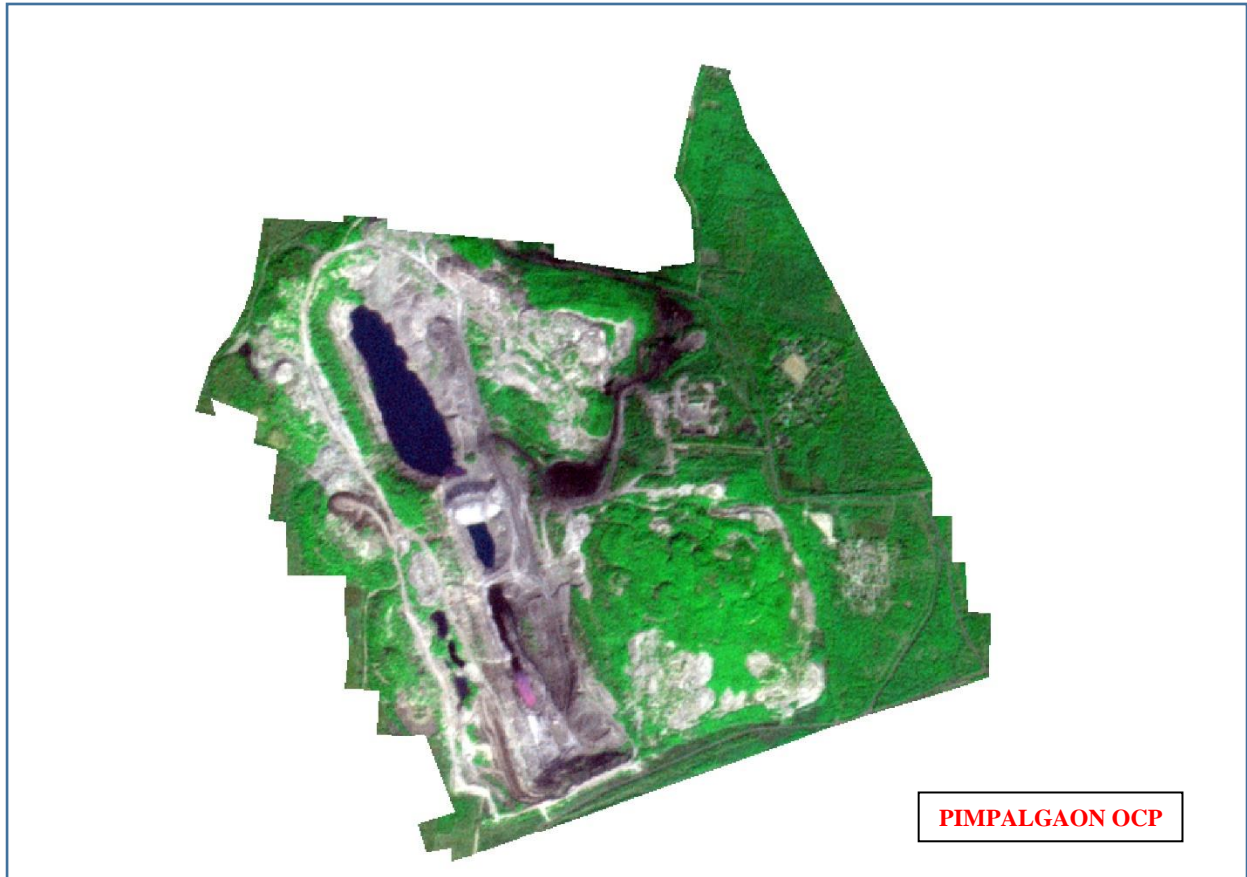


**Land Restoration/Reclamation Monitoring of more than  
5 million cu.m (Coal+OB) Capacity Opencast Coal Mines of Western  
Coalfields Limited based on Satellite Data of the Year 2017**



*Submitted to*  
**Western Coalfields Limited**



*cmpdi*  
*A Mini-Ratna Company*

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March 2018



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

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## Executive Summary

- 1.0 Project** Land restoration / reclamation monitoring of 10 opencast coal mines of Western Coalfields Ltd. (WCL) producing 5 million cu.m. and more (Coal+OB) per year based on satellite data, regularly on annual basis.
- 2.0 Objective** Objective of the land restoration / reclamation monitoring is to assess the area of backfilled, plantation, social forestry, active mining area, water bodies, and distribution of wasteland, agricultural land and forest 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 94.38 Km<sup>2</sup> of the 10 opencast projects of WCL viz. Sasti, Padmapur, Durgapur, Mugoli, Umrer, Ukni, Niljai, New Majri, Pimpalgaon and Ghugus considered for monitoring during 2017-18; total excavated area is 30.23 Km<sup>2</sup> out of which 3.18 Km<sup>2</sup> area (10.52%) has been planted, 7.92 Km<sup>2</sup> area (26.20%) has been backfilled and 19.13 Km<sup>2</sup> area (63.28%) is under active mining. It is evident from the analysis that 36.72% areas of the OC projects has been reclaimed (biological and technical) and balance 63.28% 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 2017 with respect to the year 2016 in different projects, it is evident from the analysis that area under land reclamation has increased from 10.60 Km<sup>2</sup> (Yr. 2016) to 11.10 Km<sup>2</sup> (Yr.2017). Out of 10 projects of WCL, Ghugus OC ranks on top for land reclamation (87.85%) followed by Sasti OC (76.86%) and Umrer OC (76.43%).
  - Area of biological reclamation (plantation) has increased marginally from 3.06 Km<sup>2</sup> (Yr.2016) to 3.18 Km<sup>2</sup> (Yr.2017) whereas area of technical reclamation (area under backfilling) has increased from 7.54 Km<sup>2</sup> (Yr. 2016) to 7.92 Km<sup>2</sup> (Yr.2017) in WCL. The total increase of 0.50 Km<sup>2</sup> under reclamation is the result of the efforts of the Western Coalfields Ltd. taken up towards environmental protection.
  - 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 data for the year 2016-17 has been fed into the new format so that it can be compared with the result of 2017-18.

**Table-1**  
**Projectwise Land Reclamation Status in Opencast Projects of WCL**  
 (>5 Million cu. M coal+OB) based on Satellite Data of the year 2017

(Area in Sq. Kms.)

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, Avaneu Plantation Etc.									
1	2	3		4		5		6		7		8		9 (=4+5+8)		10 (=5+6+7)		11(=4+5)	
		2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
1	Sasti	12.69	9.20	2.10	2.15	0.48	0.54	1.55	1.66	1.44	0.57	0.85	0.81	3.43	3.50	3.47	2.77	2.58	2.69
				61.22%	61.43%	13.99%	15.43%					24.78%	23.14%			27.34%	30.11%	75.22%	76.86%
2	Padmapur	7.34	8.29	0.13	0.13	0.15	0.15	1.61	1.70	0.38	0.53	1.11	1.59	1.39	1.87	2.14	2.38	0.28	0.28
				9.35%	6.95%	10.79%	8.02%					79.86%	85.03%			29.16%	28.71%	20.14%	14.97%
3	Durgapur	8.88	11.86	0.26	0.26	0.4	0.40	2.1	2.10	0.99	1.33	0.95	3.85	1.61	4.51	3.49	3.83	0.66	0.66
				16.15%	5.76%	24.84%	8.87%					59.01%	85.37%			39.30%	32.29%	40.99%	14.63%
4	Mugoli	7.88	7.88	0.18	0.24	0.24	0.24	1.14	1.14	0.26	0.26	1.62	2.16	2.04	2.64	1.64	1.64	0.42	0.48
				8.82%	9.09%	11.76%	9.09%					79.41%	81.82%			20.81%	20.81%	20.59%	18.18%
5	Umrer	9.45	9.45	1.81	2.08	1.39	1.39	1.15	1.27	2.77	2.77	0.91	1.07	4.11	4.54	5.31	5.43	3.20	3.47
				44.04%	45.81%	33.82%	30.62%					22.14%	23.57%			56.19%	57.46%	77.86%	76.43%
6	Ukni	9.30	9.94	0.00	0.00	0.00	0.00	2.06	2.10	0.18	0.18	1.43	2.16	1.43	2.16	2.24	2.28	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			24.09%	22.94%	0.00%	0.00%
7	Neeljai	15.30	15.30	0.00	0.00	0.10	0.10	1.05	1.16	0.83	1.33	2.61	3.47	2.71	3.57	1.98	2.59	0.10	0.10
				0.00%	0.00%	3.69%	2.80%					96.31%	97.20%			12.94%	16.93%	3.69%	2.80%
8	New Majri	9.05	7.74	0.31	0.31	0.00	0.00	1.73	1.84	1.94	1.35	0.94	3.01	1.25	3.32	3.67	3.19	0.31	0.31
				24.80%	9.34%	0.00%	0.00%					75.20%	90.66%			40.55%	41.21%	24.80%	9.34%
9	Pimpalgaon	4.92	4.52	0.00	0.00	0.00	0.00	0.97	1.02	0.84	0.88	0.59	0.58	0.59	0.58	1.81	1.90	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			36.79%	42.04%	0.00%	0.00%
10	Ghugus	10.20	10.20	2.75	2.75	0.30	0.36	1.35	1.35	0.52	0.62	0.49	0.43	3.54	3.54	2.17	2.33	3.05	3.11
				77.68%	77.68%	8.47%	10.17%					13.84%	12.15%			21.27%	22.84%	86.16%	87.85%
	<b>TOTAL</b>	<b>95.01</b>	<b>94.38</b>	<b>7.54</b>	<b>7.92</b>	<b>3.06</b>	<b>3.18</b>	<b>14.71</b>	<b>15.34</b>	<b>10.15</b>	<b>9.82</b>	<b>11.50</b>	<b>19.13</b>	<b>22.10</b>	<b>30.23</b>	<b>27.92</b>	<b>28.34</b>	<b>10.60</b>	<b>11.10</b>
				<b>34.12%</b>	<b>26.20%</b>	<b>13.85%</b>	<b>10.52%</b>					<b>52.04%</b>	<b>63.28%</b>			<b>29.39%</b>	<b>30.03%</b>	<b>47.96%</b>	<b>36.72%</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 backfilled only
3. Area under Active mining includes coal quarry site, quarry filled with water etc. if any. Coal dump excluded from active mining in this table.
4. Social Forestry and Plantation on external OB dump are not included in Biological Reclamation and are put under separate categories as shown in the table.
5. (%) calculated in the above table is in respect of total excavated area except for "Total area under plantation" where % is in terms of leasehold area.

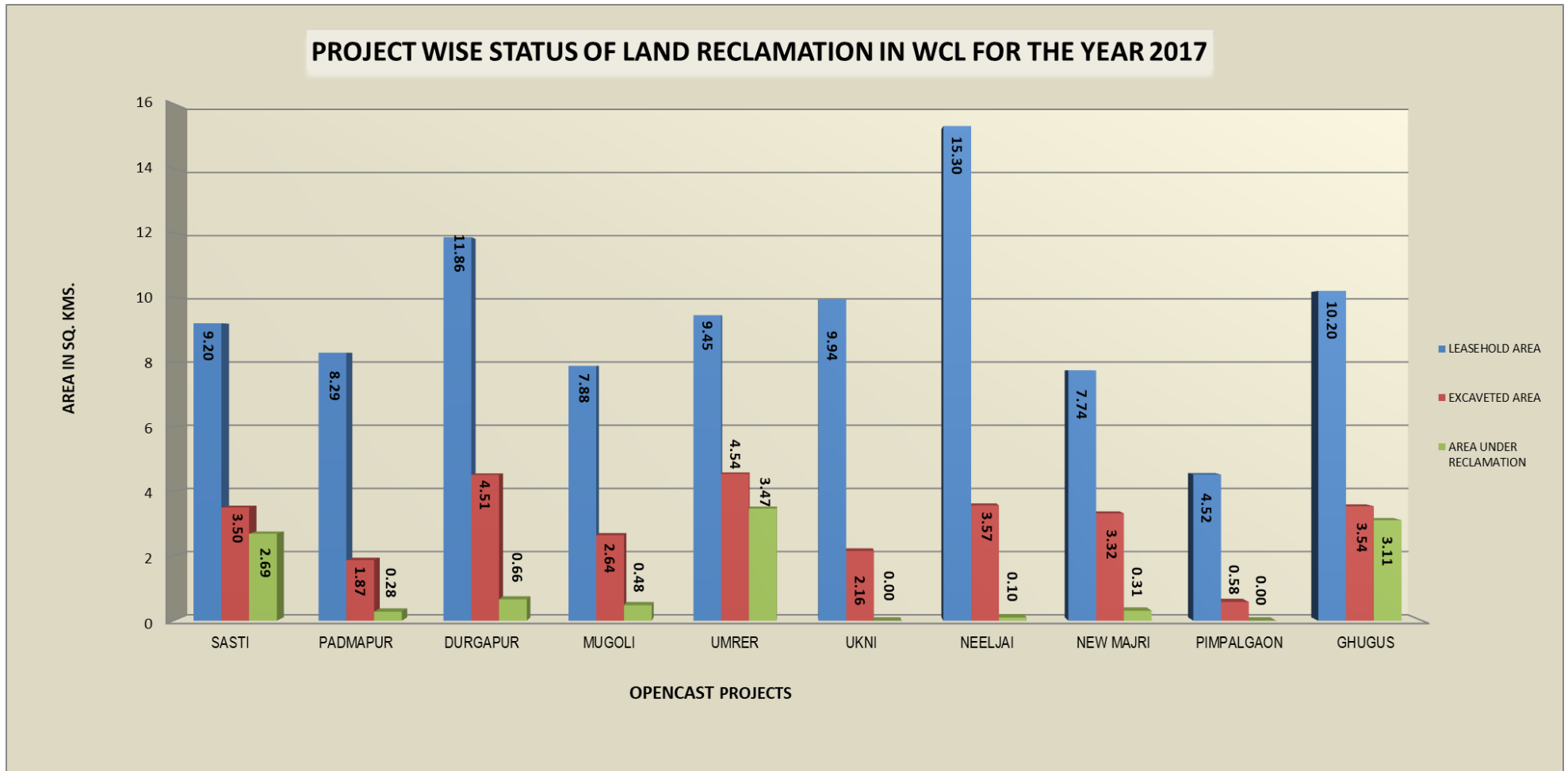


Fig.1: Land reclamation status in OC projects of WCL for the year 2017

## **1.0 Background**

- 1.1** Land is the most important natural resource which embodies soil, water, flora, fauna and total ecosystem. All human activities are based on the land which is the most scarce natural resource in our country. Mining is a site specific industry and it could not be shifted anywhere else from the location where mineral occurs. It is a fact that surface mining activities do effect the land environment due to ground breaking. Therefore, there is an urgent need to reclaim and restore the mined out land for its productive use for sustainable development of mining. This will not only mitigate environmental degradation, but would also help in creating a more congenial environment for land acquisition by coal companies in future.
- 1.2** Keeping above in view, Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/Env/2009/2428 dated 29.12.2009 to Central Mine Planning & Design Institute (CMPDI), Ranchi, for monitoring land reclamation. status of all the opencast coal mines having production of more than 5 million m<sup>3</sup> per annum (coal + OB taken together per annum) based on remote sensing satellite data, regularly on annual basis for sustainable development of mining. Further, another work order vide letter no. CIL/WBP/ENV./2011 dated 23/08/11 was issued by CIL for monitoring of less than 5 million m<sup>3</sup> per annum capacity (Coal +OB) projects from the year 2011 at interval of three years. This order has been renewed in CIL letter no. CIL/WBP/Env/2011/4706 dated 12.10.2012 for the next five years. Again this work order has been renewed vide letter no. CIL/WBP/Env/2017/DP/8391 dated 22.06.2017 for a period next five years starting from 2017-18 to 2021-22. The result of land reclamation status of all such mines will be uploaded on the website of 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 2017 carried out for all the OC projects producing more 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 Fig 1. Following steps are involved in land reclamation /restoration monitoring:

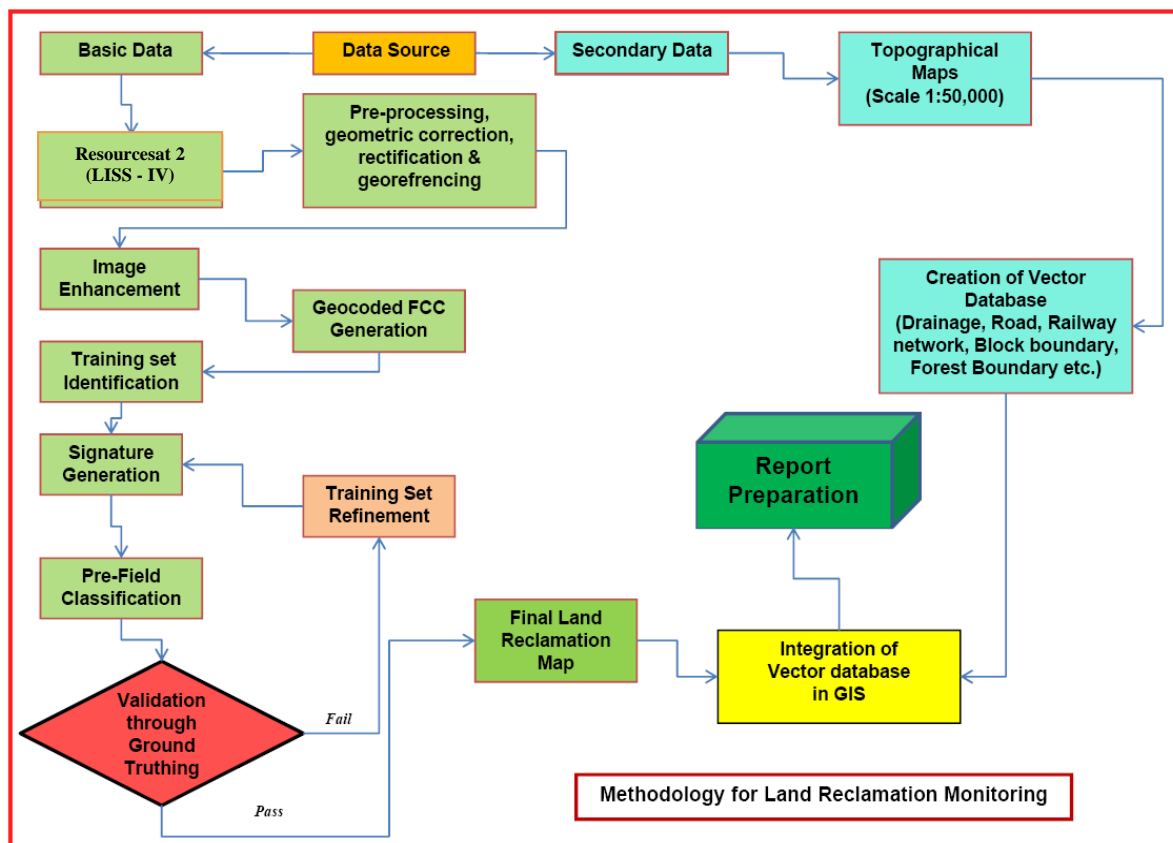


Figure: 2 - **Methodology for Land Reclamation Monitoring**

**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 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 10.2 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 Limited**

**4.1** Following ten opencast projects of WCL producing more than 5 million cubic meter and more (Coal + OB) were taken up for land reclamation monitoring during year 2017-18 based on satellite data of the year 2017.

- Sasti
- Padmapur
- Durgapur
- Mugoli
- Umrer
- Ukni
- Niljai
- New Majri
- Pimpalgaon
- Ghugus

**4.2** Area statistics of different land use class present in the mine leasehold of the above projects for the year 2017 are shown in the Table - 2. Land use maps derived from satellite data are shown in Plate 1 - 10. Land reclamation status of the above mentioned 10 projects, were also prepared for the year 2015, 2016 and 2017. Year wise changes in the different land use classes based on satellite data are depicted in Bar Charts in Fig. 3 - 12

**4.3** Study reveals that 36.72% of mining area has been reclaimed by WCL out of which 10.52% area has been revegetated and 26.20% area is backfilled. There is an increase of 0.50 Km<sup>2</sup> area under reclamation in WCL with respect to the year 2016, out of which 0.12 Km<sup>2</sup> increases in biological reclamation (plantation on backfilled) and 0.38 Km<sup>2</sup> increase in the technical reclamation (backfilling).

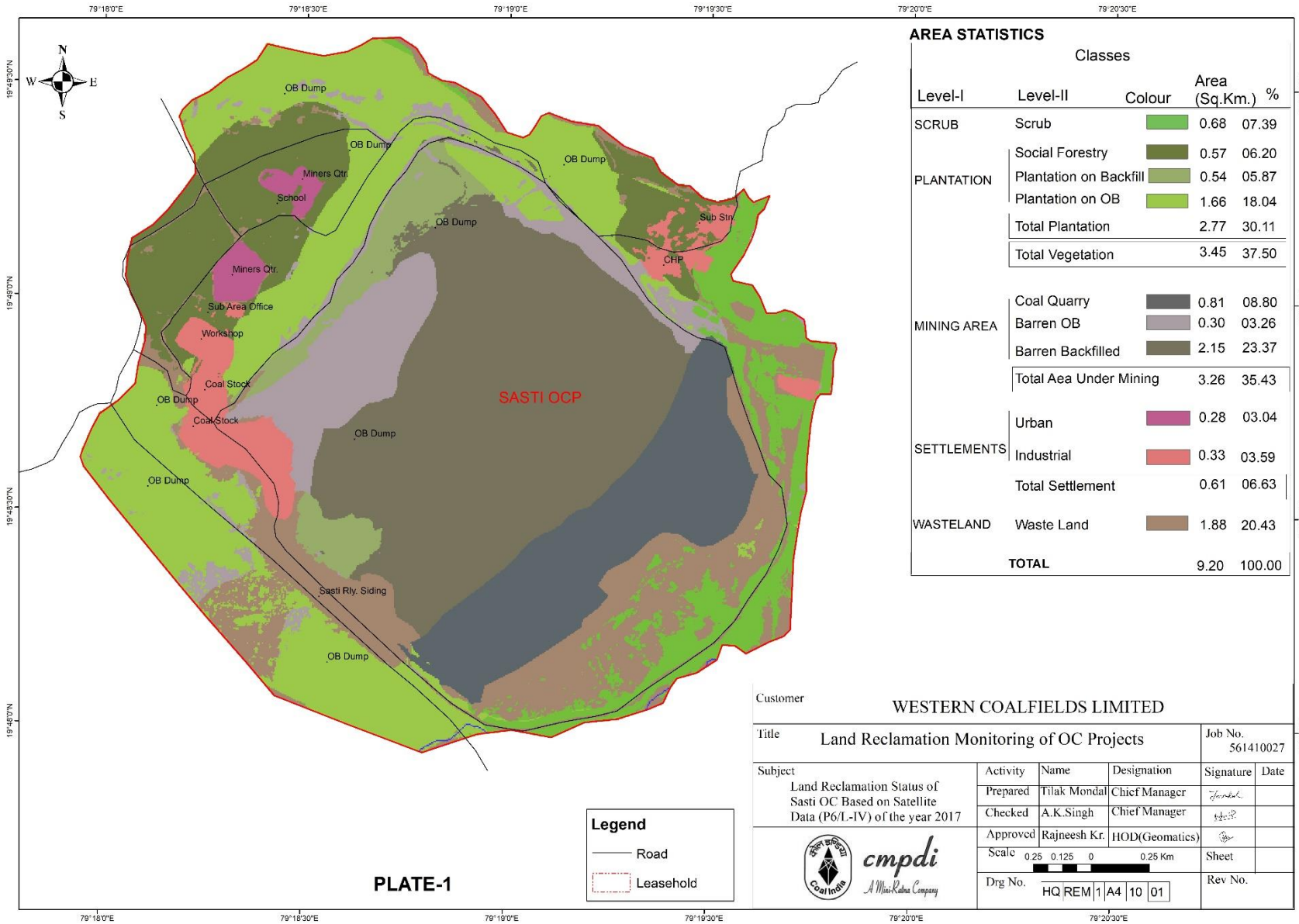
- 4.4** Analysis of satellite data indicates that area of plantation has increased from 27.92 Km<sup>2</sup> (2016) to 28.34 Km<sup>2</sup> (2017). The increase of 0.42 Km<sup>2</sup> plantation areas in one year attributed to continuous effort of WCL towards environmental protection. It has been observed in some of the projects natural vegetation has also started growing on stabilized old backfilled areas and OB dumps due to increase in soil fertility.
- 4.5** On comparing the status of land reclamation for the year 2017 with respect to the year 2016 in different projects, it is evident that area of land reclamation has increased from 10.60 Km<sup>2</sup> (Yr. 2016) to 11.10 Km<sup>2</sup> (Yr.2017).
- 4.6** Out of 10 projects of WCL, Ghugus OC ranks on top for land reclamation (87.85%) followed by Sasti OC (76.86%) and Umrer OC (76.43%)

Table-2

STATUS OF LAND USE/ RECLAMATION IN OC MINES (>5mcu.m) OF WESTERN COALFIELDS LTD BASED ON SATELLITE DATA OF THE YEAR 2017

(Area in Sq Km)

	SASTI		PADMAPUR		DURGAPUR		MUGOLI		UMRER		UKNI		NILJAI		NEW MAJRI		PIMPALGAON		GHUGUS		TOTAL	
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
<b>FORESTS</b>																						
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
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total Forest</b>	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
<b>SCRUBS</b>																						
Scrubs	0.68	7.39	0.32	3.86	0.28	2.36	1.47	18.65	0.00	0.00	0.53	5.33	1.55	10.13	0.19	2.45	0.22	4.87	1.24	12.16	6.48	6.87
Social Forestry	0.57	6.20	0.53	6.39	1.33	11.21	0.26	3.30	2.77	29.31	0.18	1.81	1.33	8.69	1.35	17.44	0.88	19.47	0.62	6.08	9.82	10.40
Plantation on OB Dump	1.66	18.04	1.70	20.51	2.10	17.71	1.14	14.47	1.27	13.44	2.10	21.13	1.16	7.58	1.84	23.77	1.02	22.57	1.35	13.24	15.34	16.25
Plantation on Backfill (Biological Reclamation)	0.54	5.87	0.15	1.81	0.40	3.37	0.24	3.05	1.39	14.71	0.00	0.00	0.10	0.65	0.00	0.00	0.00	0.00	0.36	3.53	3.18	3.37
<b>Total Plantation</b>	2.77	30.11	2.38	28.71	3.83	32.29	1.64	20.81	5.43	57.46	2.28	22.94	2.59	16.93	3.19	41.21	1.90	42.04	2.33	22.84	28.34	30.03
<b>Total Vegetation</b>	3.45	37.50	2.70	32.57	4.11	34.65	3.11	39.47	5.43	57.46	2.81	28.27	4.14	27.06	3.38	43.67	2.12	46.90	3.57	35.00	34.82	36.89
<b>ACTIVE MINING</b>																						
Coal Quarry	0.81	8.80	1.59	19.18	3.85	32.46	2.16	27.41	1.07	11.32	2.16	21.73	3.47	22.68	3.01	38.89	0.58	12.83	0.32	3.14	19.02	20.15
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
Quarry Filled With Water	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	0.11	1.85	0.11	0.12
Coal Dump	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05
<b>Total Area Under Active Mining</b>	0.81	8.80	1.59	19.18	3.85	32.46	2.16	27.41	1.07	11.32	2.16	22.23	3.47	22.68	3.01	38.89	0.58	12.83	0.43	4.99	19.13	20.27
Area under Backfilling (Technical Reclamation)	2.15	23.37	0.13	1.57	0.26	2.19	0.24	3.05	2.08	22.01	0.00	0.00	0.00	0.00	0.31	4.01	0.00	0.00	2.75	26.96	7.92	8.39
Barren OB Dump	0.30	3.26	2.13	25.69	1.85	15.60	1.25	15.86	0.63	6.67	2.74	27.57	2.96	19.35	0.08	1.03	1.39	30.75	0.16	1.57	13.49	14.29
<b>Total Area Under Mine Operation</b>	3.26	35.43	3.85	46.44	5.96	50.25	3.65	46.32	3.78	40.00	4.95	49.80	6.43	42.03	3.40	43.93	1.97	43.58	3.34	33.52	40.54	42.95
<b>WASTELANDS</b>																						
Waste Lands	1.88	20.43	1.33	16.04	1.35	11.38	0.91	11.55	0.00	0.00	0.65	6.54	4.16	27.19	0.52	6.72	0.16	3.54	2.40	23.53	13.36	14.16
Sand Body	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total Wasteland</b>	1.88	20.43	1.33	16.04	1.35	11.38	0.91	11.55	0.00	0.00	0.65	6.54	4.16	27.19	0.52	6.72	0.16	3.54	2.40	23.53	13.36	14.16
<b>WATERBODIES</b>																						
Reservoir, nallah, ponds	0.00	0.00	0.12	1.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	1.29	0.00	0.00	0.02	0.20	0.24	0.25
<b>Total Waterbodies</b>	0.00	0.00	0.12	1.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	1.29	0.00	0.00	0.02	0.20	0.24	0.25
<b>AGRICULTURE</b>																						
Crop Lands	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
Fallow Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.29	12.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.29	1.37
<b>Total Agriculture</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.29	12.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.29	1.37
<b>SETTLEMENTS</b>																						
Urban Settlement	0.28	3.04	0.00	0.00	0.44	3.71	0.00	0.00	0.13	1.38	0.00	0.00	0.17	1.11	0.34	4.39	0.09	1.99	0.28	2.75	1.73	1.83
Rural Settlement	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.38	0.00	0.00	0.08	0.80	0.00	0.00	0.00	0.00	0.04	0.88	0.43	4.22	0.58	0.61
Industrial Settlement	0.33	3.59	0.29	3.50	0.00	0.00	0.18	2.28	0.11	1.16	0.16	1.61	0.40	2.61	0.00	0.00	0.14	3.10	0.16	1.57	1.77	1.88
<b>Total Settlement</b>	0.61	6.63	0.29	3.50	0.44	3.71	0.21	2.66	0.24	2.54	0.24	2.41	0.57	3.73	0.34	4.39	0.27	5.97	0.87	8.53	4.08	4.32
<b>Grand Total</b>	9.20	100.0	8.29	100.0	11.86	100.0	7.88	100.0	9.45	100.0	9.94	100.0	15.30	100.0	7.74	100.0	4.52	100.0	10.20	100.8	94.38	100.00



**AREA STATISTICS**

Classes			
Level-I	Level-II	Colour	Area (Sq.Km.) %
SCRUB	Scrub		0.68 07.39
	Social Forestry		0.57 06.20
	Plantation on Backfill		0.54 05.87
	Plantation on OB		1.66 18.04
<b>Total Plantation</b>			<b>2.77 30.11</b>
<b>Total Vegetation</b>			<b>3.45 37.50</b>
MINING AREA	Coal Quarry		0.81 08.80
	Barren OB		0.30 03.26
	Barren Backfilled		2.15 23.37
	<b>Total Aea Under Mining</b>		
SETTLEMENTS	Urban		0.28 03.04
	Industrial		0.33 03.59
	<b>Total Settlement</b>		
WASTELAND	Waste Land		1.88 20.43
<b>TOTAL</b>			<b>9.20 100.00</b>

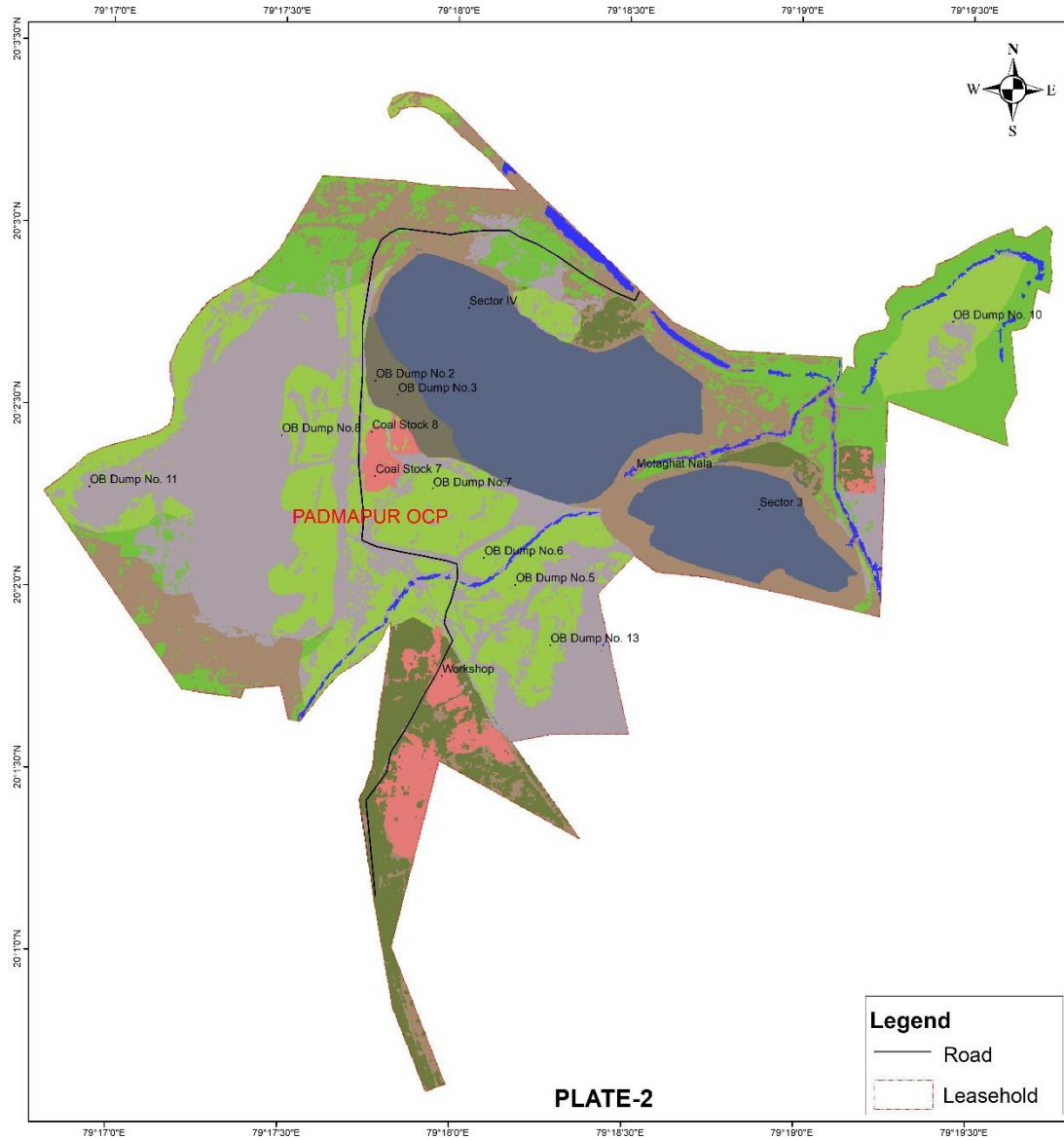
PLATE-1

**Legend**

- Road
- Leasehold

Customer		WESTERN COALFIELDS LIMITED			
Title		Land Reclamation Monitoring of OC Projects		Job No. 561410027	
Subject	Land Reclamation Status of Sasti OC Based on Satellite Data (P6/L-IV) of the year 2017	Activity	Name	Designation	Signature
		Prepared	Tilak Mondal	Chief Manager	
		Checked	A.K.Singh	Chief Manager	
		Approved	Rajneesh Kr.	HOD(Geomatics)	
		Scale	0.25 0.125 0 0.25 Km		Sheet
Drg No.		HQ REM   1   A4   10   01			Rev No.





**AREA STATISTICS**

Classes		Colour	Area (Sq.Km.)	%
Level-I	Level-II			
Scrub	Scrub		0.32	03.86
PLANTATION	Social Forestry		0.53	06.39
	Plantation on OB		1.70	20.51
	Plantation on Backfilled		0.15	01.81
	<b>Total Plantation</b>		<b>2.38</b>	<b>28.71</b>
	<b>Total Vegetation</b>		<b>2.70</b>	<b>32.57</b>
MINING AREA	Coal Quarry		1.59	19.18
	Barren OB		2.13	25.69
	Barren Backfilled		0.13	01.57
	<b>Total Aea Under Mining</b>		<b>3.85</b>	<b>46.44</b>
SETTLEMENTS	Industrial		0.29	03.50
WASTELAND	Waste Land		1.33	16.04
WATERBODIES	Reservoir, nallah		0.12	01.45
<b>TOTAL</b>			<b>8.29</b>	<b>100.00</b>

Customer					WESTERN COALFIELDS LIMITED					
Title					Land Reclamation Monitoring of OC Projects					
Job No.					561410027					
Subject		Activity	Name	Designation	Signature	Date				
Land Reclamation Status of Padmapur OC Based on Satellite Data (P6/L-IV) of the year 2017		Prepared	Tilak Mondal	Chief Manager						
		Checked	A.K.Singh	Chief Manager						
		Approved	Rajneesh Kr.	HOD(Geomatics)						
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Dwg No.		HQ/REM/1/A4/10/02				Rev No.				

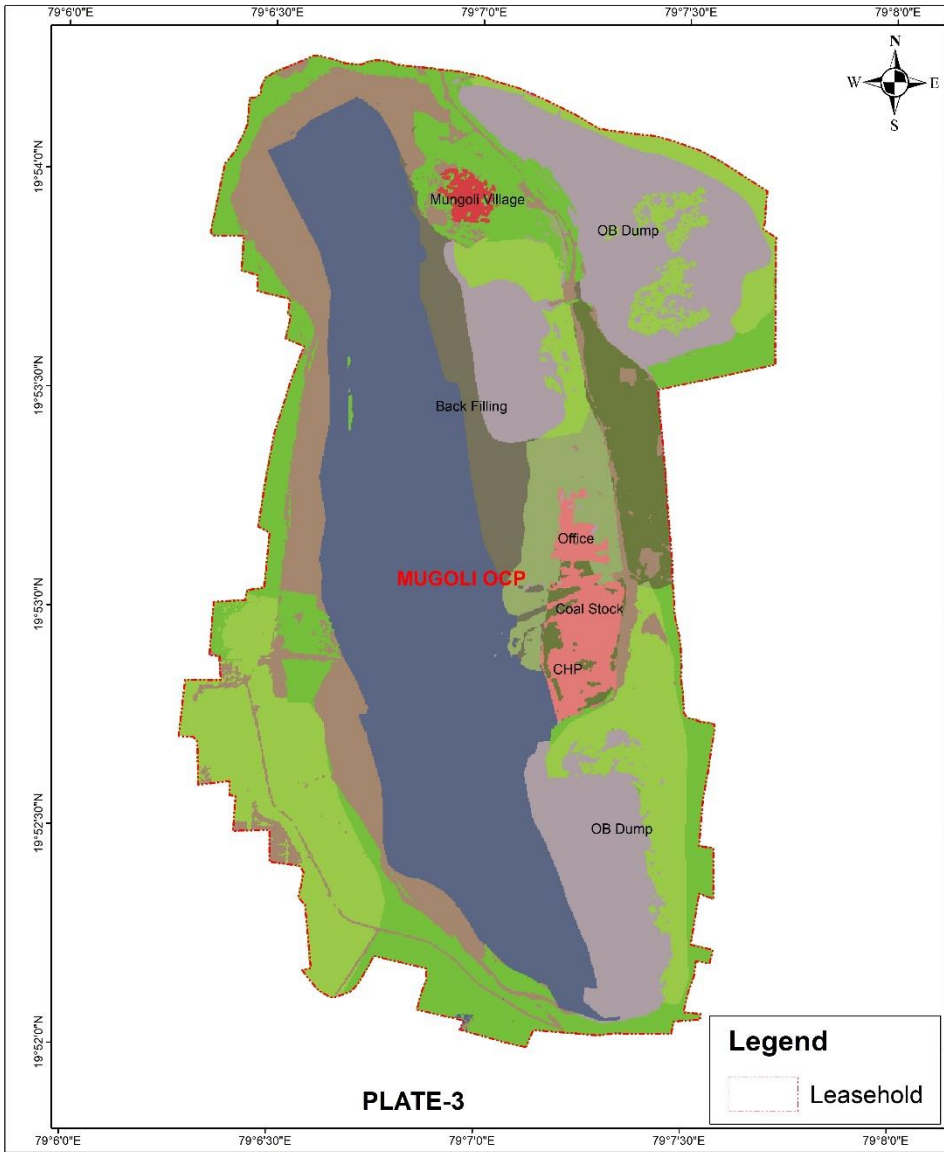


PLATE-3

**Legend**  
 Leasehold

**AREA STATISTICS**

Classes		Area (Sq.Km.)	%
Level-I	Level-II	Colour	
SCRUB	Scrub		1.47 18.65
	Social Forestry		0.26 03.30
PLANTATION	Plantation on OB		1.14 14.47
	Plantation on Backfill		0.24 03.05
	<b>Total Plantation</b>		<b>1.64 20.81</b>
<b>Total Vegetation</b>			<b>3.11 39.47</b>
MINING AREA	Coal Quarry		2.16 27.41
	Barren Backfilled		0.24 03.05
	Barren OB		1.25 15.86
<b>Total Aea Under Mining</b>			<b>3.65 46.32</b>
WASTELAND	Waste Land		0.91 11.55
SETTLEMENTS	Rural		0.03 00.38
	Industrial		0.18 02.28
	<b>Total Settlement</b>		<b>0.21 02.66</b>
<b>TOTAL</b>			<b>7.88 100.00</b>

Customer						WESTERN COALFIELDS LIMITED									
Title						Land Reclamation Monitoring of OC Projects						Job No. 561410027			
Subject						Activity		Name		Designation		Signature		Date	
Land Reclamation Status of Mugoli OC based on Satellite Data (P6/L-IV) of the year 2017						Prepared		Tilak Mondal		Chief Manager					
						Checked		A.K.Singh		Chief Manager					
						Approved		Rajneesh Kr.		HOD(Geomatics)					
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Drg No.						HQ		REM		1		A4		10 03	
												Rev No.			



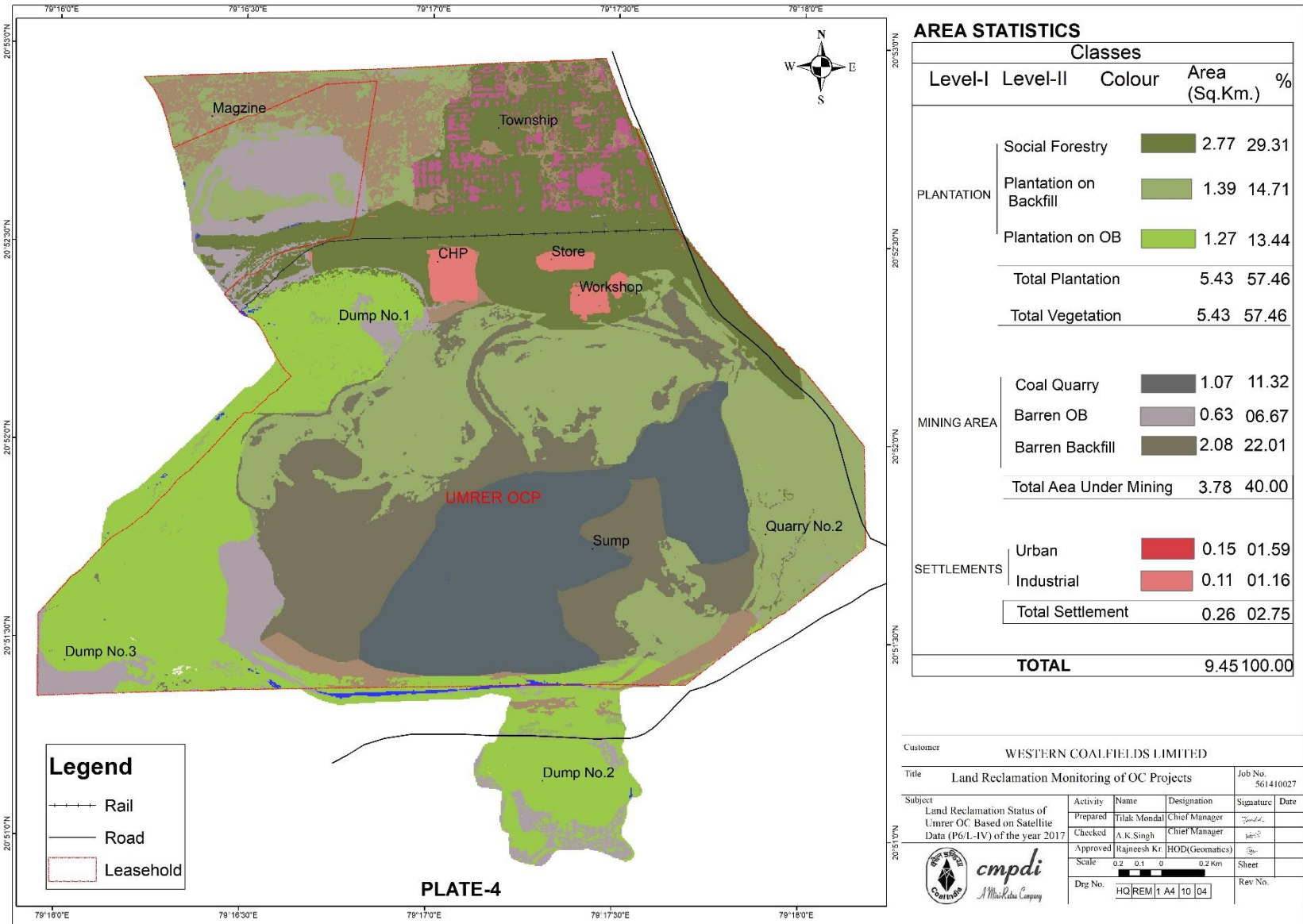
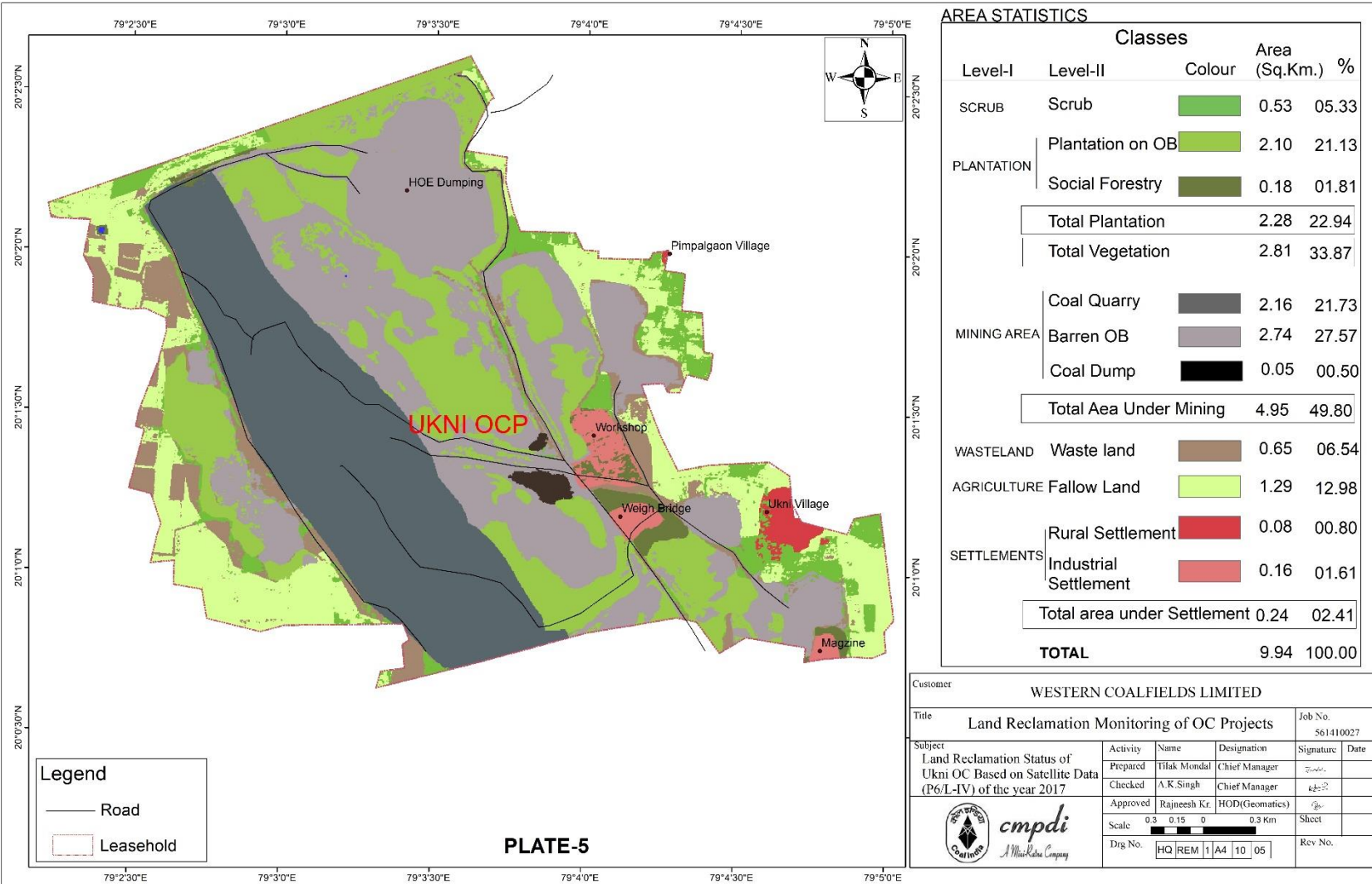
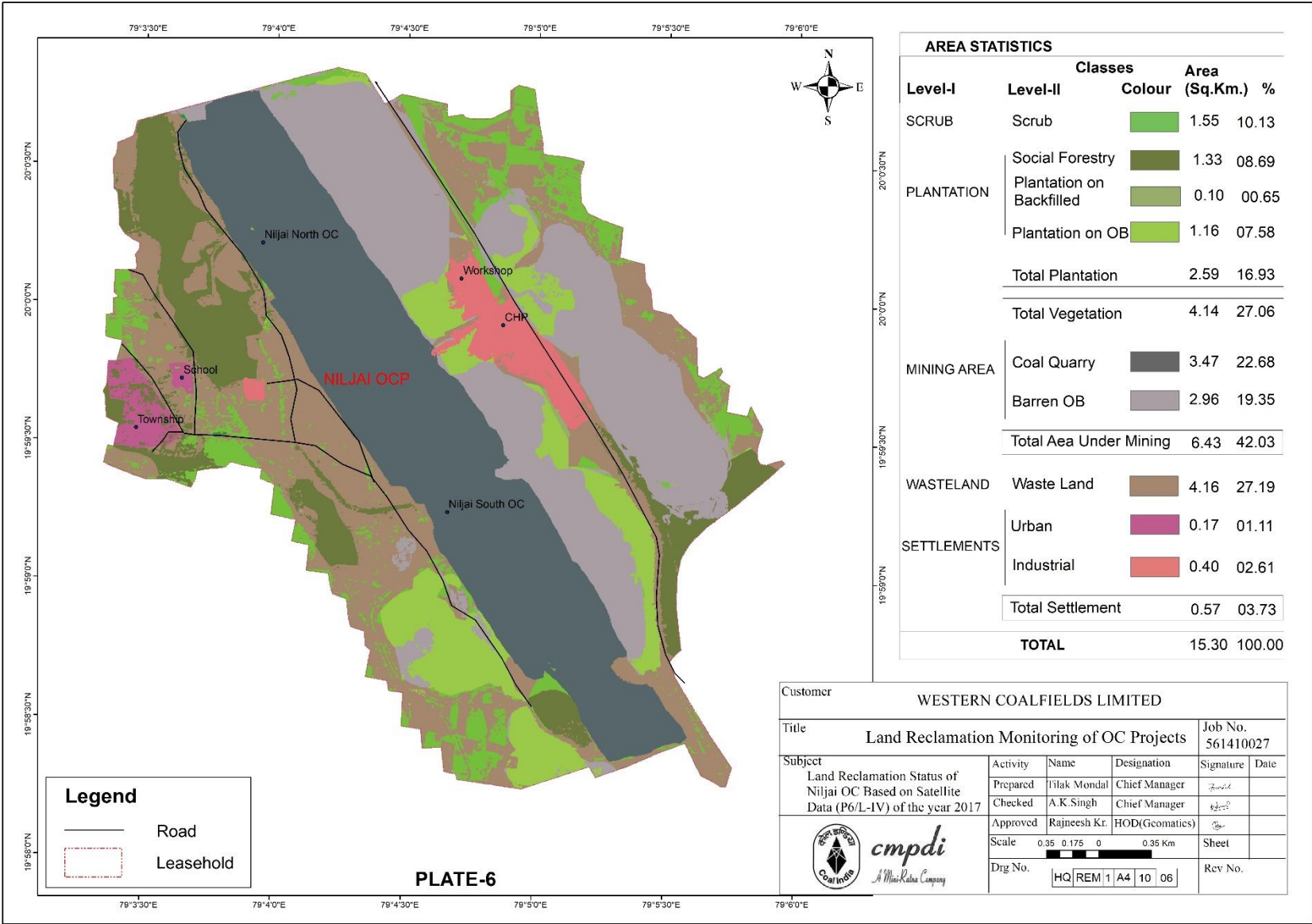


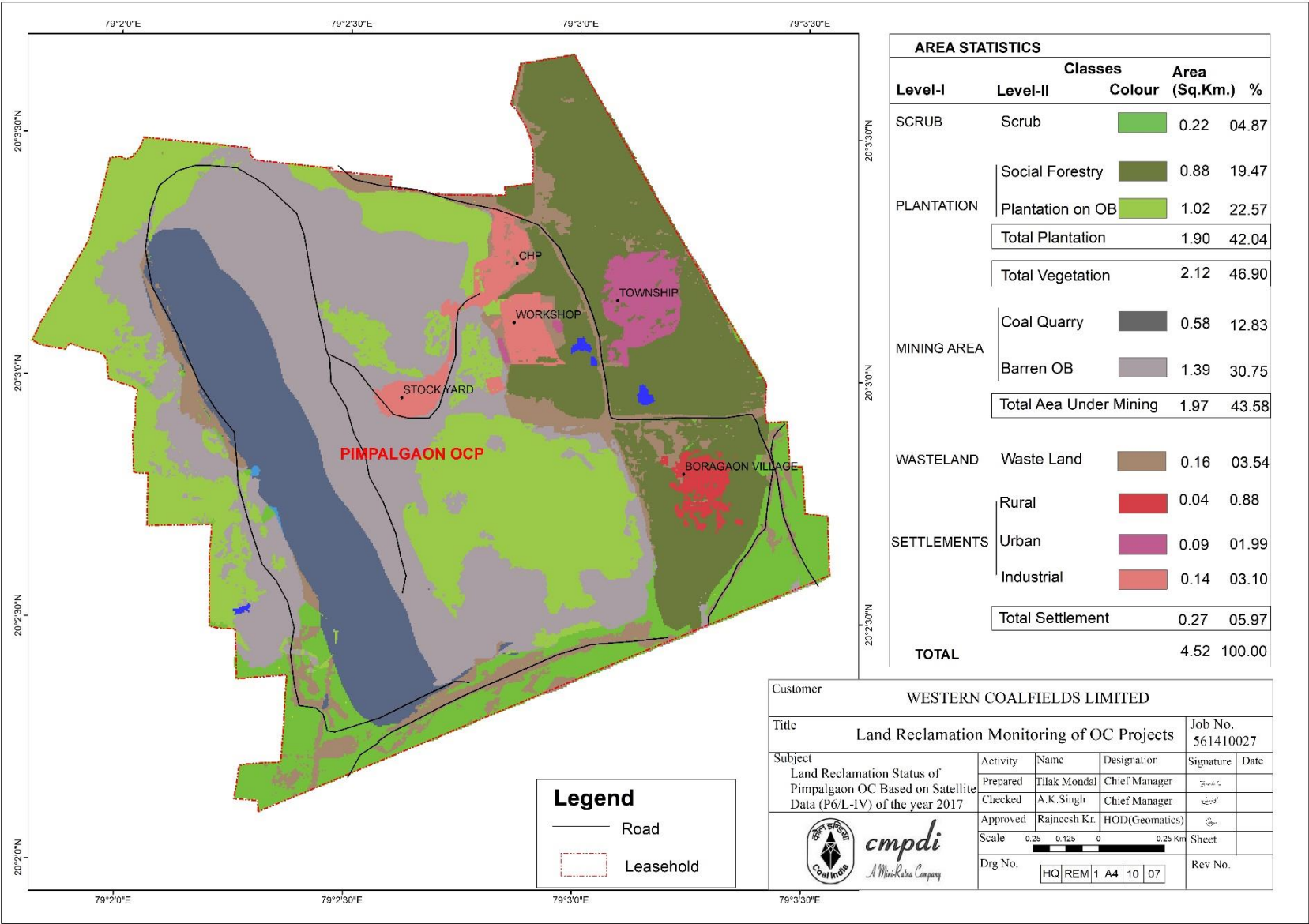
PLATE-4







Customer						WESTERN COALFIELDS LIMITED									
Title						Land Reclamation Monitoring of OC Projects						Job No. 561410027			
Subject						Activity		Name		Designation		Signature		Date	
Land Reclamation Status of Niljai OC Based on Satellite Data (P6/L-IV) of the year 2017						Prepared		Tilak Mondal		Chief Manager		[Signature]			
						Checked		A.K.Singh		Chief Manager		[Signature]			
						Approved		Rajneesh Kr.		HOD(Geomatics)		[Signature]			
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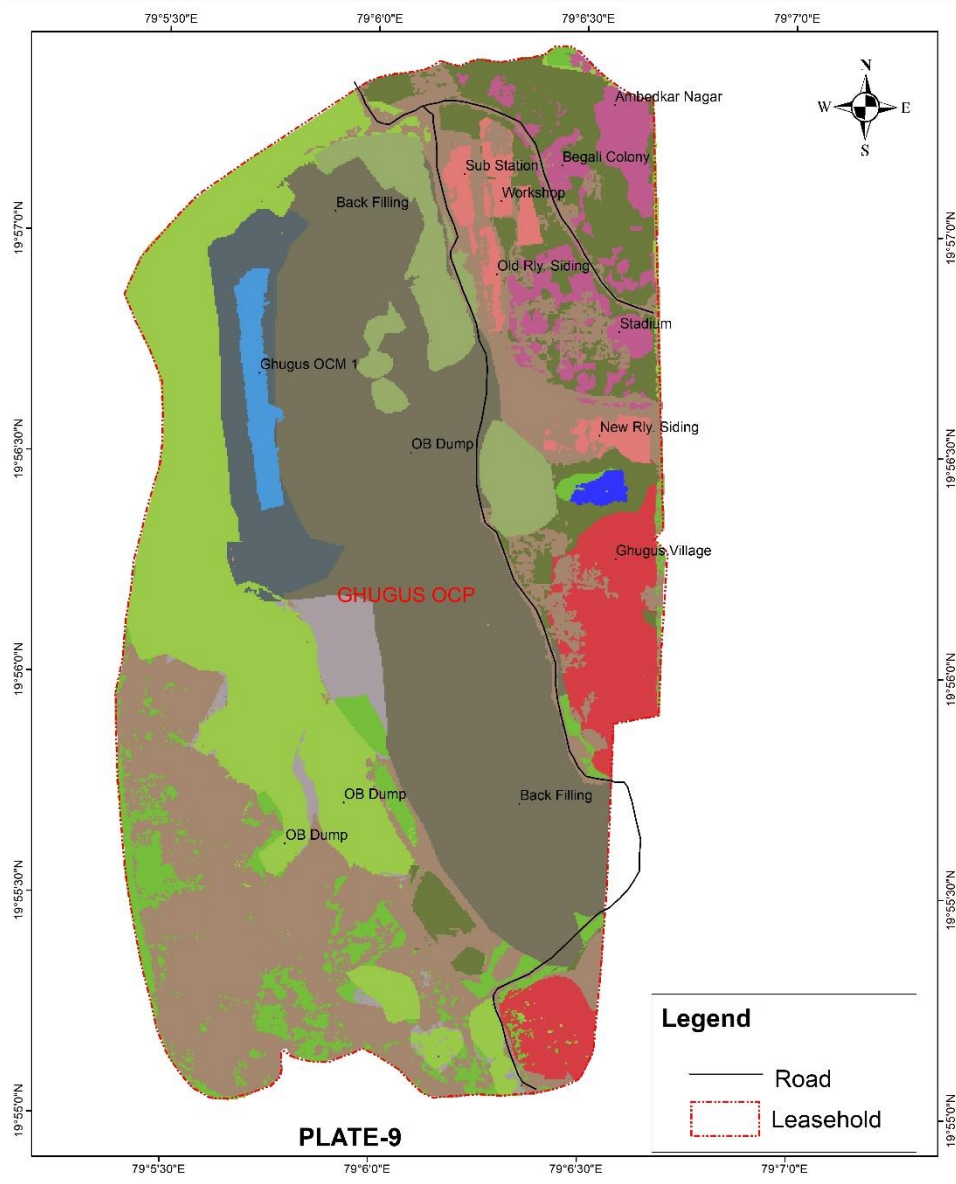




**AREA STATISTICS**

Classes				
Level-I	Level-II	Colour	Area (Sq.Km.)	%
SCRUB	Scrub		0.19	02.45
PLANTATION	Social Forestry		1.35	17.44
	Plantation on OB		1.84	23.77
	<b>Total Plantation</b>		<b>3.19</b>	<b>41.21</b>
	<b>Total Vegetation</b>		<b>3.38</b>	<b>43.67</b>
MINING AREA	Coal Quarry		3.01	38.89
	Barren OB		0.08	01.03
	Barren Backfilled		0.31	04.01
	<b>Total Aea Under Mining</b>		<b>3.40</b>	<b>43.93</b>
SETTLEMENTS	Urban		0.34	04.39
WASTELAND	Waste Land		0.52	06.72
WATERBODIES	Nallah		0.10	01.29
<b>TOTAL</b>			<b>7.74</b>	<b>100.00</b>

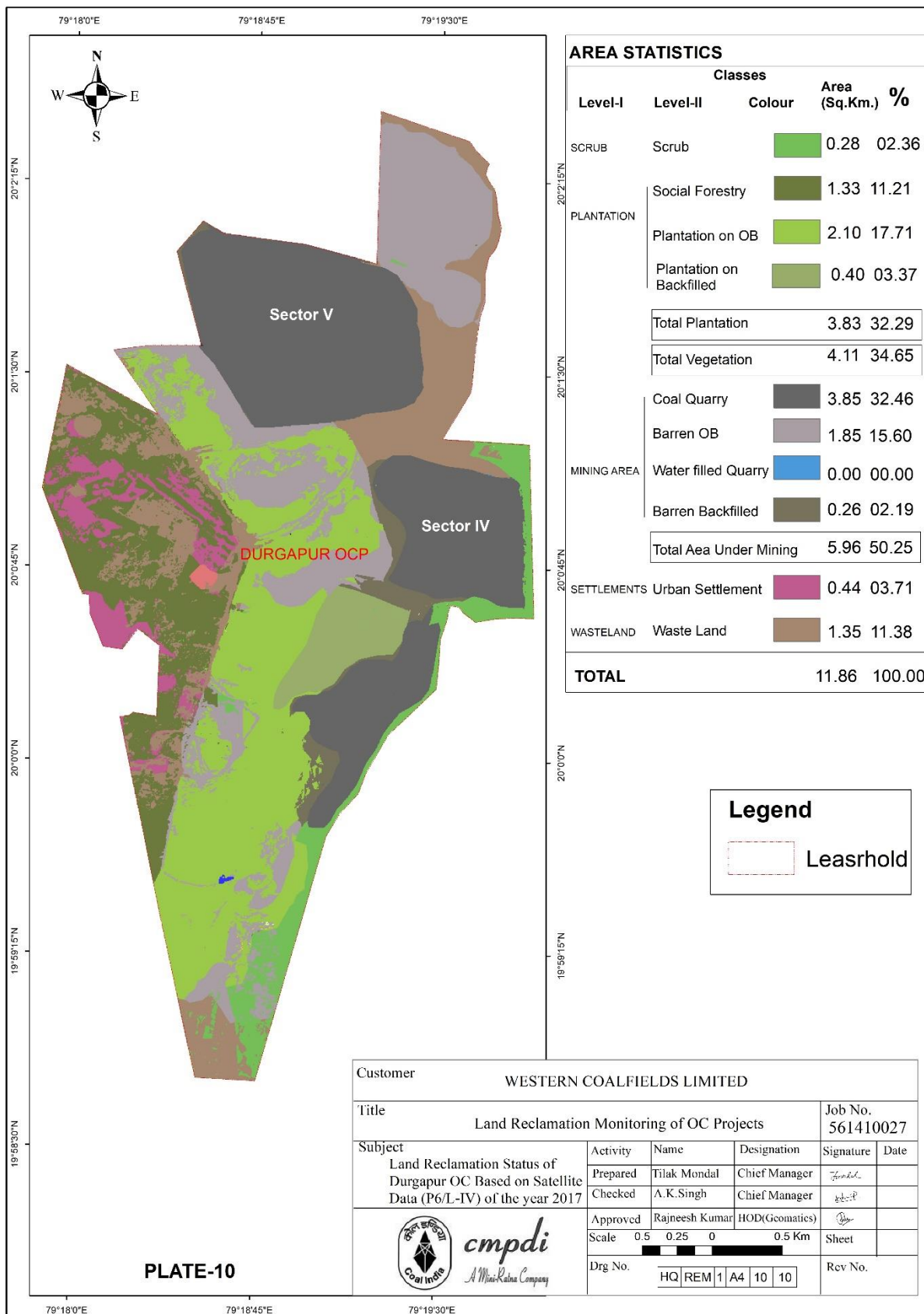
Customer					
WESTERN COALFIELDS LIMITED					
Title					Job No.
Land Reclamation Monitoring of OC Projects					561410027
Subject	Activity	Name	Designation	Signature	Date
	Prepared	Hilak Mondal	Chief Manager		
	Checked	A.K.Singh	Chief Manager		
	Approved	Rajneesh Kr.	HOD(Geomatics)		
Scale		0.25 0.125 0 0.25 Km		Sheet	
Drg No.		HQ REM 1 A4 10 08			Rev No.



AREA STATISTICS				
Level-I	Level-II	Classes Colour	Area (Sq.Km.)	%
SCRUB	Scrub		1.24	12.16
	Social Forestry		0.62	06.08
	Plantation on Backfill		0.36	03.53
	Plantation on OB		1.35	13.24
Total Plantation			2.33	22.84
Total Vegetation			3.57	35.00
MINING AREA	Coal Quarry		0.32	03.14
	Water filled quarry		0.11	01.08
	Barren OB		0.16	01.57
	Barren Backfilled		2.75	26.96
Total Aea Under Mining			3.34	32.75
SETTLEMENTS	Rural		0.43	04.22
	Urban		0.28	02.75
	Industrial		0.16	01.57
Total Settlement			0.87	08.53
WASTELAND	Waste Land		2.40	23.53
WATERBODIES	Pond		0.02	0.20
TOTAL			10.20	100.00

Customer		WESTERN COALFIELDS LIMITED			
Title		Land Reclamation Monitoring of OC Projects		Job No. 561410027	
Subject	Activity	Name	Designation	Signature	Date
	Prepared	Tilak Mondal	Chief Manager		
	Checked	A.K.Singh	Chief Manager		
Land Reclamation Status of Ghugus OC Based on Satellite Data (P6/L-IV) of the year 2017		Approved	Rajneesh Kr	HOD(Geomatics)	
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Drg No.		HQ REM 1 A4 10 09			Rev No.





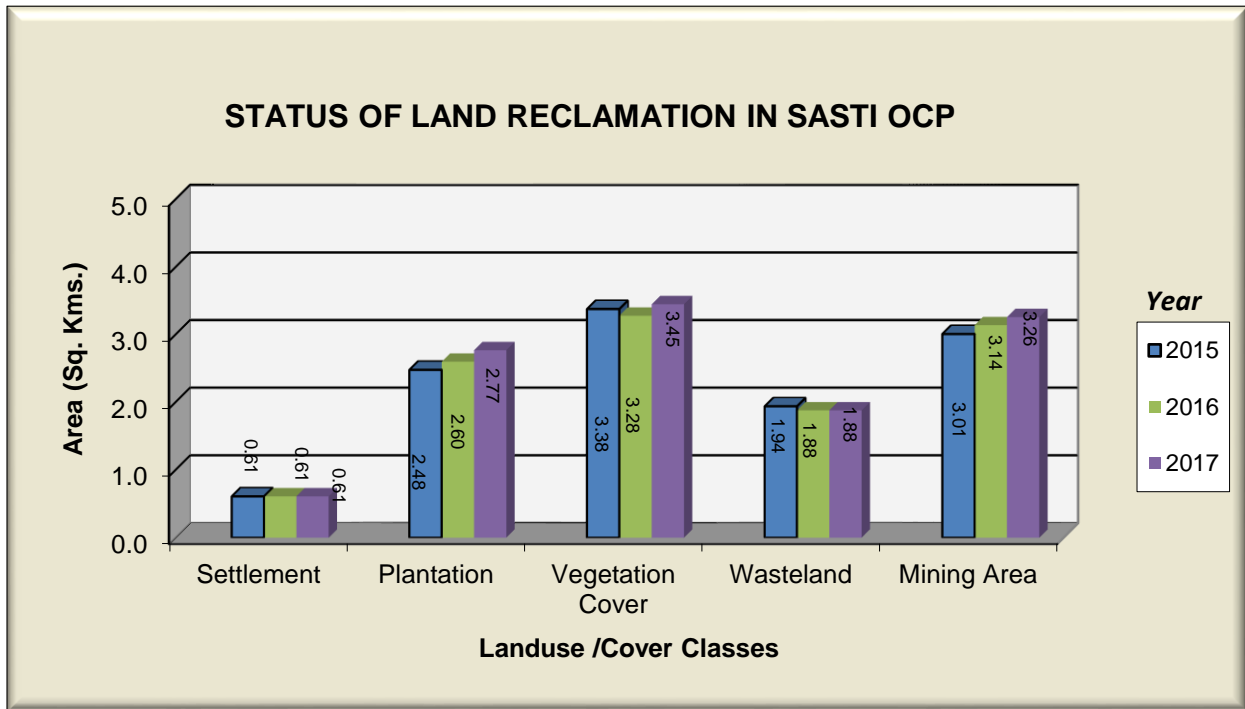


Figure 3

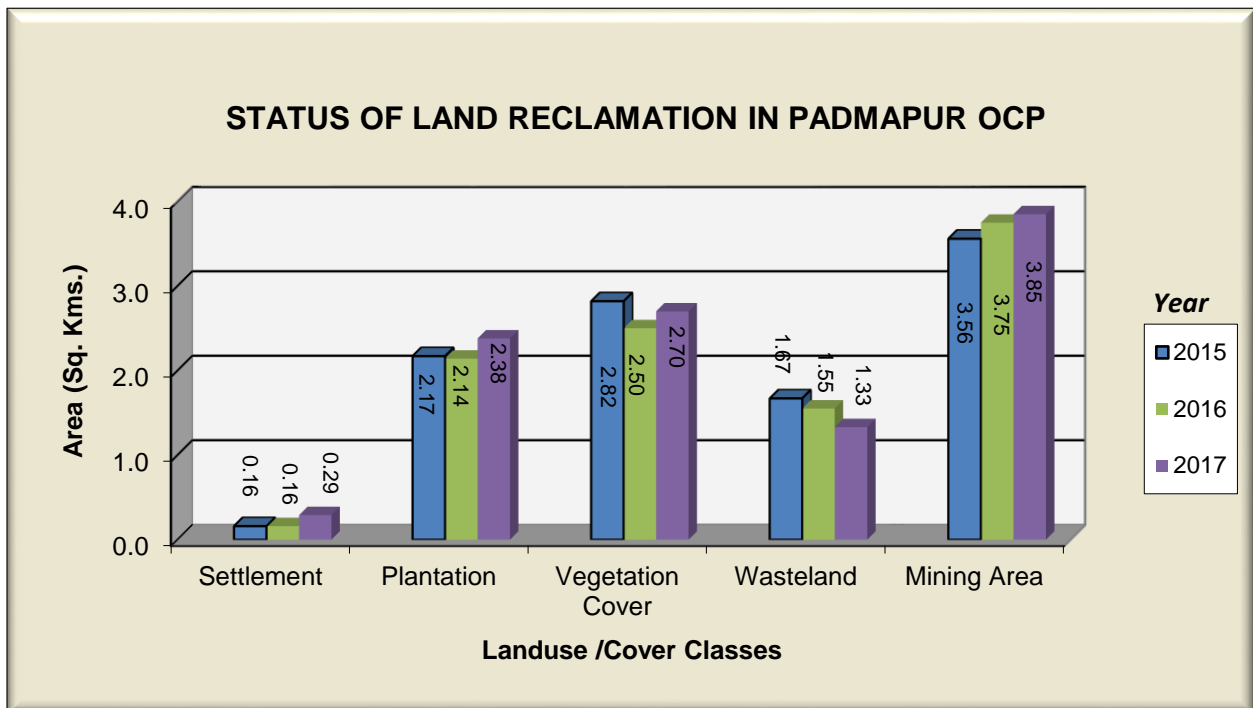


Figure 4

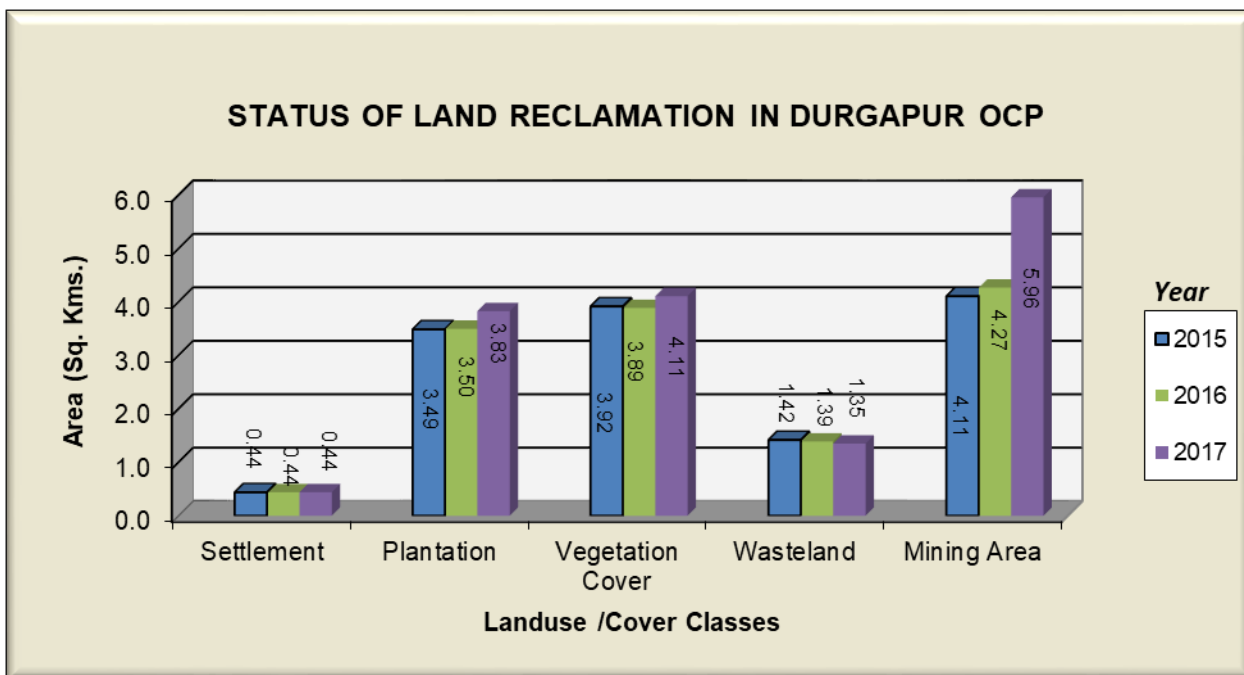


Figure 5

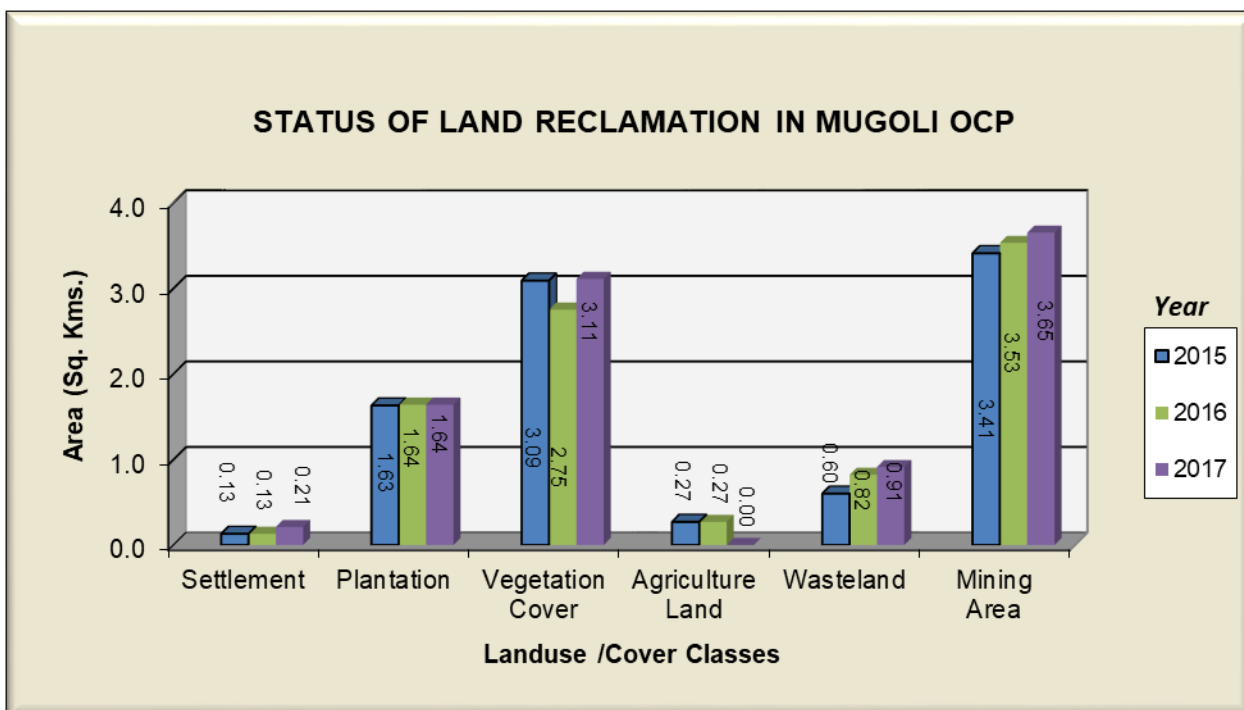


Figure 6

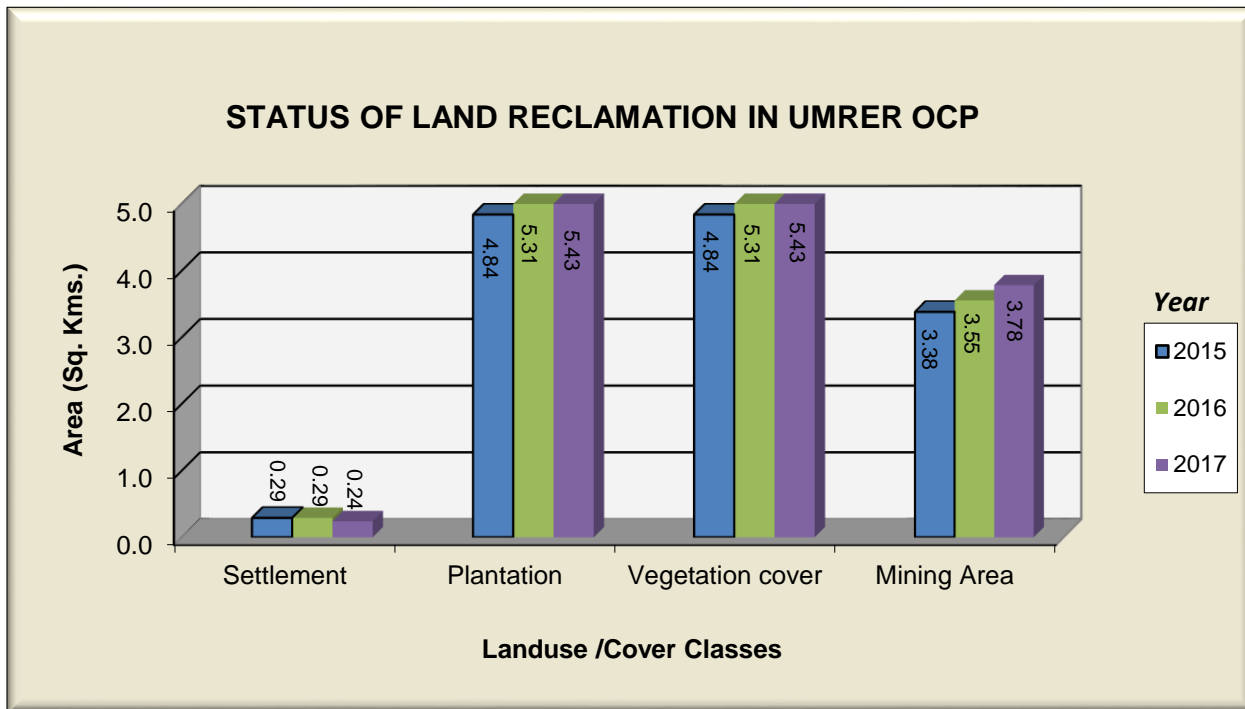


Figure 7

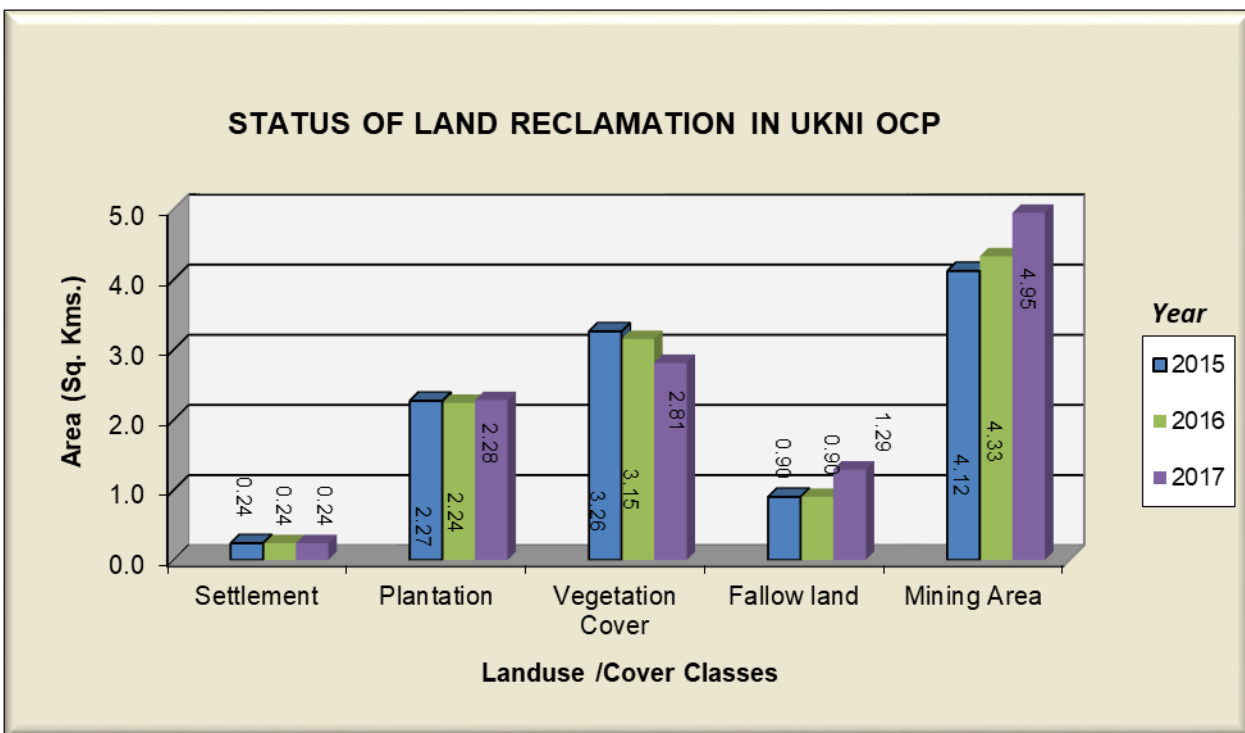


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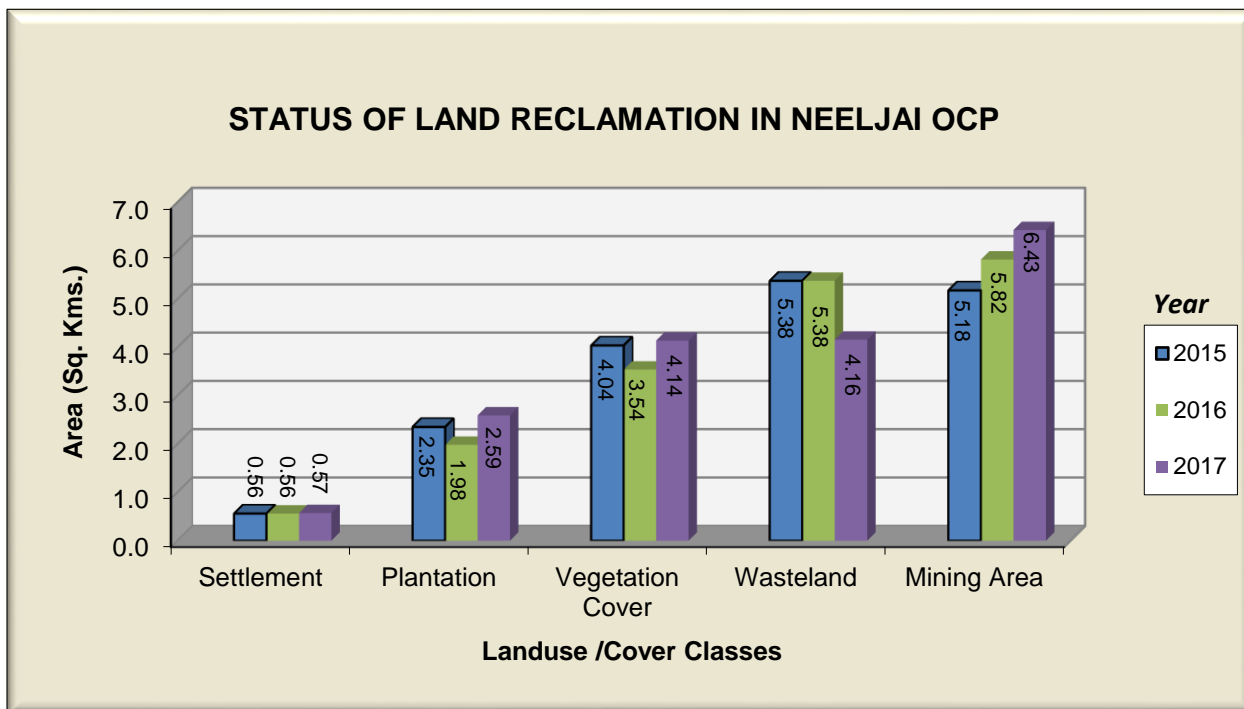


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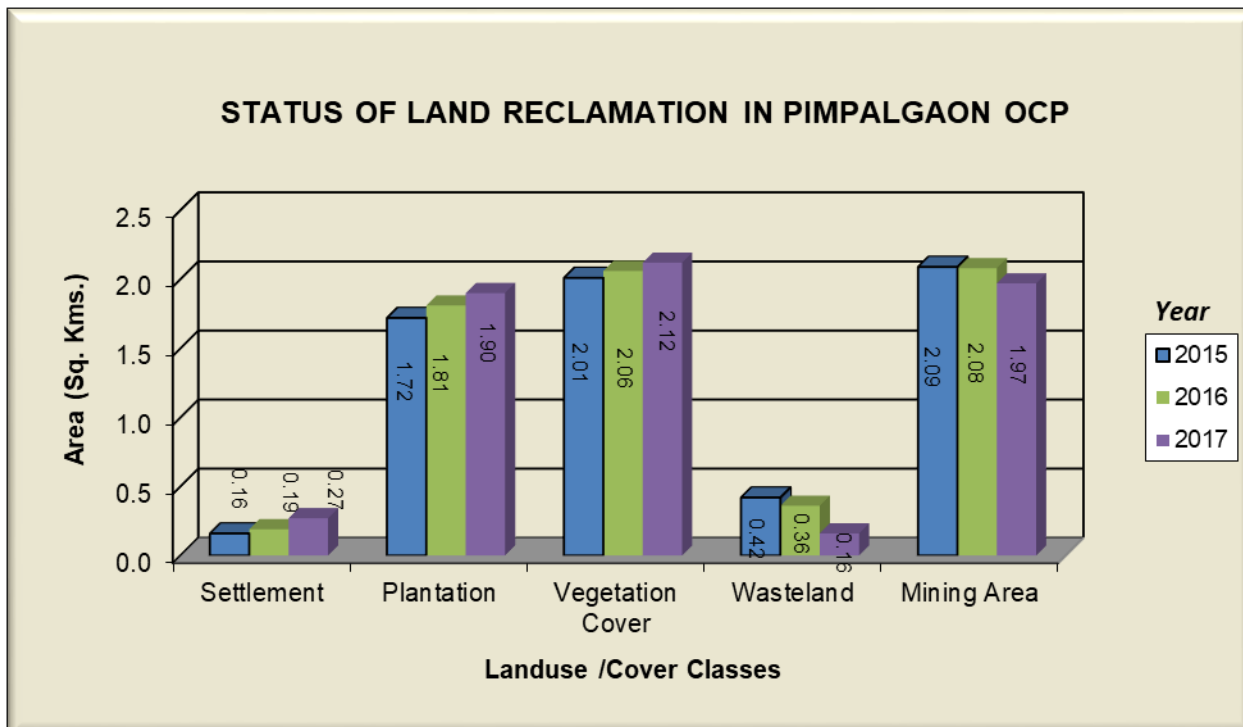


Figure 10

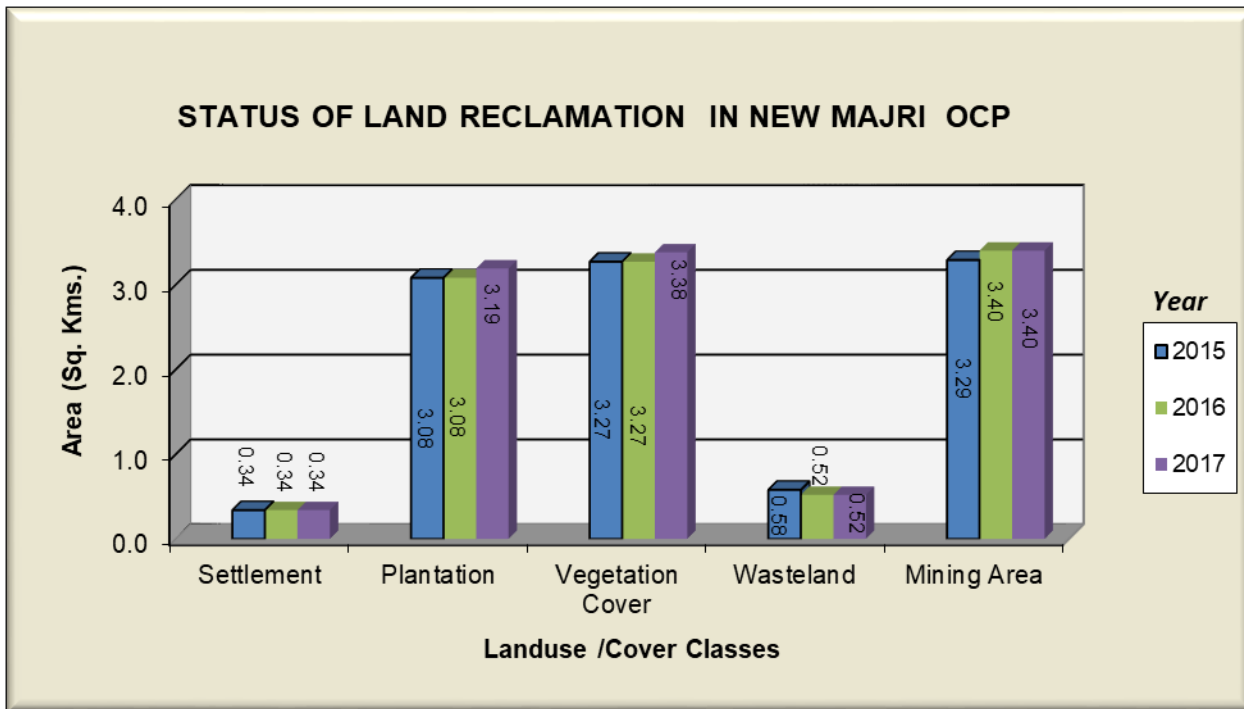


Figure 11

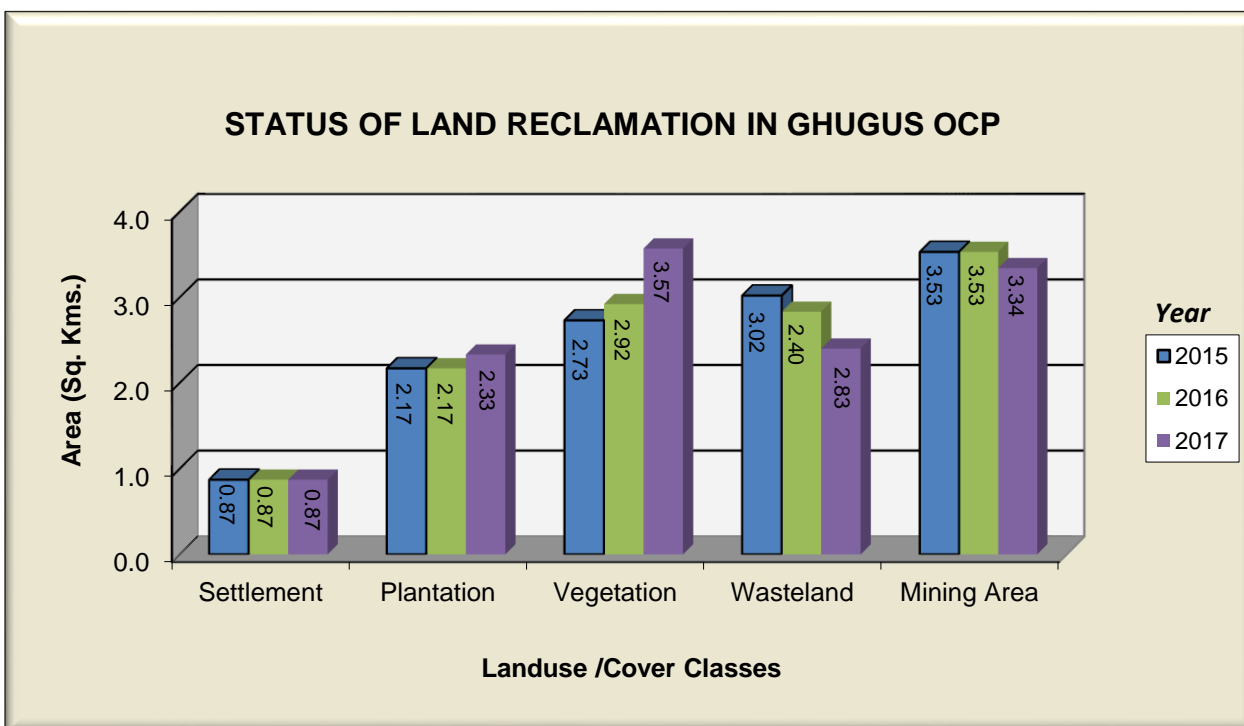


Figure 12





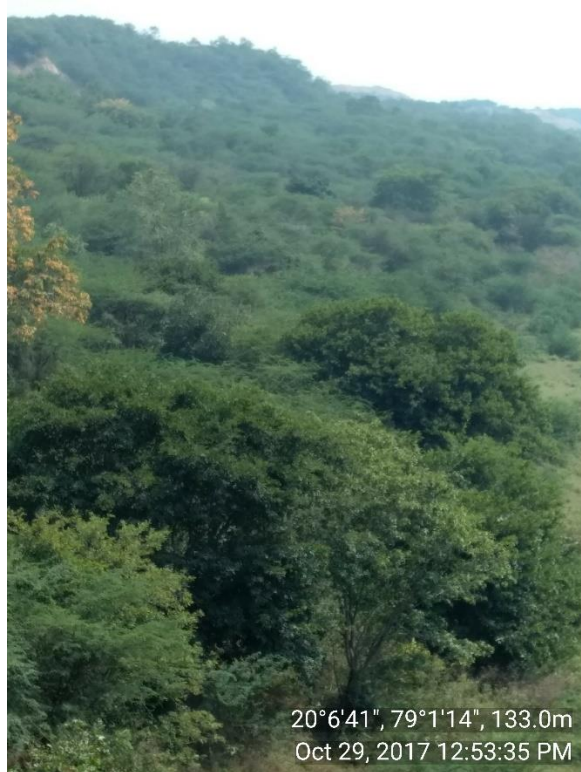
**Photograph-1: Plantation on Internal Backfill (Sasti OC mine)2016**



**Photograph-2: Plantation on External OB/Backfill (Ghugus OC Mine)2016**



**Photograph-3: Plantation on OB (Mugoli OC Mine) 2016**



**Photograph-4: Plantation on External OB (New Majri OC Mine) 2016**





**Photograph-5: Social forestry (Niljai OC Mine) 2016**

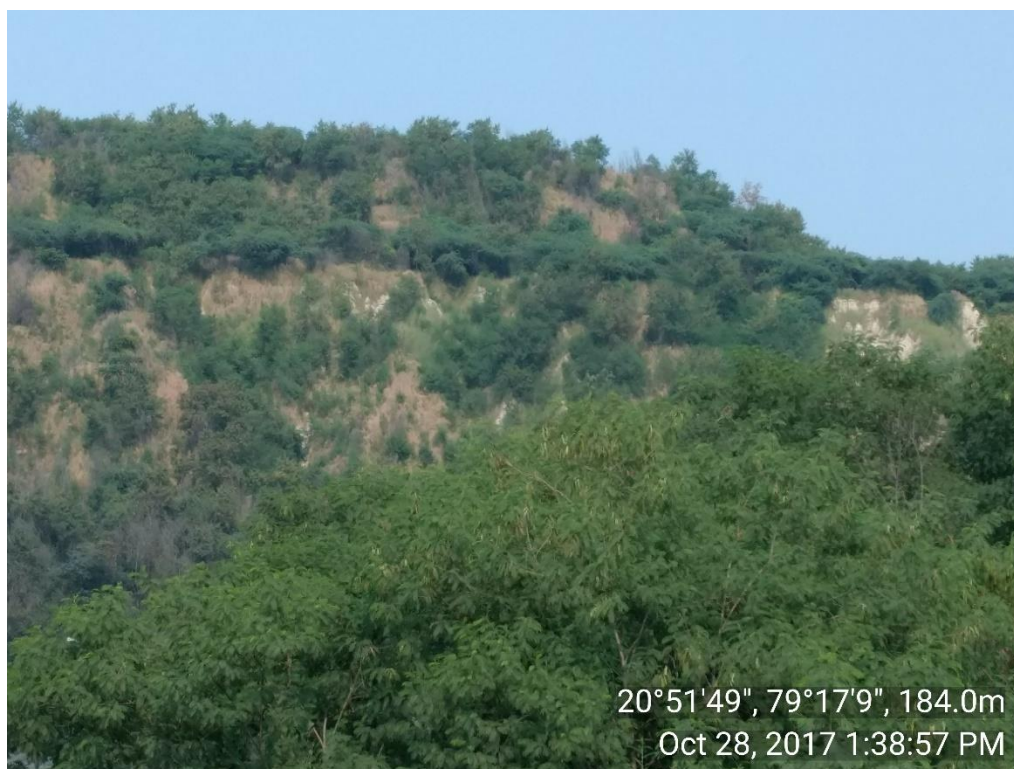


**Photograph-6: Social forestry (Pimpalgaon OC Mine) 2016**





**Photograph-7: Plantation on Internal OB/Backfill (Ukni OC Mine) 2016**



**Photograph-8: Plantation along road (Umrer OC Mine) 2016**





**Photograph-9: Social forestry (Durgapur OC Mine) 2016**



**Photograph-10: Plantation on OB dump (Padmapur OC Mine) 2016**



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