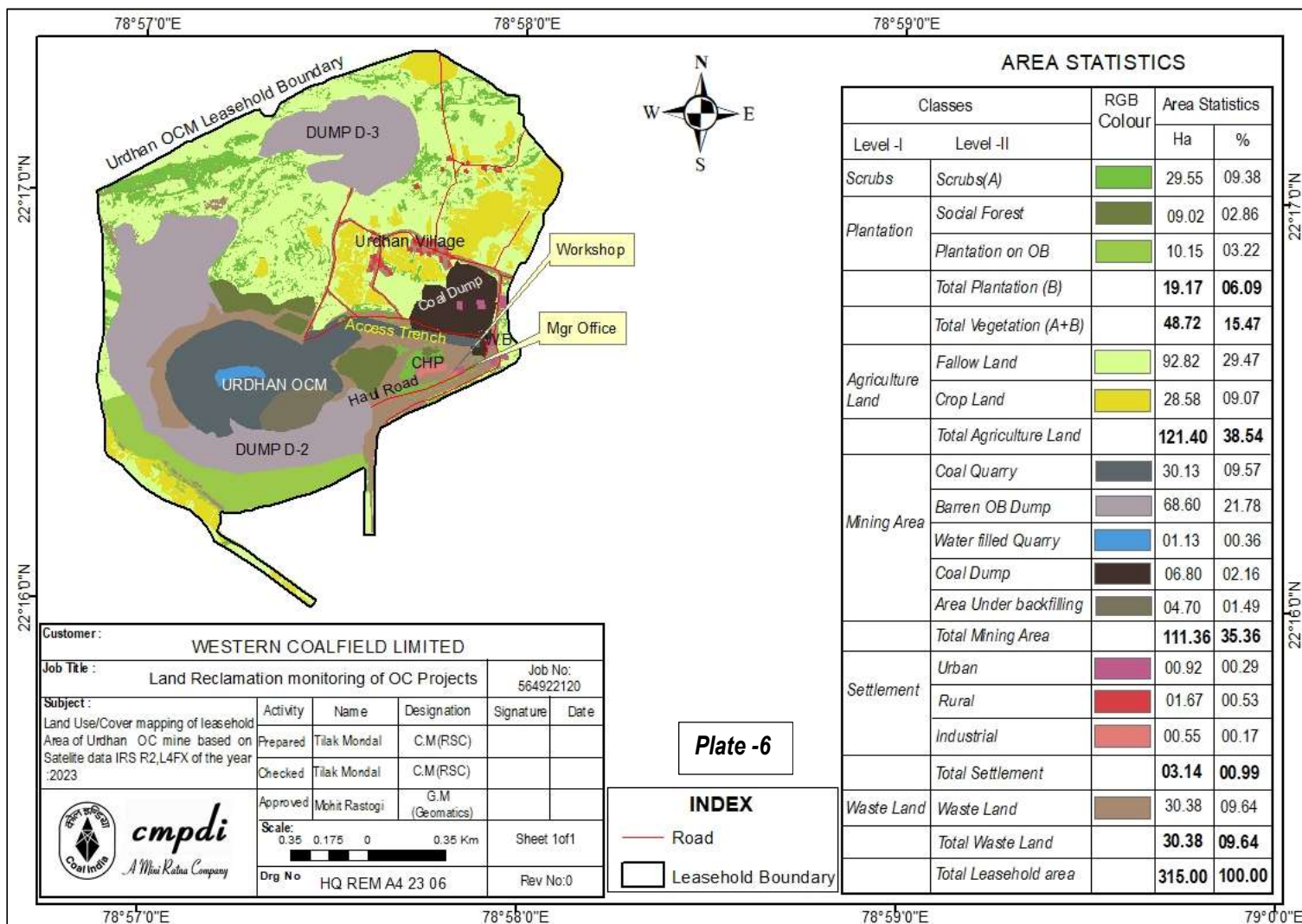












**AREA STATISTICS**

Classes		RGB Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrub	Scrub(A)		29.55	09.38
Plantation	Social Forest		09.02	02.86
	Plantation on OB		10.15	03.22
<b>Total Plantation (B)</b>			<b>19.17</b>	<b>06.09</b>
<b>Total Vegetation (A+B)</b>			<b>48.72</b>	<b>15.47</b>
Agriculture Land	Fallow Land		92.82	29.47
	Crop Land		28.58	09.07
<b>Total Agriculture Land</b>			<b>121.40</b>	<b>38.54</b>
Mining Area	Coal Quarry		30.13	09.57
	Barren OB Dump		68.60	21.78
	Water filled Quarry		01.13	00.36
	Coal Dump		06.80	02.16
<b>Area Under backfilling</b>			04.70	01.49
<b>Total Mining Area</b>			<b>111.36</b>	<b>35.36</b>
Settlement	Urban		00.92	00.29
	Rural		01.67	00.53
	Industrial		00.55	00.17
<b>Total Settlement</b>			<b>03.14</b>	<b>00.99</b>
Waste Land	Waste Land		30.38	09.64
	<b>Total Waste Land</b>		<b>30.38</b>	<b>09.64</b>
<b>Total Leasehold area</b>			<b>315.00</b>	<b>100.00</b>

Customer: **WESTERN COALFIELD LIMITED**

Job Title: **Land Reclamation monitoring of OC Projects** Job No: 564922120

Subject: Land Use/Cover mapping of leasehold Area of Urdhan OC mine based on Satellite data IRS R2,L4FX of the year 2023

Activity	Name	Designation	Signature	Date
Prepared	Tilak Mondal	C.M(RSC)		
Checked	Tilak Mondal	C.M(RSC)		
Approved	Mohit Rastogi	G.M (Geomatics)		

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Sheet 10f1

Drwg No HQ REM A4 23 06 Rev No:0

**Plate -6**

**INDEX**

Road

Leasehold Boundary

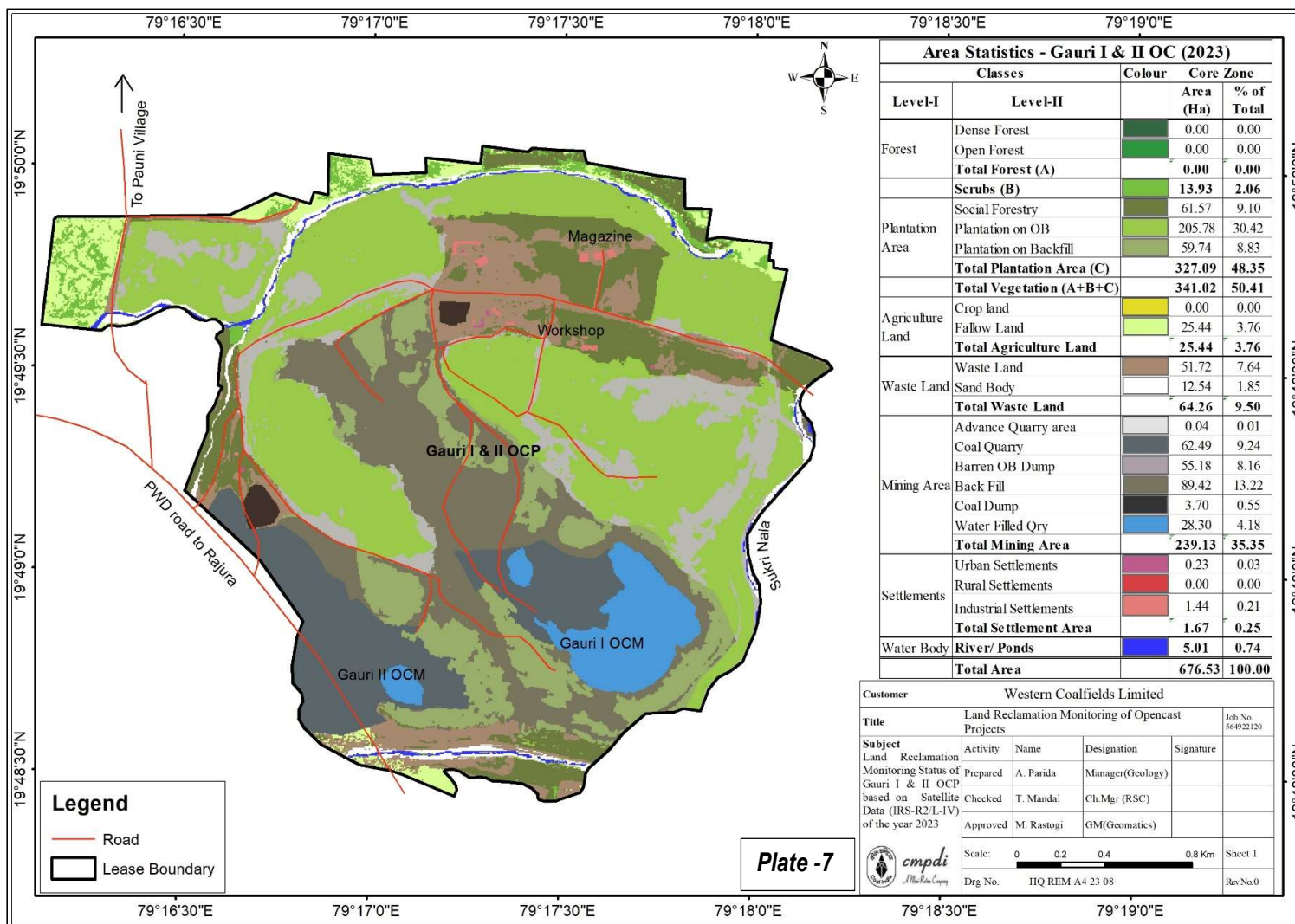
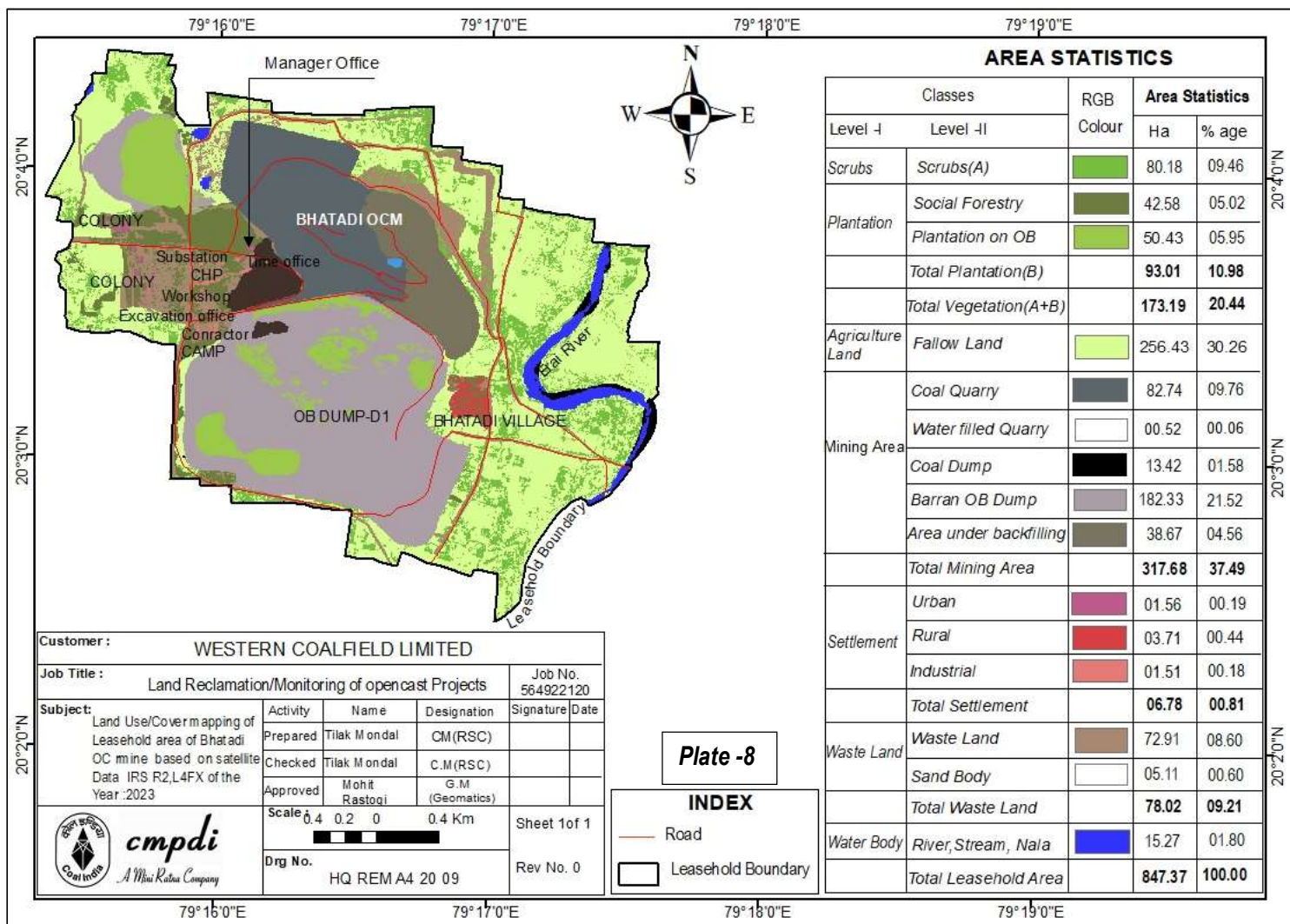


Plate -7



**Customer :** WESTERN COALFIELD LIMITED

**Job Title :** Land Reclamation/Monitoring of opencast Projects Job No. 564922120

Subject:	Activity	Name	Designation	Signature	Date
Land Use/Cover mapping of Leasehold area of Bhatadi OC mine based on satellite Data IRS R2,L4FX of the Year :2023	Prepared	Tilak Mondal	CM(RSC)		
	Checked	Tilak Mondal	C.M(RSC)		
	Approved	Mohit Rastogi	G.M (Geomatics)		

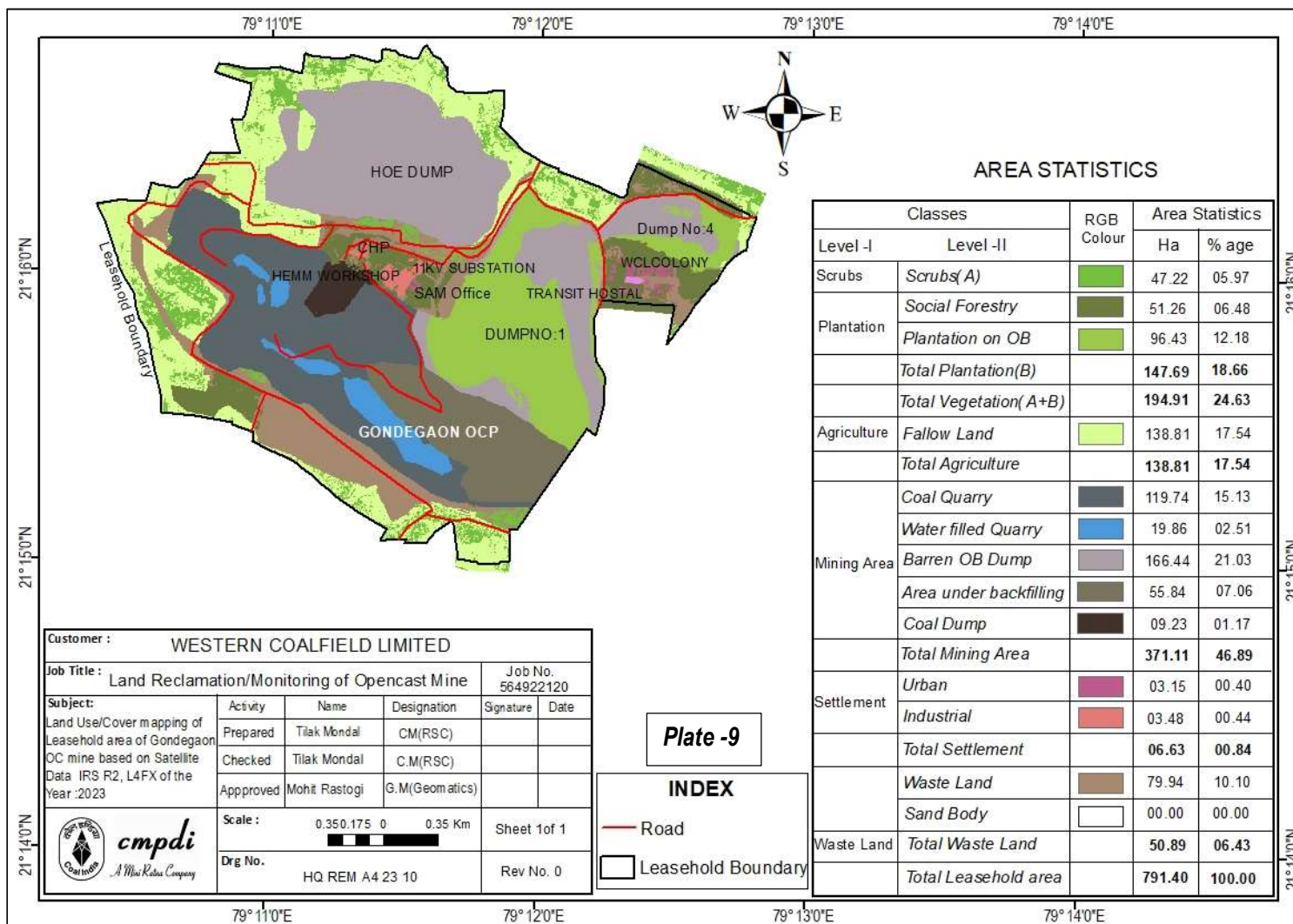
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Drg No. HQ REMA4 20 09 Rev No. 0

**Plate -8**

**INDEX**

- Road
- Leasehold Boundary




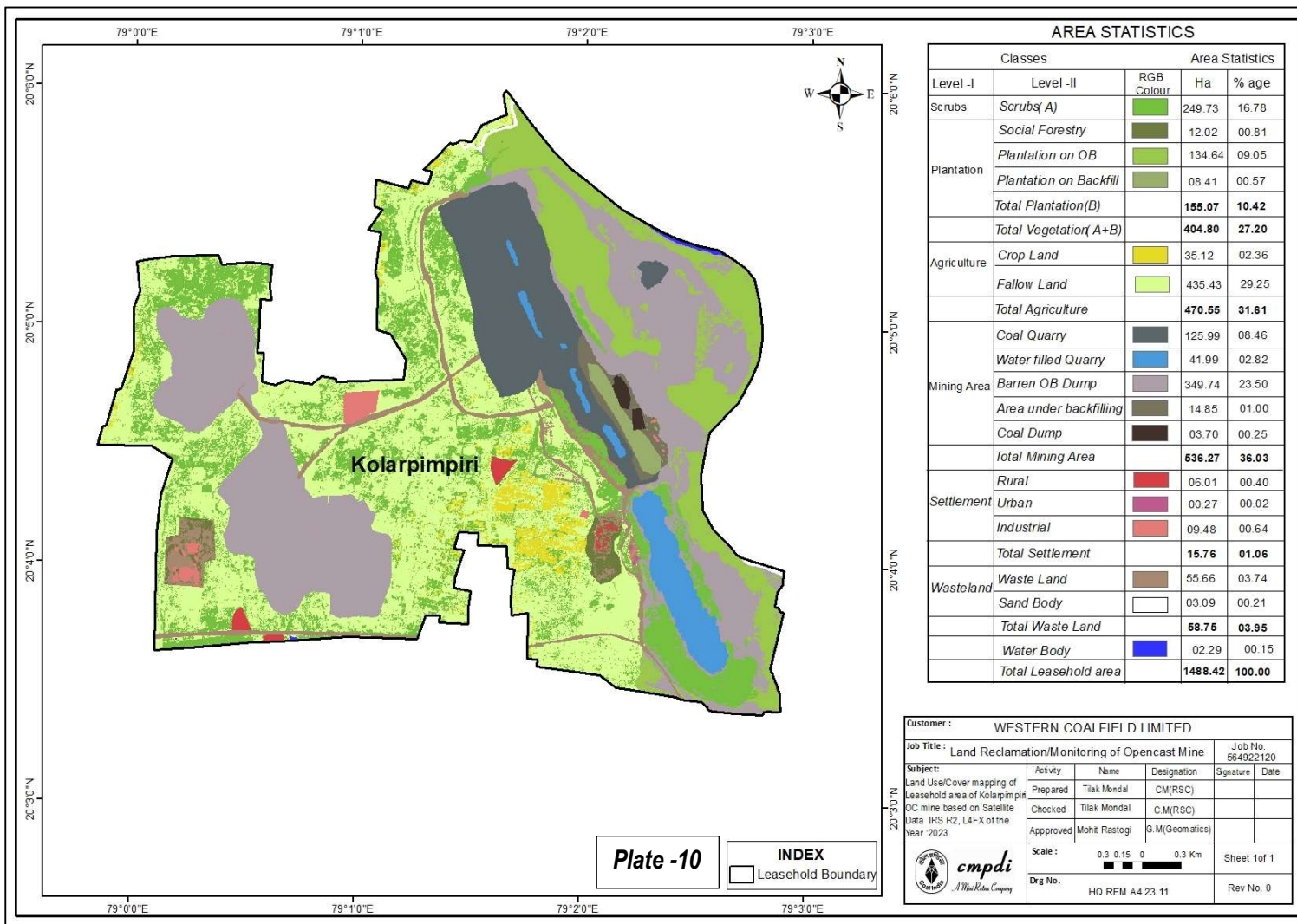
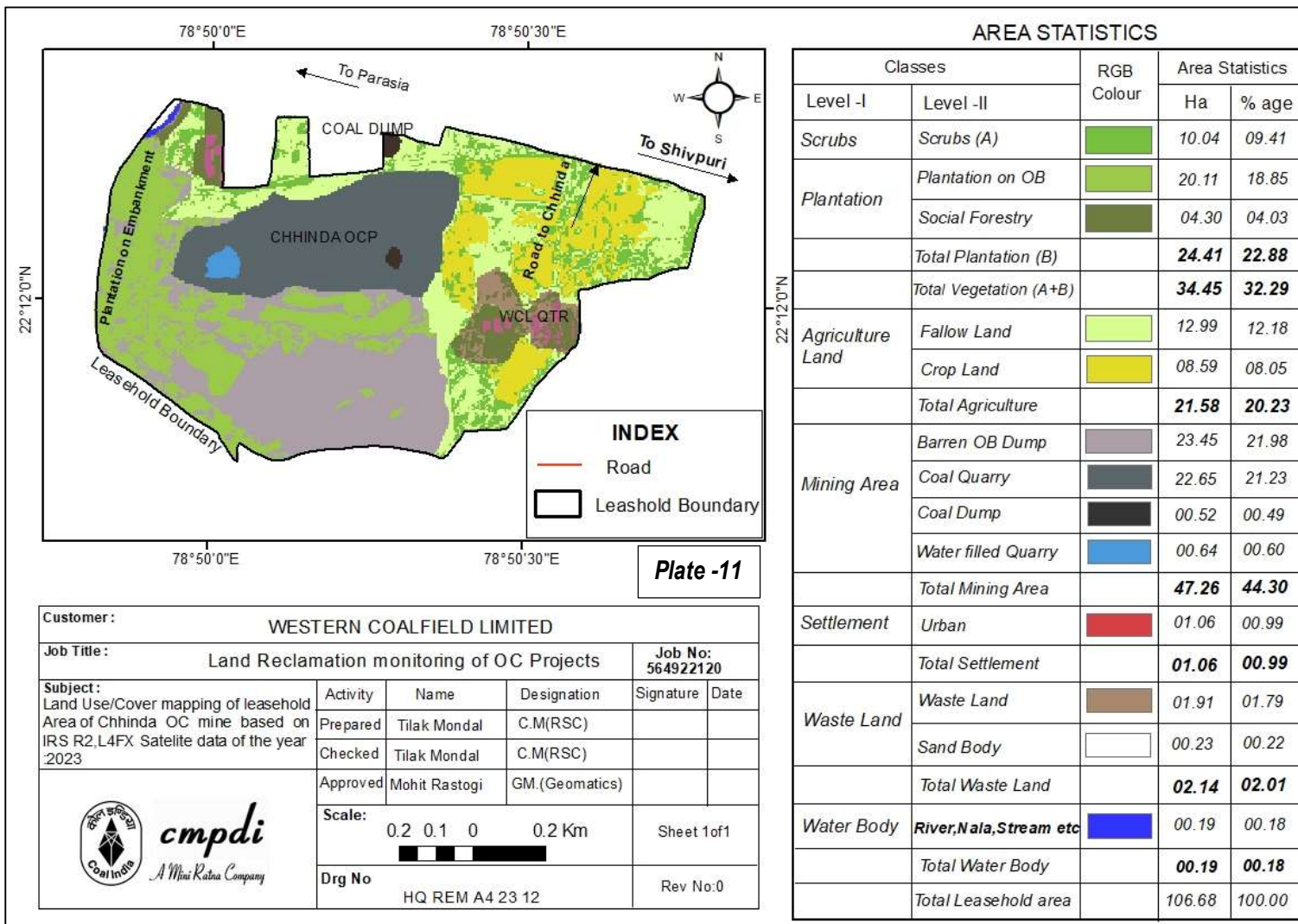
Customer : WESTERN COALFIELD LIMITED					
Job Title : Land Reclamation/Monitoring of Opencast Mine				Job No. 564922120	
Subject: Land Use/Cover mapping of Leasehold area of Gondegaon OC mine based on Satellite Data IRS R2, L4FX of the Year :2023	Activity	Name	Designation	Signature	Date
	Prepared	Tilak Mondal	CM(RSC)		
	Checked	Tilak Mondal	C.M(RSC)		
	Approved	Mohit Rastogi	G.M(Geomatics)		
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	Drg No. HQ REM A4 23 10		Rev No. 0		

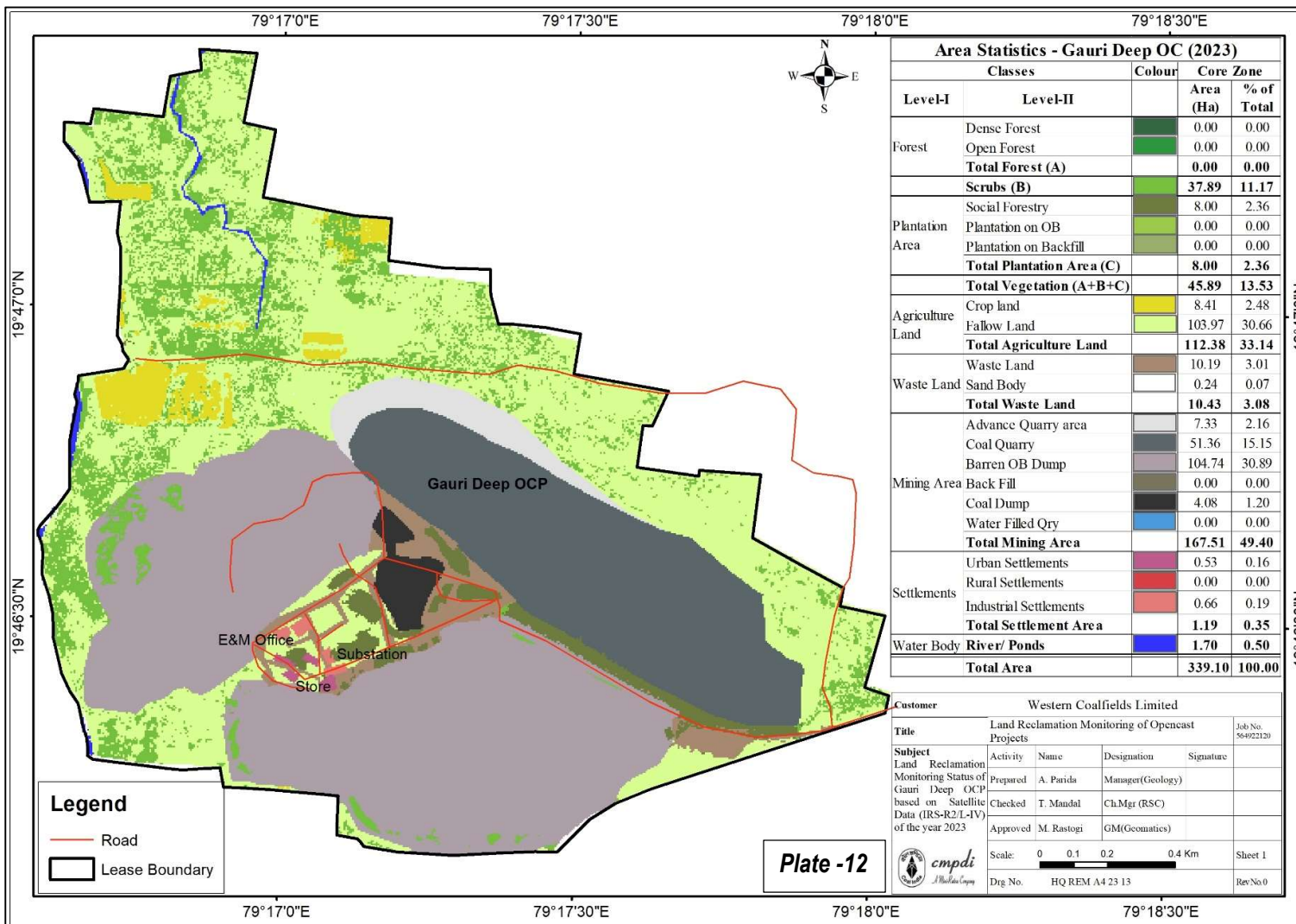
Plate -9

INDEX	
	Road
	Leasehold Boundary





Customer:		WESTERN COALFIELD LIMITED			
Job Title:		Land Reclamation monitoring of OC Projects		Job No: 564922120	
Subject: Land Use/Cover mapping of leasehold Area of Chhinda OC mine based on IRS R2,L4FX Satellite data of the year 2023	Activity	Name	Designation	Signature	Date
	Prepared	Tilak Mondal	C.M(RSC)		
	Checked	Tilak Mondal	C.M(RSC)		
	Approved	Mohit Rastogi	GM.(Geomatics)		
 <b>cmpdi</b> <i>A Mini Ratna Company</i>	Scale:		0.2 0.1 0 0.2 Km	Sheet 1 of 1	
	Drg No		HQ REM A4 23 12	Rev No:0	



**Area Statistics - Gauri Deep OC (2023)**

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	<b>Total Forest (A)</b>		<b>0.00</b>	<b>0.00</b>
<b>Scrubs (B)</b>			<b>37.89</b>	<b>11.17</b>
Plantation Area	Social Forestry		8.00	2.36
	Plantation on OB		0.00	0.00
	Plantation on Backfill		0.00	0.00
<b>Total Plantation Area (C)</b>			<b>8.00</b>	<b>2.36</b>
<b>Total Vegetation (A+B+C)</b>			<b>45.89</b>	<b>13.53</b>
Agriculture Land	Crop land		8.41	2.48
	Fallow Land		103.97	30.66
	<b>Total Agriculture Land</b>		<b>112.38</b>	<b>33.14</b>
Waste Land	Waste Land		10.19	3.01
	Sand Body		0.24	0.07
	<b>Total Waste Land</b>		<b>10.43</b>	<b>3.08</b>
Mining Area	Advance Quarry area		7.33	2.16
	Coal Quarry		51.36	15.15
	Barren OB Dump		104.74	30.89
	Back Fill		0.00	0.00
	Coal Dump		4.08	1.20
	Water Filled Qry		0.00	0.00
<b>Total Mining Area</b>			<b>167.51</b>	<b>49.40</b>
Settlements	Urban Settlements		0.53	0.16
	Rural Settlements		0.00	0.00
	Industrial Settlements		0.66	0.19
	<b>Total Settlement Area</b>		<b>1.19</b>	<b>0.35</b>
Water Body	<b>River/ Ponds</b>		<b>1.70</b>	<b>0.50</b>
<b>Total Area</b>			<b>339.10</b>	<b>100.00</b>

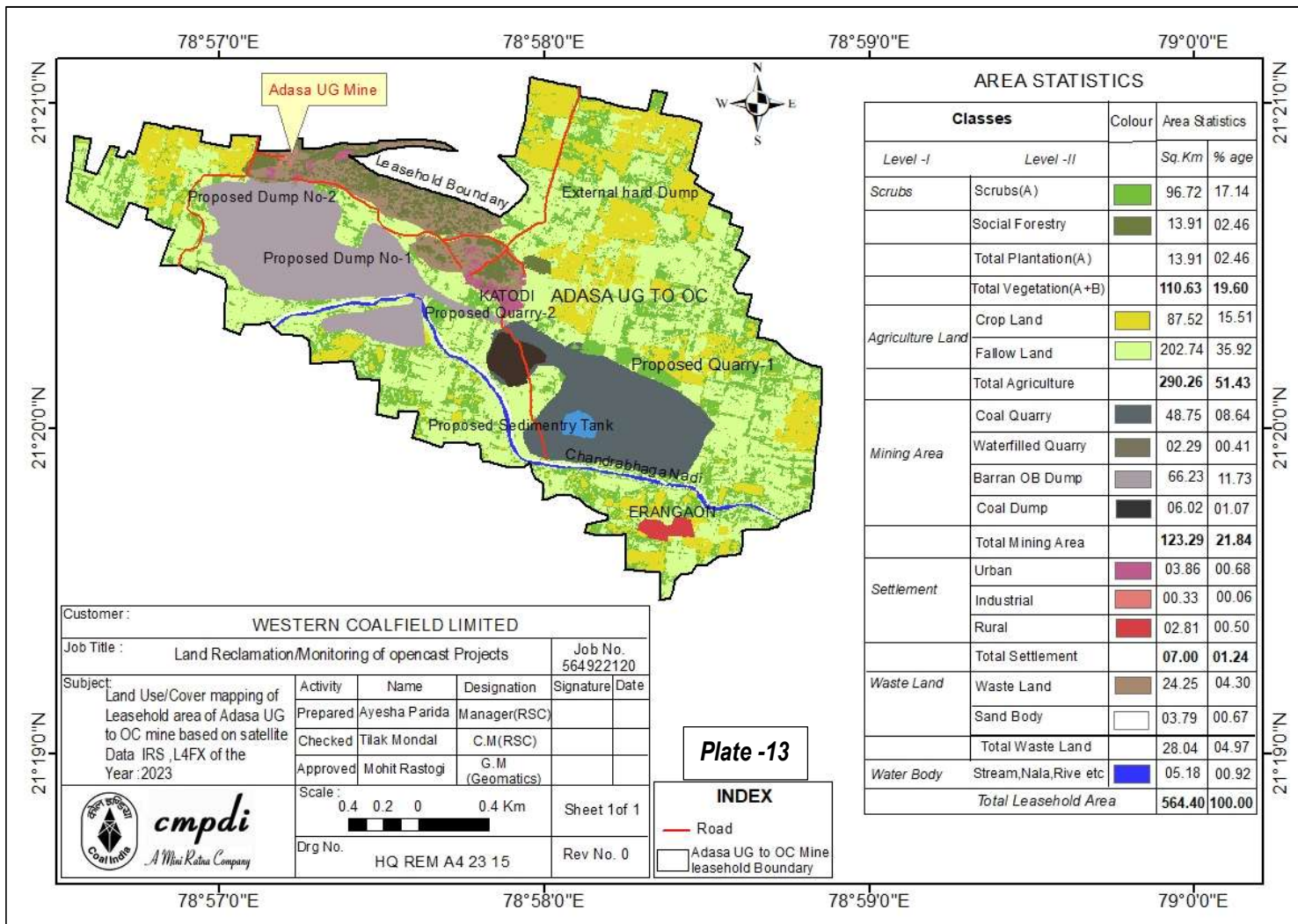
**Customer** Western Coalfields Limited

<b>Title</b>	Land Reclamation Monitoring of Opencast Projects			Job No. 564922120
<b>Subject</b>	Activity	Name	Designation	Signature
Land Reclamation Monitoring Status of Gauri Deep OCP based on Satellite Data (IRS-R2/L-IV) of the year 2023	Prepared	A. Parida	Manager(Geology)	
	Checked	T. Mandal	Ch.Mgr (RSC)	
	Approved	M. Rastogi	GM(Geomatics)	
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Dwg No.	HQ REM A4 23 13			Rev/No 0

**Legend**

- Road
- Lease Boundary

**Plate -12**





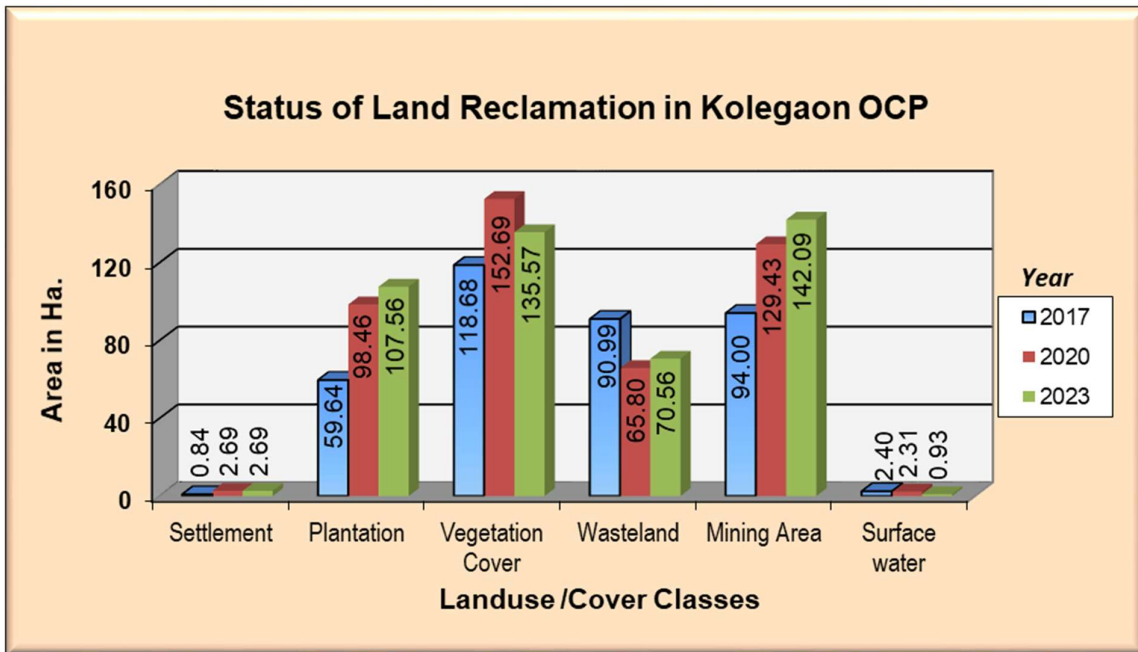


Figure-3

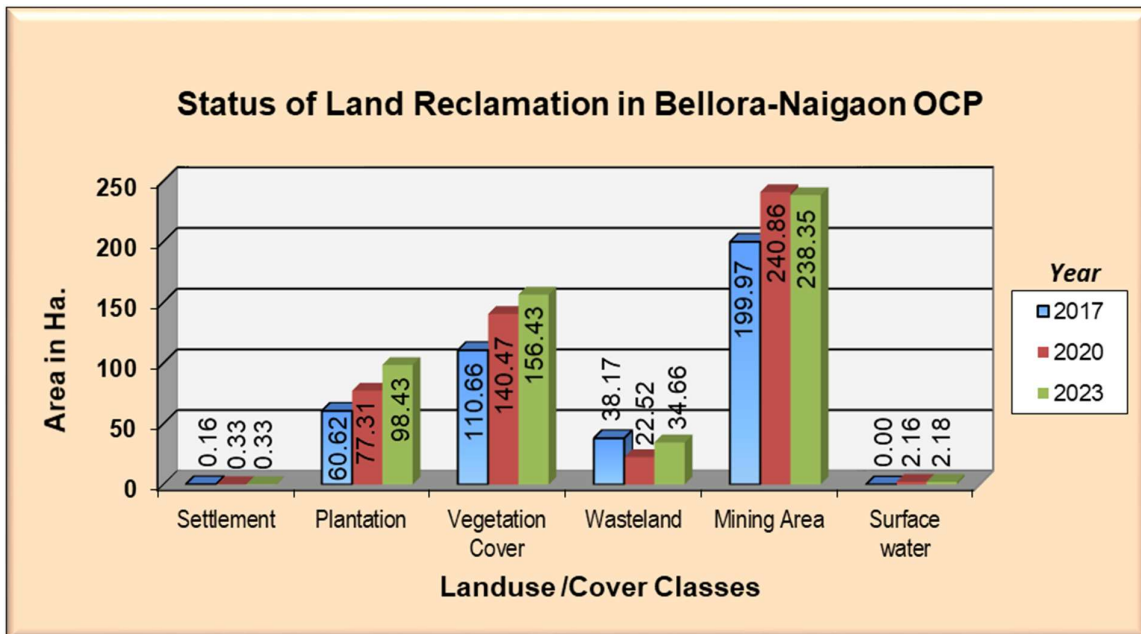


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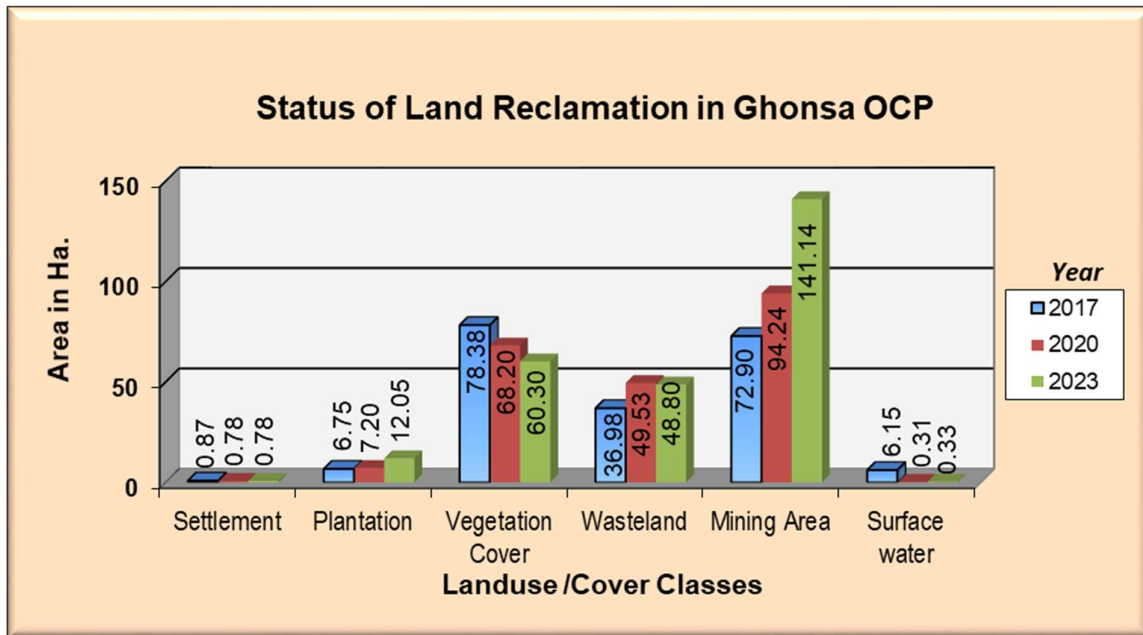


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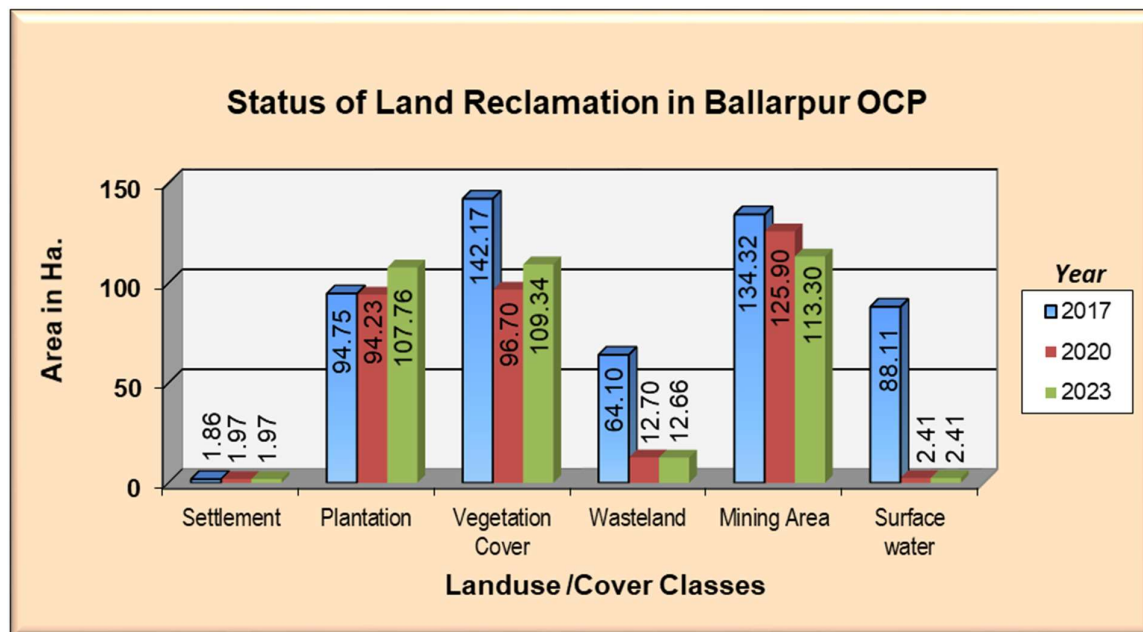


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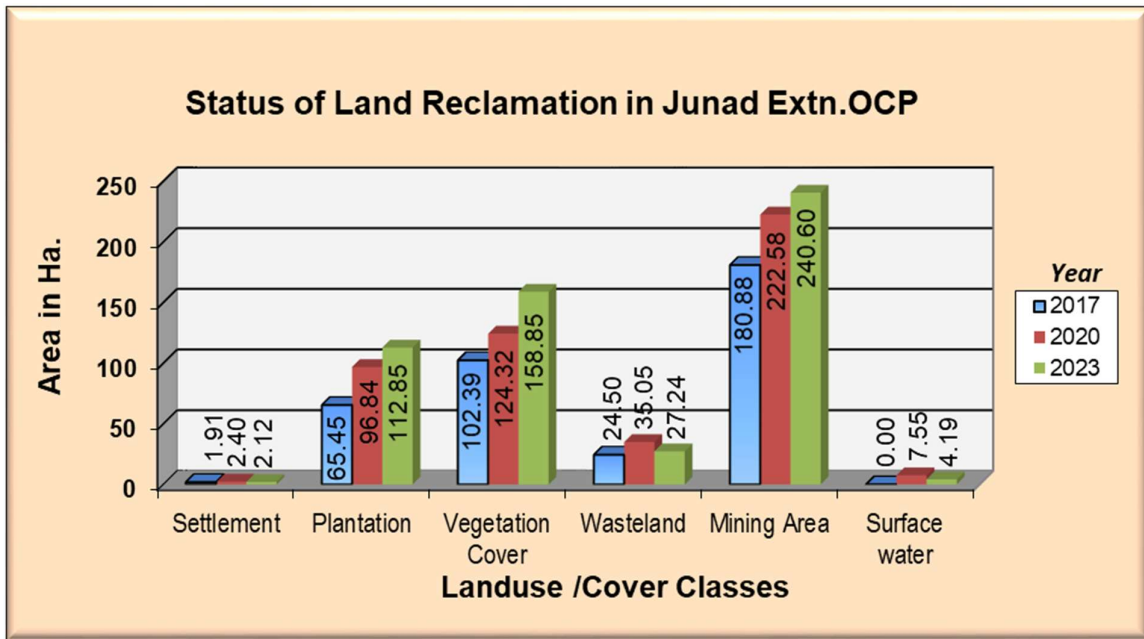


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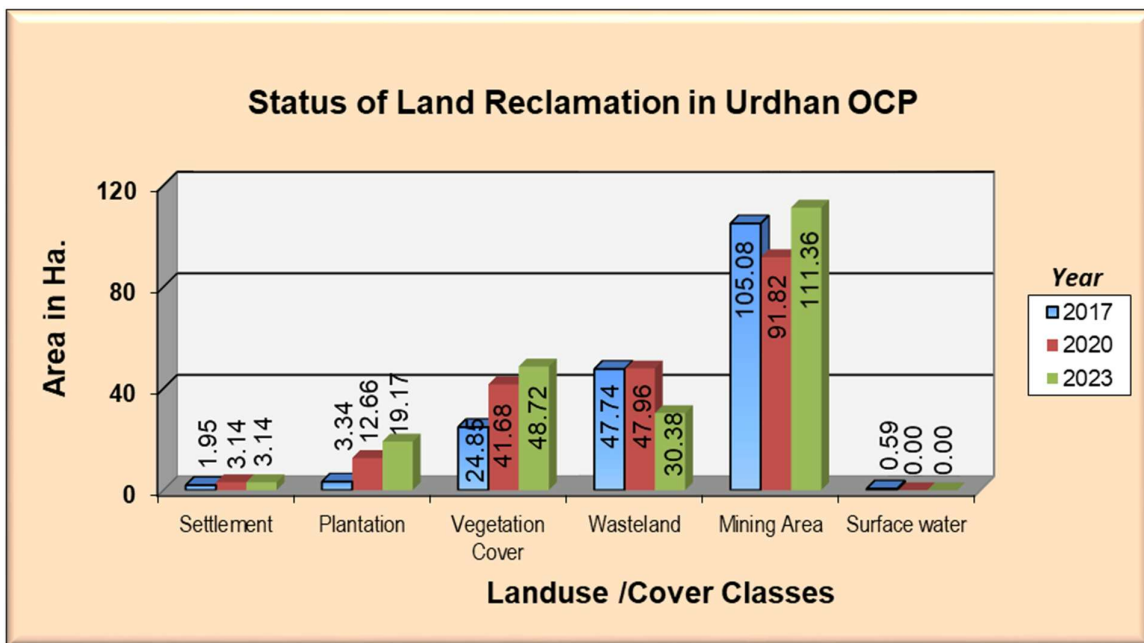


Figure-8

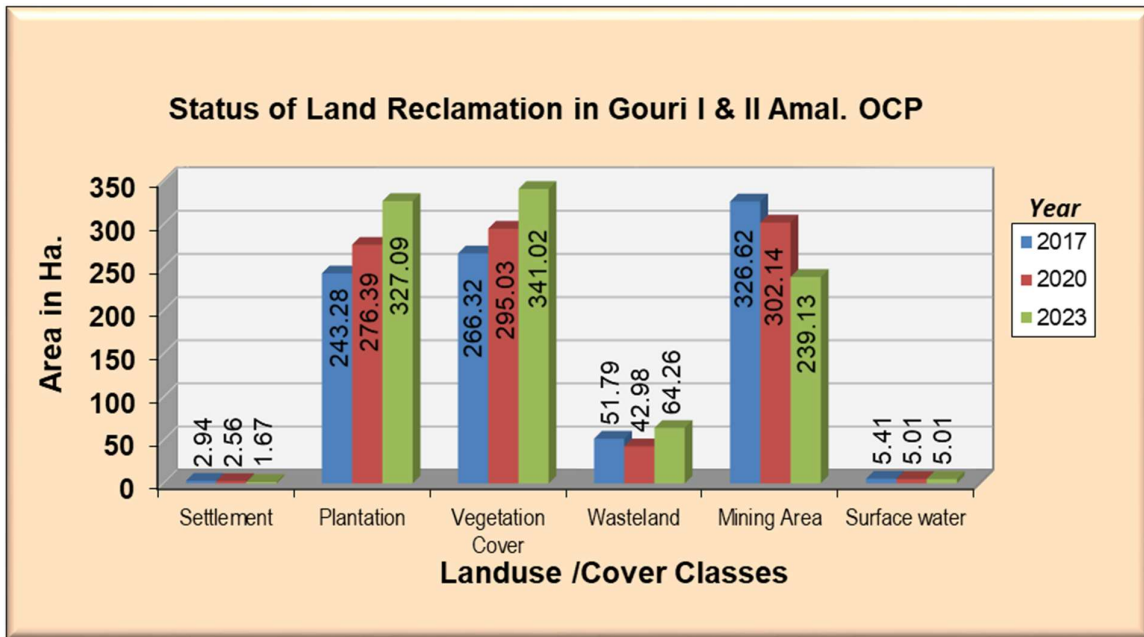


Figure-9

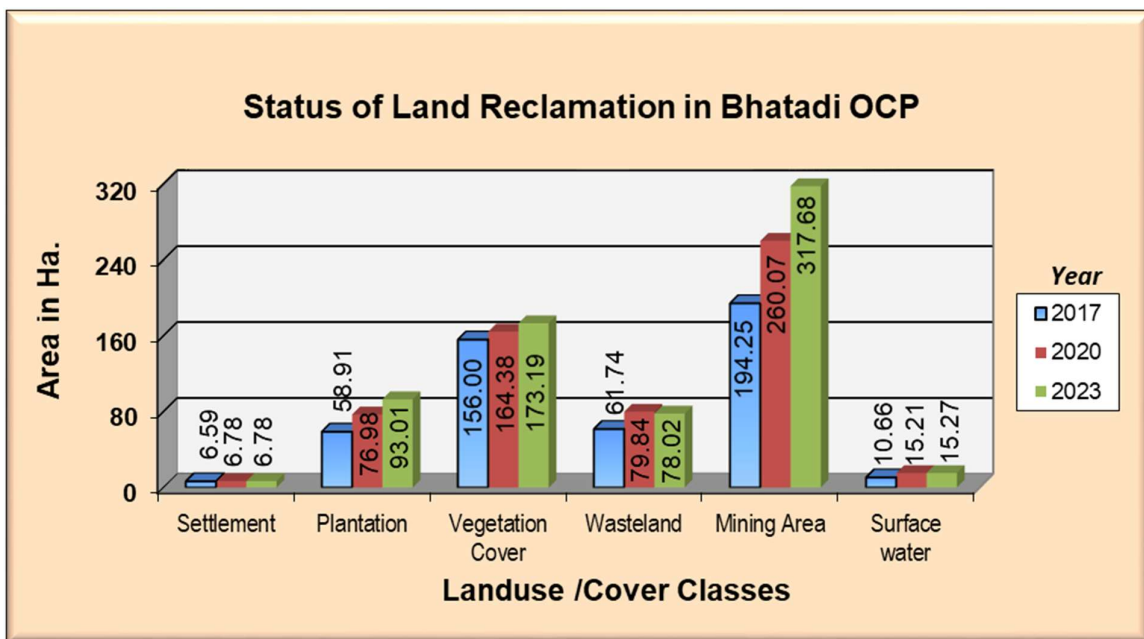


Figure-10

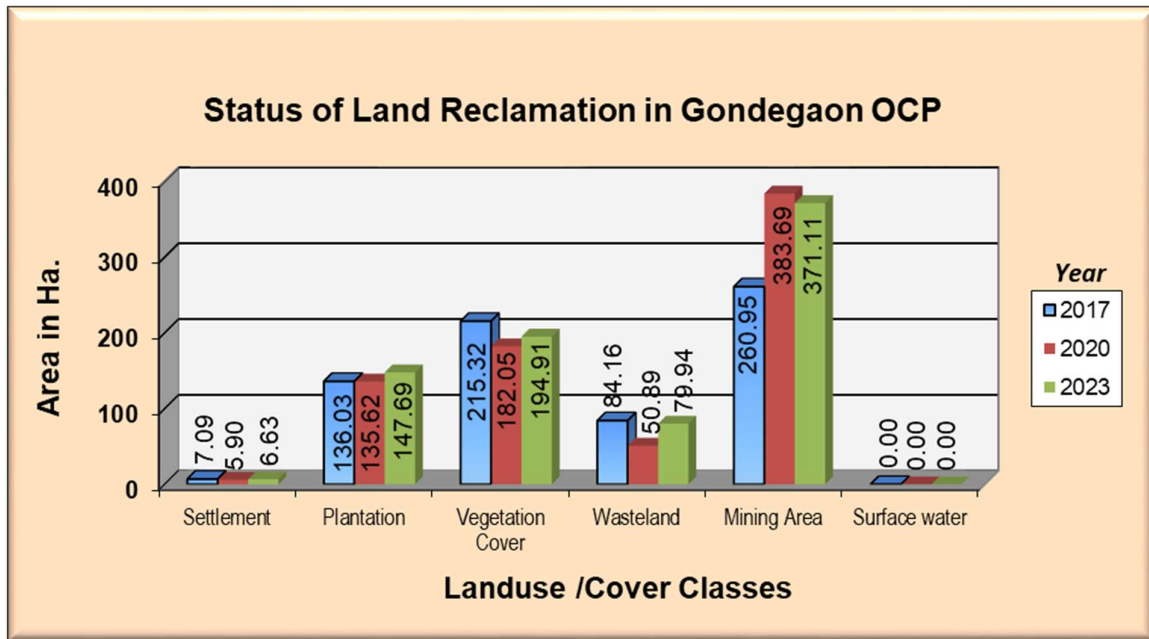


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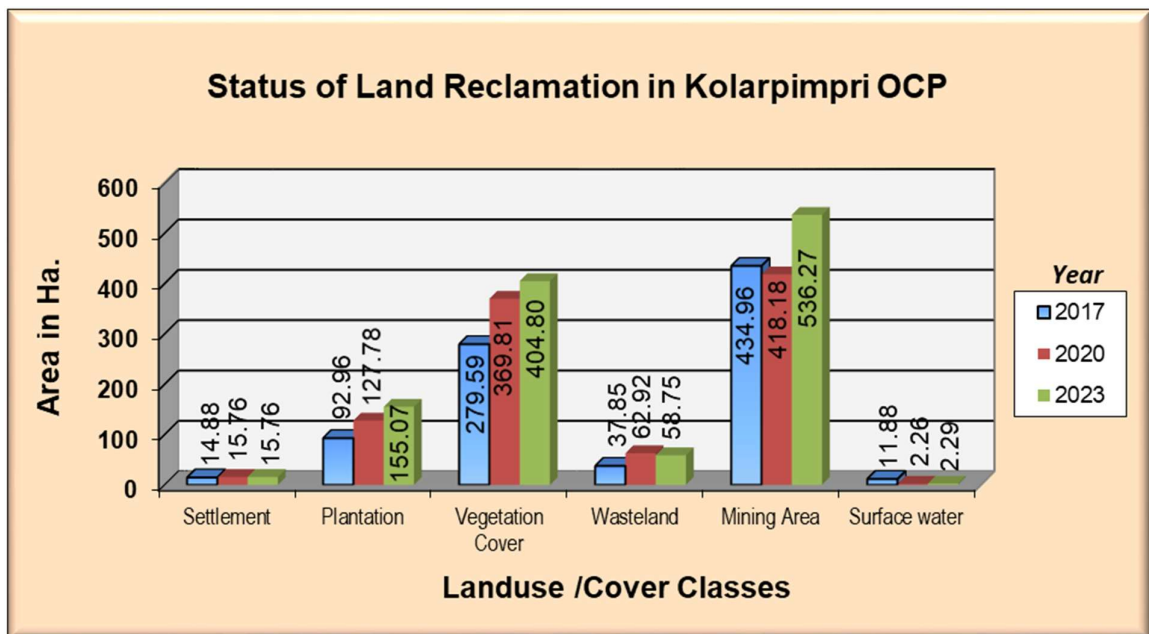


Figure-12

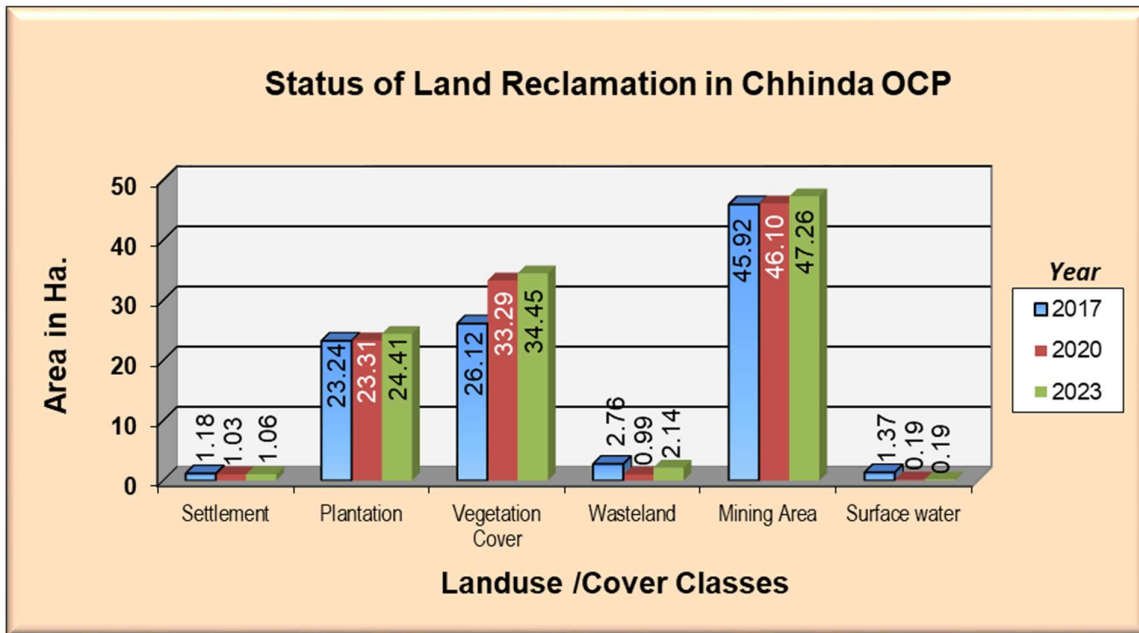


Figure-13

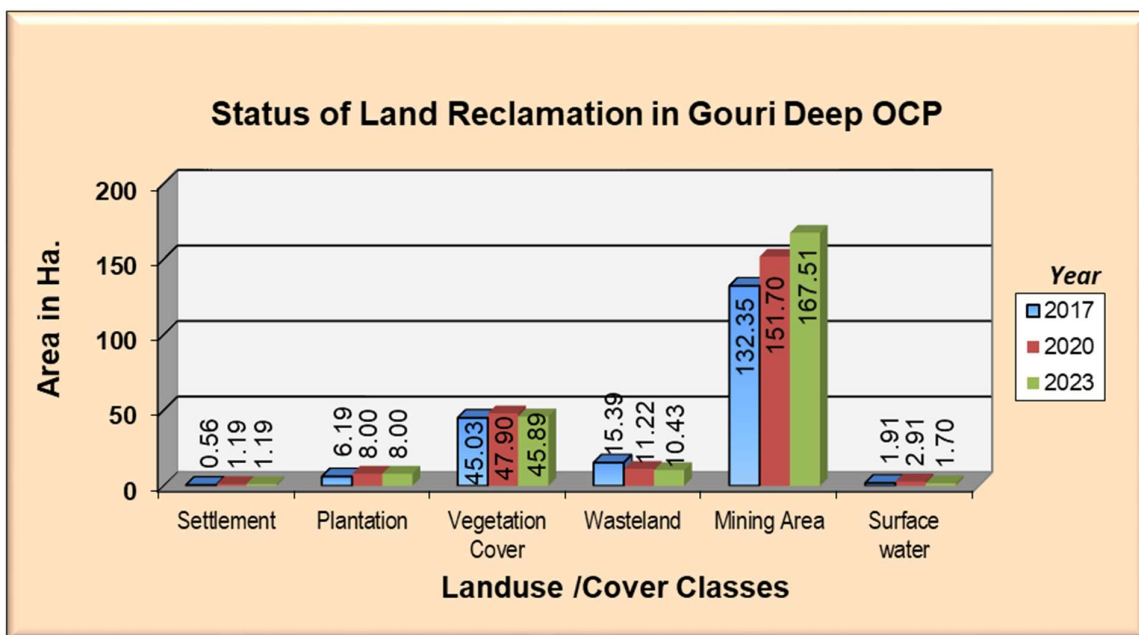


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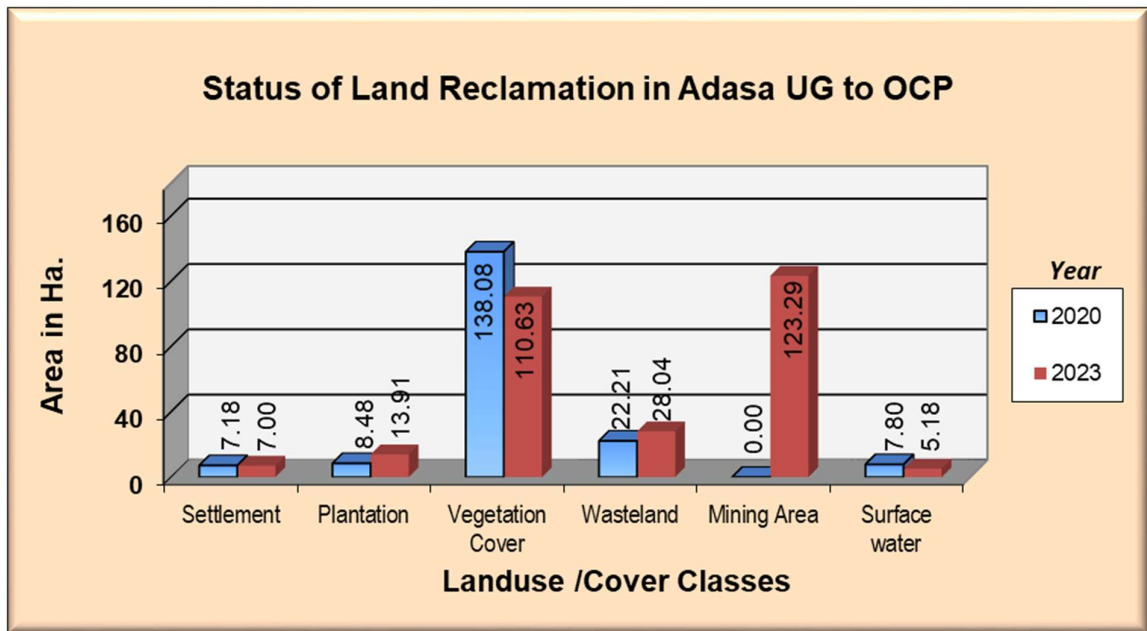
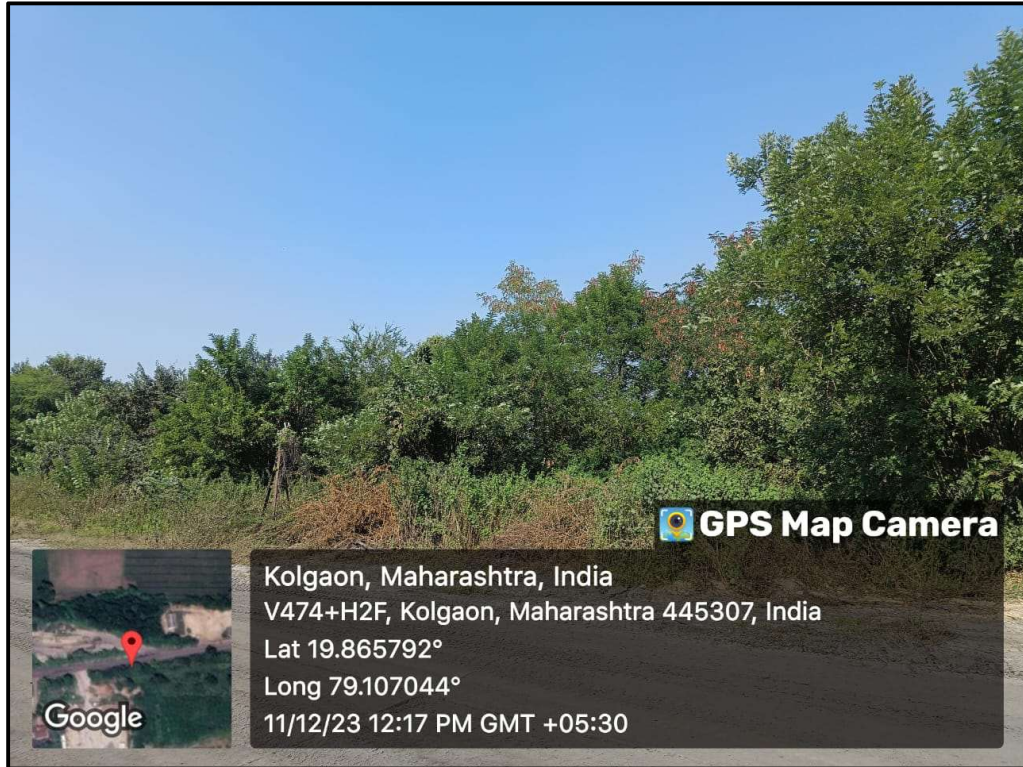


Figure -15



Photograph 1: Plantation under social forestry in Adasa UG to OC Project



Photograph 2: Social Forestry Plantation in Kolgaon OCP



Photograph 3: Plantation on Barren OB in Bellora-Naigaon OCP

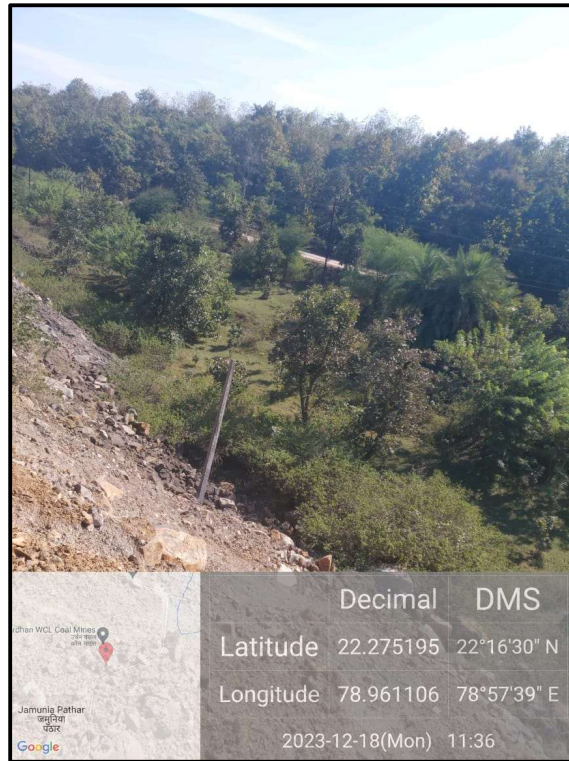




*Photograph 4: Plantation on Barren OB Dump in Ghonsa OCP*



*Photograph 5: Plantation on Barren OB Dump in Junad Extn. OCP*



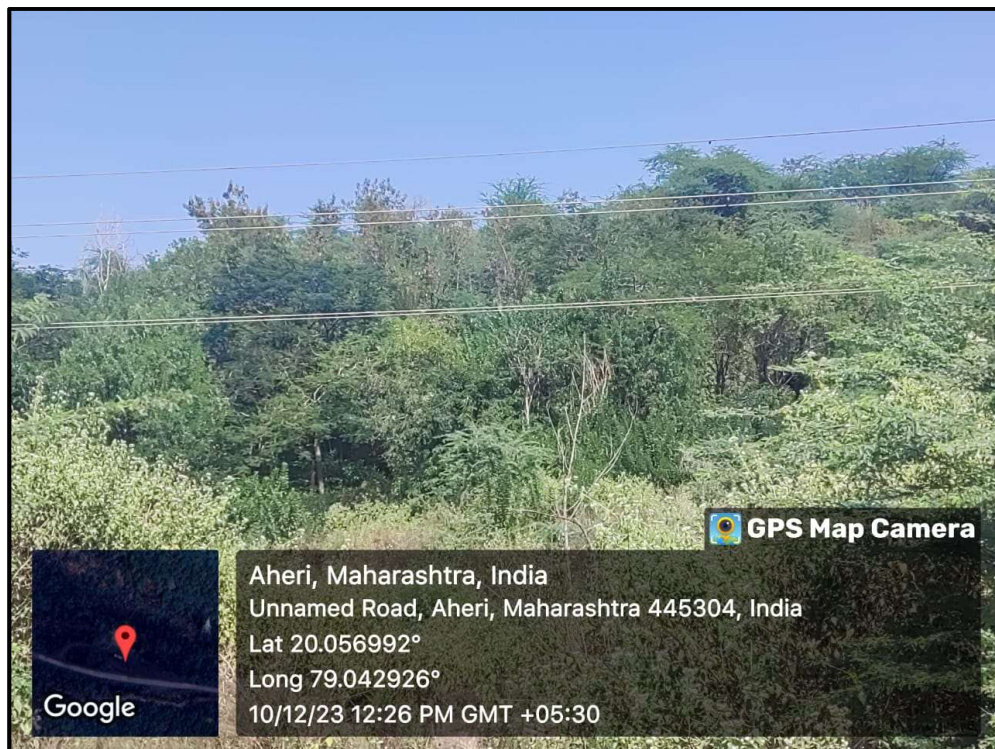
*Photograph 6: Social Forestry Plantation in Urdhan OCP*



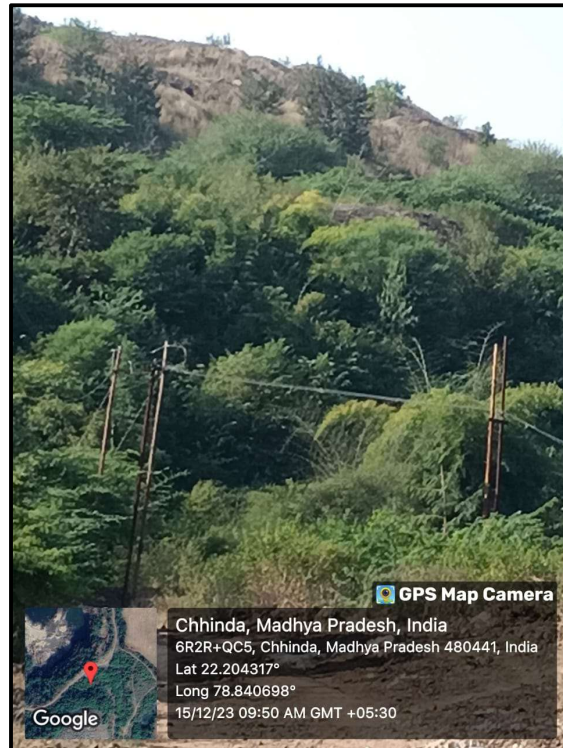
*Photograph 7: Plantation on Barren OB Dump in Bhatadi OCP*



Photograph 8: *Plantation on Barren OB Dump in Gondegaon OCP*



Photograph 9: *Plantation on OB in Kolarpimpri OCP*



Photograph 10: Plantation on OB in Chhinda OCP



Photograph 11: Plantation on OB in Gauri Deep OCP

## शब्द-कोष

शब्द-कोष		
1	Land Reclamation	भूमि पुनरुद्धार
2	Over Burden	अधिभार
3	Monitoring	निगरानी
4	Report	प्रतिवेदन
5	Executive Summary	कार्यकारी सारांश
6	Opencast Mine	खुली खदान
7	Objective	उद्देश्य
8	Methodology	कार्य प्रणाली अथवा प्रक्रिया
9	Table	तालिका
10	List of Tables	तालिकाओं की सूची
11	Map	मानचित्र
12	Social Forestry	सामाजिक वानिकी
13	Plantation	पौधारोपण
14	Million	घनमीटर
15	Background	पृष्ठभूमि
16	Planning	योजनाबद्ध
17	Asses	आकलन
18	Status	स्थिति
19	Regularly	निरंतर
20	Satellite	उपग्रह
21	Subsidiary	अनुषांगिक
22	Production	उत्पादन
23	Biological Reclamation	जैविक पुनरुद्धार
24	Technical Reclamation	तकनीकी पुनरुद्धार
25	Leasehold Area	पट्टाक्षेत्र
26	Excavated Area	उत्खनन क्षेत्र
27	Active mining	सक्रिय खनन
28	Environmental Protection	पर्यावरण संरक्षण
29	Remedial Measure	उपचारात्मक उपाय
30	Interval	अंतराल
31	Systematic Error	व्यवस्थित त्रुटियाँ।
32	Error	अशुद्धियाँ
33	Curvature	वक्रता
34	Geometric	ज्यामितिक
35	Distortion	विरूपण

36	Plantation	पौधारोपण
37	Capacity	क्षमता
38	Software	सॉफ्टवेयर
39	Class	वर्ग
40	Accuracy	सटीकता
41	Statistical Separation	सांख्यिकीय पृथक्करण
42	Cubic meter	घनमीटर
43	Depicted	दर्शाया गया
44	Percentage	प्रतिशत
45	Salient Findings	मुख्य निष्कर्ष
46	Methodology	पद्धति
47	Data Procurement	डाटाक्रय
48	Satellite data Processing	उपग्रह डाटा प्रसंस्करण
49	Rectification and geo-referencing	सुधार और भूसन्दर्भ-
50	Image enhancement	छवि गुण वृद्धि
51	Training set selection	प्रशिक्षण सेट का चयन
52	Classification and Accuracy assessment	वर्गीकरण और मूल्यांकन की सटीकता
53	Area calculation	क्षेत्र गणना
54	Temporal	लौकिक
55	Processing	प्रसंस्करण
56	Overlay of Vector data base	वेक्टर डाटाबेस का अरोपन
57	Pre-field map preparation	क्षेत्र जाने के पहले नक्शे की तैयारी
58	Ground Truthing	भू-सत्यापन
59	Ground Information	भू-सूचना
60	Interpretation	व्याख्या
61	Eco-system	पारिस्थितिकी तंत्र
62	Minor	मामुली
63	Water Drainage	जलनिकाय
64	Interval	अंतराल
65	Maximum	अधिकतम
66	Coal field	कोयला क्षेत्र
67	Design	परिकल्पना
68	Superimpose	आरोपित
69	Update	अद्यतनीकरण/नवीनीकरण
70	Cumulative	संचयित
71	Embankment	तटबंध
72	Cluster	खुली तथा भूमिगत खदानों के समूह

**ABBREVIATIONS**

SoI	Survey of India
MoEF & CC	Ministry of Environment, Forest & Climate Change
CIL	Coal India Limited
ECL	Eastern Coalfields Limited
BCCL	Bharat Coking Coal Limited
CCL	Central Coalfields Limited
WCL	Western Coalfields Limited
SECL	South Eastern Coalfields Limited
NCL	Northern Coalfields Limited
MCL	Mahanadi Coalfields Limited
NEC	North Eastern Coalfields
CMPDIL	Central Mine Planning & Design Institute Ltd
NRSC	National Remote Sensing Centre
R2/ R2A	Resource Sat Satellites
LISS - 4	Linear Imaging and Self Scanning Sensor
FCC	False Color Composite
OCP	Opencast Project
UGP	Underground Project
OB	Over Burden
GCP	Ground Control points
GIS	Geographic Information System
WGS-84	World Geodetic System
UTM	Universal Transverse Mercator

## GLOSSARY

Sl.	Term	Definition
1.	Land Reclamation	To manage, reclaim and restore mined out/ degraded land as close as possible to its original stage.
2.	Over Burden	The material that lies above the coal seam/ deposit
3.	Monitoring	A process of evaluation to check or keep record for a period of time.
4.	Opencast Coal Mine	Open-pit mining, also known as opencast mining, is a surface mining technique that extracts minerals from an open pit in the ground.
5.	Social Forestry	Social forestry is the management and protection of forests and afforestation of barren and deforested lands with the purpose of helping environmental, social and rural development. Plantation (Social/ Avenue or other) carried out outside mining area.
6.	Biological Reclamation	Plantation on Backfilled areas (Stabilized Internal Dumps)
7.	Technical Reclamation	Area under backfilling (Over burden dumped inside the mine voids) in mining area.
8.	Green Cover Generated	Total Plantation carried out in the lease area of Project. This includes Plantation on Backfill, Plantation on OB and Social Forestry.
9.	Leasehold Area	The area, for which lease is granted for the purpose of undertaking mining and allied operations.
10.	Excavated area	Mined out area which includes active mining, area under backfilling and plantation on backfilled areas
11.	Active Mining	Mining areas which include Coal Quarry, Advance Quarry, Quarry Filled with Water etc.
12.	Environmental Protection	It is the practice of protecting the natural environment by individuals, organizations and governments. Its objectives are to conserve natural resources and the existing natural environment and, where possible, to mitigate damage and reverse trends.
13.	Remedial Measure	Any measure or action required or undertaken to investigate, monitor, clean up, remove, treat, prevent, contain or otherwise remediate the presence or release of any hazardous substance or activity.
14.	Systematic Error	Every measurement differing from the true measurement in the same direction, and even by the same amount in some cases.



15.	Geometric Distortion	It refers to the improper positioning of any image with respect to their true geographic position when viewed in a properly scaled common image display plane.
16.	Land Use/ Cover Class	Land cover is what covers the surface of the earth and land use describes how the land is used.
17.	Accuracy	The closeness of agreement between a measured quantity value and a true quantity value.
18.	Environmental Clearance	Environmental Clearance (EC) for any developmental projects like coal mining projects etc. has been made mandatory by the Ministry of Environment, Forests and Climate Change (MoEF & CC) through its Notification issued on 27.01.1994 under the provisions of Environment (Protection) Act, 1986.
19.	Rectification and Geo-referencing	Geo-referencing is the assigning of absolute location of a data point or data points. Geo-rectification refers to the removal of geometric distortions between sets of data points, most often the removal of terrain, platform, and sensor induced distortions from remote sensing imagery.
20.	Image Enhancement	It is the process of modifying digital images so that the results are more suitable for processing or further image analysis.
21.	Training set selection	It is a portion of a data set used to fit or train a model for prediction or classification of values that are known in the training set, but unknown in other (future) data.
22.	Image Classification	It refers to the task of extracting information classes from a multiband raster image. The resulting raster from image classification can be used to create thematic maps.
23.	Temporal Changes	The 'temporal change' means the change in any entity with a period of time.
24.	Ground Truthing	Collection of primary/ basic information from ground realities for satellite image interpretation and thematic mapping.
25.	Cluster	Group of opencast and/ or underground mines clubbed together for administrative purposes.
26.	Arc GIS	GIS Software used for Map preparation
27.	ERDAS IMAGINE	Satellite Image Data Classification Software



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