सेन्ट्रल माईन प्लानिंग एण्ड डिजाइन इन्स्टीच्यूट लिमिटेड
(कोल इण्डिया लिमिटेड की अनुषंगी कम्पनी / भारत सरकार का एक लोक उपक्रम)
गोन्दवाना प्लेस, कांके रोड, राँची - 834 008, झारखंड (भारत)
Central Mine Planning & Design Institute Limited
(A Subsidiary of Coal India Limited / Govt. of India Public Sector Undertaking)
Gondwana Place, Kanke Road, Ranchi - 834 008, Jharkhand (INDIA)
CORPORATE IDENTITY NUMBER - U14292JH1975GOI001223

An ISO 9001: 2015 & ISO 37001: 2016 Certified Company

स्पीड पोस्ट द्वारा

संख्या:जियोम:आर.एस.सी.:24: 500 दिनांक: 27.03.2025

सेवा में,
महाप्रबंधक (पर्यावरण)
वेस्टर्न कोलफ़ील्डस लिमिटेड
कोल इस्टेट, सिविल लाइंस
नागपुर – 440 001

विषय: **Report on "Land Restoration/Reclamation Monitoring of 5 Opencast Coal Mines of WCL producing less than 5 million cubic meter (Coal+OB) p.a. based on Satellite Data for the year 2024".**

संदर्भ: **Work order No.CIL/ENV/11463 dated 03.07.2024**

महोदय,

Kindly refer to the above work order from Coal India Ltd. for land reclamation of Coal Mines (Opencast + Underground) producing less than 5 million cu.m. (Coal+OB) p.a. which is carried out in a phase wise manner at an interval of every three years for all the subsidiaries of CIL based on satellite data. The study report based on satellite data of the year 2024 for the 5 OC projects of WCL taken up for monitoring this year has been prepared. Soft copy of the same along with all Project wise KMLs as per work order is attached herewith the email for your reference and further necessary perusal.

As per the above work order, three hard copies of the report are being sent separately through courier. Kindly acknowledge the receipt of the same and arrange to upload the report on website of WCL.

Encl.: As above.

भवदीय,

27.3.25

(मोहित रस्तोगी)
महाप्रबंधक (जियोमेटिक्स)

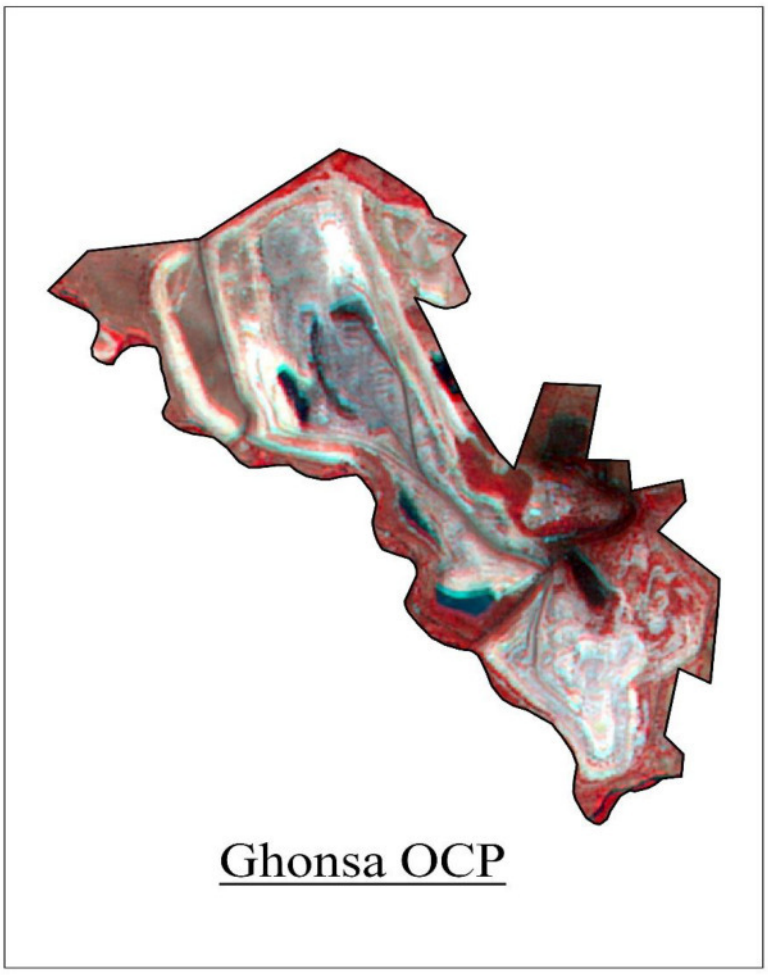
Copy to:

(1) The General Manager (ENV), Coal India Ltd., Coal Bhawan Premise No-04 MAR,Plot No-AF-III,Action Area-1A,Newtown,Rajarhat,Kolkata-700156 – *for kind information.*
(2) The Regional Director, Regional Institute-IV, CMPDI, Kasturba Nagar, Jaripatka, Nagpur - 440 014 (Tel:0712-2642134)– *along with a copy of the report.*
(3) The General Manager (BDD), CMPDI (HQ), Ranchi – *for kind information on Job No. 564924124*

फोन नम्बर/Phone No. :
ई-मेल/E-mail:
वेब साईट/Website:

वेस्टर्न कोल्फील्ड्स लिमिटेड के ५ मिलियन घन मीटर (कोल + अधिभार) से कम उत्पादन क्षमतावाले ५ खुली खदानों का भूमि पुनरुद्धार हेतु २०२४ के उपग्रह डाटा के आधार पर निगरानी का प्रतिवेदन

Land Restoration / Reclamation Monitoring of 5 opencast projects of Western Coalfield Limited producing less than 5 million Cu. M. (Coal+OB) per annum based on Satellite Data of the Year 2024



Submitted to

WESTERN COALFIELDS LIMITED

वेस्टर्न कोल्फील्ड्स लिमिटेड के ५ मिलियन घन मीटर (कोल + अधिभार) से कम उत्पादन क्षमतावाले ५ खुली खदानों का भूमि पुनरुद्धार हेतु २०२४ के उपग्रह डाटा के आधार पर निगरानी का प्रतिवेदन

Land Restoration / Reclamation Monitoring of 5 opencast projects of Western Coalfield Limited producing less than 5 million Cu. M. (Coal+OB) per annum based on Satellite Data of the Year 2024

March-2025

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

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(8) Aim of the Report	To prepare land use/cover map of leasehold area of 05 opencast projects based on high resolution satellite data (IRSR2-L4FX) of the year 2024 using digital image processing technique.
(9) Executing Unit	Remote Sensing Cell, Geomatics Division, Central Mine Planning & Design Institute Limited, Gondwana Place, Kanke Road, Ranchi 834008
(10) User Agency	Western Coalfields Ltd., Nagpur, Maharashtra.
(11) Author	1) Swabhiman Dehariya, Asst. Manager (Mining/Geomatics) 2) Tilak Mondal, Chief Manager (E&M /Geomatics)
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१.० परियोजना वेस्टर्न कोल्फील्ड्स लिमिटेड के ५ मिलियन घन मीटर (कोल+ अधिभार) से कम उत्पादन क्षमतावाले ५ खुली खदानों के पुनरुद्धार हेतु वर्ष २०२४ 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 ड्रेनेज), 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 २०२४-२५ में कुल ०५ खुली खदान परियोजनाओं में भूमि सुधार की स्थिति की निगरानी पर विचार किया गया है। (<5 एमसीएम कोयला+ओबी)

- वर्ष २०२४-२५ में भूमि पुनरुद्धार (लैंड रिक्लेमेशन) हेतु चयन किये गए कुल ०५ खुली खदान परियोजनाओं यथा: कोलेगांव, घोंसा, उर्धन, गौरी डीप छिंदा का कुल पट्टाक्षेत्र अथवा माइन लीज होल्ड एरिया १४३६.९८ हेक्टेयर है जिसमें ३७४.९८ हेक्टेयर उत्खनन क्षेत्र के अंतर्गत है तथा २५.६७ हेक्टेयर (६.८५%) क्षेत्र में तकनीकी पुनरुद्धार (बैकफीलिंग) का कार्य प्रगति पर है और शेष ३४९.३१ हेक्टेयर (९३.१५%) क्षेत्र सक्रिय खनन के अन्तर्गत है। विश्लेषण से यह स्पष्ट है कि वर्ष २०२४-२५ के लिए कोई जैविक पुनरुद्धार यानी बैकफिल पर वृक्षारोपण नहीं किया गया 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 २०२४-२५ में ५ 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 २०२३-२४ के १६.५१ हेक्टेयर की तुलना में वर्ष २०२४-२५ में बढ़कर २५.९३ 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 ९.४२ 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।

- तालिका 1.1 में डब्ल्यूसीएल (<5 एमसीएम कोयला+ओबी) की शेष खानों में भूमि पुनरुद्धार (लैंड रिक्लेमेशन) सामूहिक रूप से दर्शाया गया हे।

- कुल वृक्षारोपण (हरित आवरण), बैकफ़िल पर किए गए वृक्षारोपण, बंजर अधिभार डंप पर किए गए वृक्षारोपण, सामाजिक वानिकी के तहत किए वृक्षारोपण के तहत आने वाले क्षेत्र का क्षेत्रफल वर्ष २०२३-२४ में १७१.८२ हेक्टेयर से बढ़कर वर्ष २०२४-२५ में २२३.४३ हेक्टेयर हो गया है।

Executive Summary

1.0 Project

Land restoration / reclamation monitoring of 5 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 5 no. of OC projects have been considered for monitoring the status of land reclamation in the year 2024-25

- Out of the total mine leasehold area of 1436.98 Hectare of the 5 OC projects Viz. Gauri Deep, Ghonsa, Kolegaon, Urdhan, and Chhinda considered for monitoring during the year 2024-25; total excavated area is only 374.98 Ha out of which 25.67 Ha area (6.85%) is under backfilling (Technically Reclaimed) and 349.31 Ha (93.15%) area is under active mining. It is evident from the analysis that there is no biological reclamation i.e. plantation on backfill for the year 2024-25. Project wise details are given in Table-1 & bar chart Fig1.

- On comparing the status of land reclamation carried out for 5 nos of OC projects in year 2024-25 with respect to previous cycle study

in WCL, it is evident from analysis that area under land reclamation has increased from 16.51 Hectares (Yr 2023-24) to 25.93 Hectares (Yr 2024-25) which includes both planation on backfill (Biological Reclamation) and area under backfilling (Technical Reclamation). This increase of 9.42 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.

- Table 1.1 Show the Composite land reclamation status in remaining mines of WCL (<5 MCM Coal+OB) as per clause 2.(ii) of the received work order from CIL.

- Overall, total area under plantation (green cover) carried out on backfill, barren OB dump and plantation under social forestry has gone up from 171.82 Hectares in the year 2023-24 to 223.43 Hectares in the year 2024-25.

Table-1

Project wise Land Reclamation Status in Opencast Projects of WCL (<5 MCM Coal+OB) based on Satellite Data of the year 2024-25

(Area in Hectare)

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, Avenue Plantation Etc.									
1	*2*	*3*		*4*		*5*		*6*		*7*		*8*		*9 (=4+5+8)*		*10 (=5+6+7)*		*11(=4+5)*	
		2023	*2024*	*2023*	*2024*	*2023*	*2024*	*2023*	*2024*	*2023*	*2024*	*2023*	*2024*	*2023*	*2024*	*2023*	*2024*	*2023*	*2024*
1	Gauri Deep	339.10	339.10	0.00	0.00	0.00	0.00	0.00	14.46	8.00	10.42	62.77	70.94	62.77	70.94	8.00	24.88	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			2.36%	7.34%	0.00%	0.00%
2	Ghonsa	278.68	278.68	11.59	18.29	0.00	0.00	5.51	8.61	6.54	10.80	98.39	118.12	109.98	136.41	12.05	19.41	11.59	18.29
				10.54%	13.41%	0.00%	0.00%					89.46%	86.59%			4.32%	6.96%	10.54%	13.41%
3	Kolegaon	397.52	397.52	0.00	0.00	0.00	0.00	83.45	96.67	24.11	29.70	67.64	82.78	67.64	82.78	107.56	126.37	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			27.06%	31.79%	0.00%	0.00%
4	Urdhan	315.00	315.00	4.70	7.38	0.00	0.00	10.15	15.44	9.02	11.13	38.06	50.96	42.76	58.34	19.17	26.57	4.70	7.38
				10.99%	12.65%	0.00%	0.00%					89.01%	87.35%			6.09%	8.43%	10.99%	12.65%
5	Chinda	106.68	106.68	0.00	0.00	0.00	0.00	20.11	20.74	4.30	4.68	23.81	26.51	23.81	26.51	24.41	25.42	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			22.88%	23.83%	0.00%	0.00%
	Total (A)	**1436.98**	**1436.98**	**16.29**	**25.67**	**0.00**	**0.00**	**119.22**	**155.92**	**51.97**	**66.73**	**290.67**	**349.31**	**306.96**	**374.98**	**171.82**	**223.43**	**16.51**	**25.93**
		A		**5.31%**	**6.85%**	**0.00%**	**0.00%**					**94.69%**	**93.15%**			**11.96%**	**15.55%**	**5.38%**	**6.92%**

(%) calculated is in respect to Total Excavated Area as applicable

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”.

Table-1.1

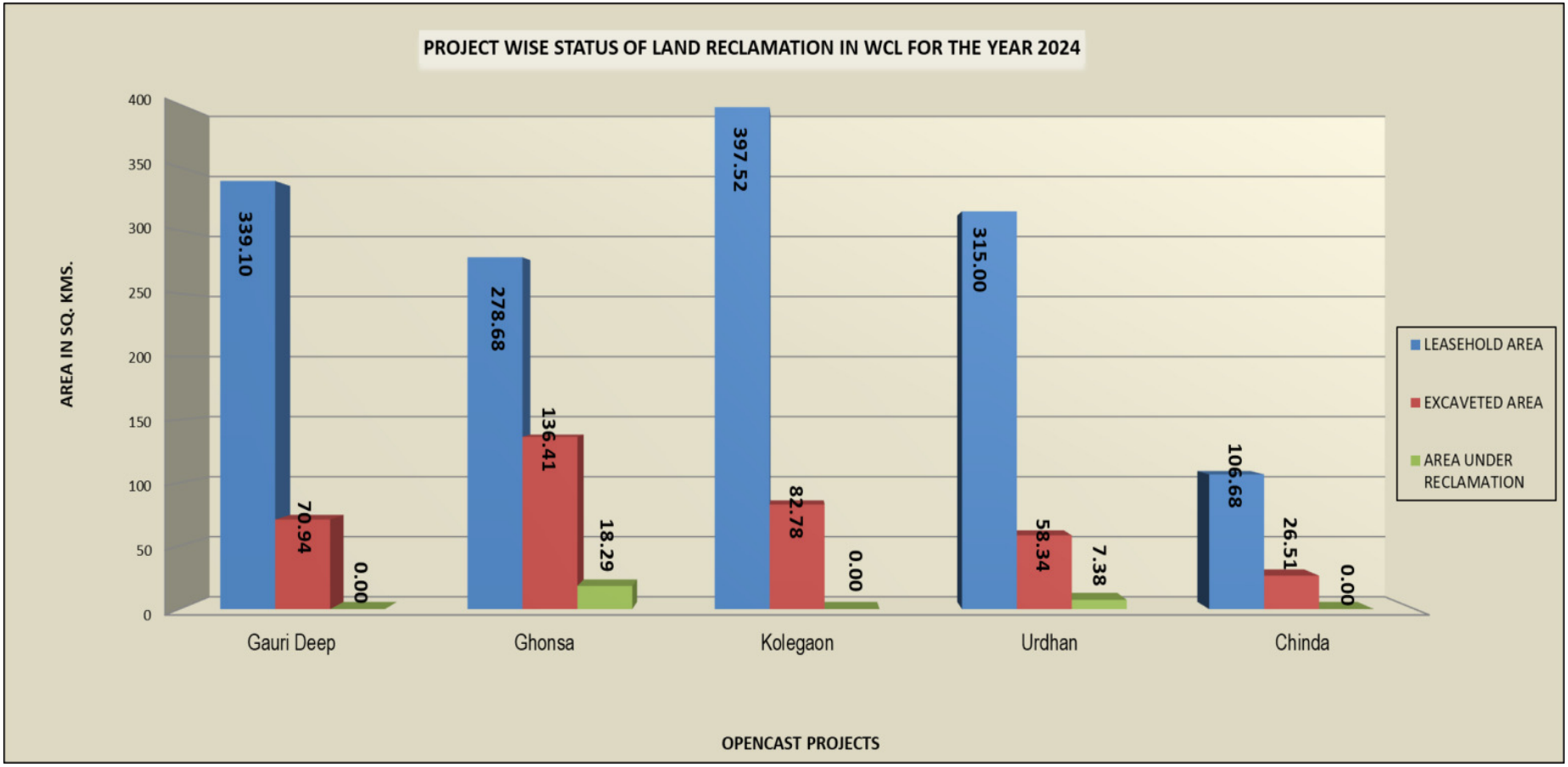
Composite land reclamation status in remaining mines of WCL (<5 MCM Coal+OB) as per clause 2.(ii) of the received work order from CIL

(Area in Hectare)

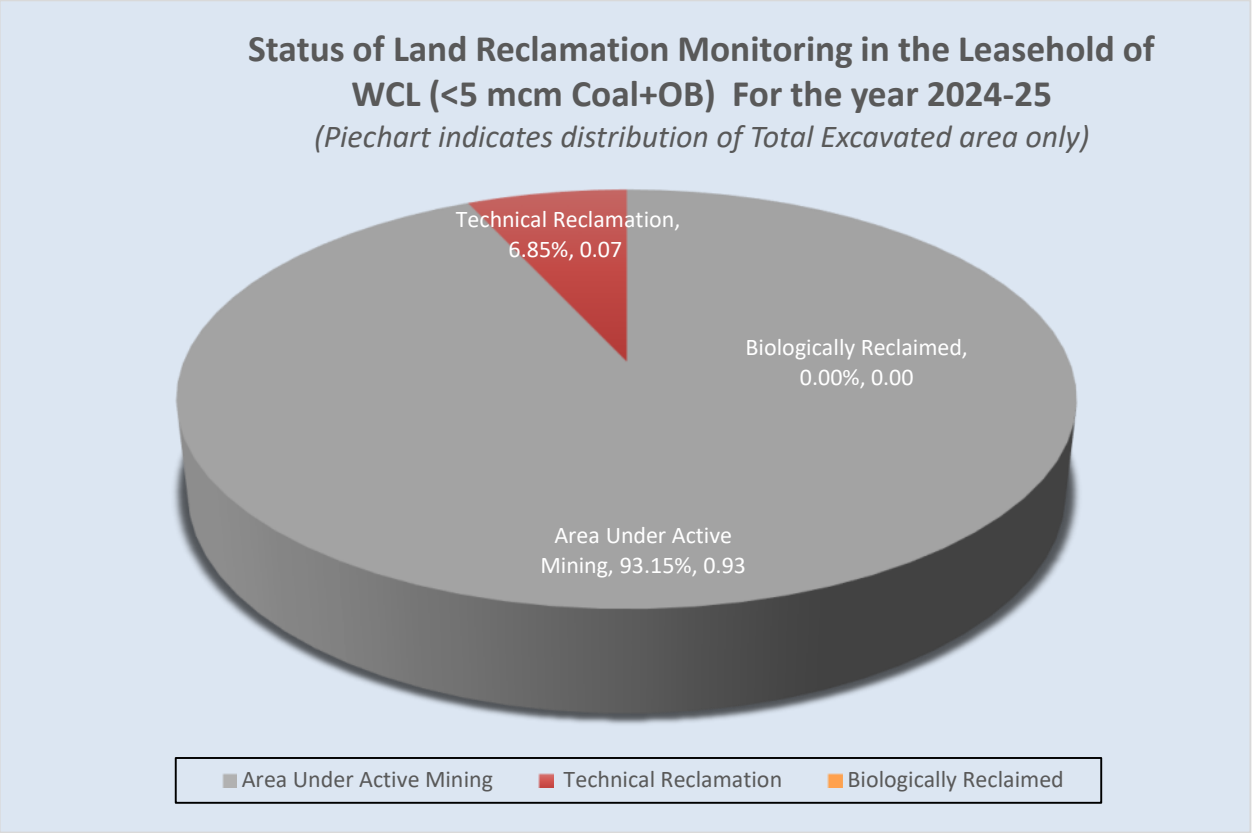
Sl.No.	Cluster No.	Total Leasehold Area		Technical Reclamation		Plantation						Area under Active Mining		Total Excavated Area		Total Area under Plantation (% Green Cover Generated in Leasehold)		Total Area under Reclamation	
						Biological		Other Plantations											
				Area under Backfilling		Plantation on Excavated / Backfilled Area		Plantation on External OB Dumps		Social Forestry, Avanue Plantation Etc.									
1	*2*	*3*		*4*		*5*		*6*		*7*		*8*		*9 (=4+5+8)*		*10 (=5+6+7)*		*11(=4+5)*	
		2022	*2023*	*2022*	*2023*	*2022*	*2023*	*2022*	*2023*	*2022*	*2023*	*2022*	*2023*	*2022*	*2023*	*2022*	*2023*	*2022*	*2023*
6	Padmapur OC **	829.00	829.00	59.00	65.00	28.00	28.00	214.00	221.00	83.00	83.00	118.00	112.00	205.00	205.00	325.00	332.00	87.00	93.00
				28.78%	31.71%	13.66%	13.66%					57.56%	54.63%			39.20%	40.05%	42.44%	45.37%
	TOTAL (B)	**829.00**	**829.00**	**59.00**	**65.00**	**28.00**	**28.00**	**214.00**	**221.00**	**83.00**	**83.00**	**118.00**	**112.00**	**205.00**	**205.00**	**325.00**	**332.00**	**87.00**	**93.00**
				28.78%	**31.71%**	**13.66%**	**13.66%**					**57.56%**	**54.63%**			**39.20%**	**40.05%**	**42.44%**	**45.37%**
		2019	*2022*	*2019*	*2022*	*2019*	*2022*	*2019*	*2022*	*2019*	*2022*	*2019*	*2022*	*2019*	*2022*	*2019*	*2022*	*2019*	*2022*
7	Singhori OC	425.04	425.04	0.00	0.00	0.00	0.00	0.00	0.00	4.59	7.63	26.82	50.56	26.82	50.56	4.59	7.63	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			1.08%	1.80%	0.00%	0.00%
8	Makardhokra -II OC	258.23	258.23	44.61	57.75	2.90	0.00	58.76	47.14	2.57	2.57	6.91	0.00	54.42	57.75	64.23	49.71	47.51	57.75
				81.97%	100.00%	5.33%	0.00%					12.70%	0.00%			24.87%	19.25%	87.30%	100.00%
9	New Sethia OC	144.45	144.45	25.99	30.65	23.58	18.92	6.80	7.01	9.53	10.15	40.81	41.65	90.38	91.22	39.91	36.08	49.57	49.57
				28.76%	33.60%	26.09%	20.74%					45.15%	45.66%			27.63%	24.98%	54.85%	54.34%
10	Ghugus OC	1020.00	1020.00	267.70	258.74	55.38	73.22	135.00	136.64	84.91	125.20	35.77	26.89	358.85	358.85	275.29	335.06	323.08	331.96
				0.00%	72.10%	0.00%	20.40%					0.00%	7.49%			26.99%	32.85%	0.00%	92.51%
11	Pimpalgaon OC	451.87	451.87	13.33	13.34	0.00	0.00	136.11	149.76	80.32	79.62	46.25	54.23	59.58	67.57	216.43	229.38	13.33	13.34
				0.00%	19.74%	0.00%	0.00%					0.00%	80.26%			47.90%	50.76%	0.00%	19.74%
	TOTAL (C)	**2299.59**	**2299.59**	**351.63**	**360.48**	**81.86**	**92.14**	**336.67**	**340.55**	**181.92**	**225.17**	**156.56**	**173.33**	**590.05**	**625.95**	**600.45**	**657.86**	**433.49**	**452.62**
				59.59%	**57.59%**	**13.87%**	**14.72%**					**26.53%**	**27.69%**			**26.11%**	**28.61%**	**73.47%**	**72.31%**
		2018	*2021*	*2018*	*2021*	*2018*	*2021*	*2018*	*2021*	*2018*	*2021*	*2018*	*2021*	*2018*	*2021*	*2018*	*2021*	*2018*	*2021*
12	Shivpuri OC	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%
13	Ghorawar OC	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%
14	Barkuhi OC	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%
15	Ambara OC	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 (D)	**2031.96**	**2031.96**	**109.22**	**149.04**	**28.49**	**40.23**	**48.01**	**48.61**	**50.24**	**58.47**	**110.57**	**117.80**	**248.28**	**307.07**	**126.74**	**147.31**	**137.71**	**189.27**
				43.99%	**48.54%**	**11.47%**	**13.10%**					**44.53%**	**38.36%**			**6.24%**	**7.25%**	**55.47%**	**61.64%**
	***GRAND TOTAL (A+B+C+D)**	**6597.53**	**6597.53**	**536.14**	**600.19**	**138.35**	**160.37**	**717.90**	**766.08**	**367.13**	**433.37**	**675.80**	**752.44**	**1350.29**	**1513.00**	**1224.01**	**1360.60**	**674.71**	**760.82**
				39.71%	**39.67%**	**10.25%**	**10.60%**					**50.05%**	**49.73%**			**18.55%**	**20.62%**	**49.97%**	**50.29%**

**Grand Total (A+B+C+D) is the composite value of all 15 mines of WCL covered in 3 years cycle of Land Reclamation Monitoring* *(% is calculated with respect to Excavated Area as applicable)*

** The Land Reclamation Monitoring for this mine was previously conducted under the category of more than 5 MTY capacity. For normalized calculations, the data from this mines has been converted from Sq.Kms to Ha.



Flg.1: Land Reclamation Status in OC projects producing less than 5mcm (Coal +OB) of WCL in the Year 2024



Flg.2: Land Reclamation Status of Total Excavated area in OC projects of WCL (<5 MCM Coal+OB) in the Year 2024

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^3 per annum (coal + OB taken together per annum) based on remote sensing satellite data regularly on annual basis and less than 5 million m^3 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. Again the above work order has been renewed vide letter no. CIL/ ENV/11463 dated 03.07.2024 for a period of 3 more years for 2024-25, 2025-26 and 2026-27. 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 & 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 2024 carried out for the 5 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. Bhoonidhi Portal of ISRO alongside 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-3. Following steps are involved in land reclamation /restoration monitoring:

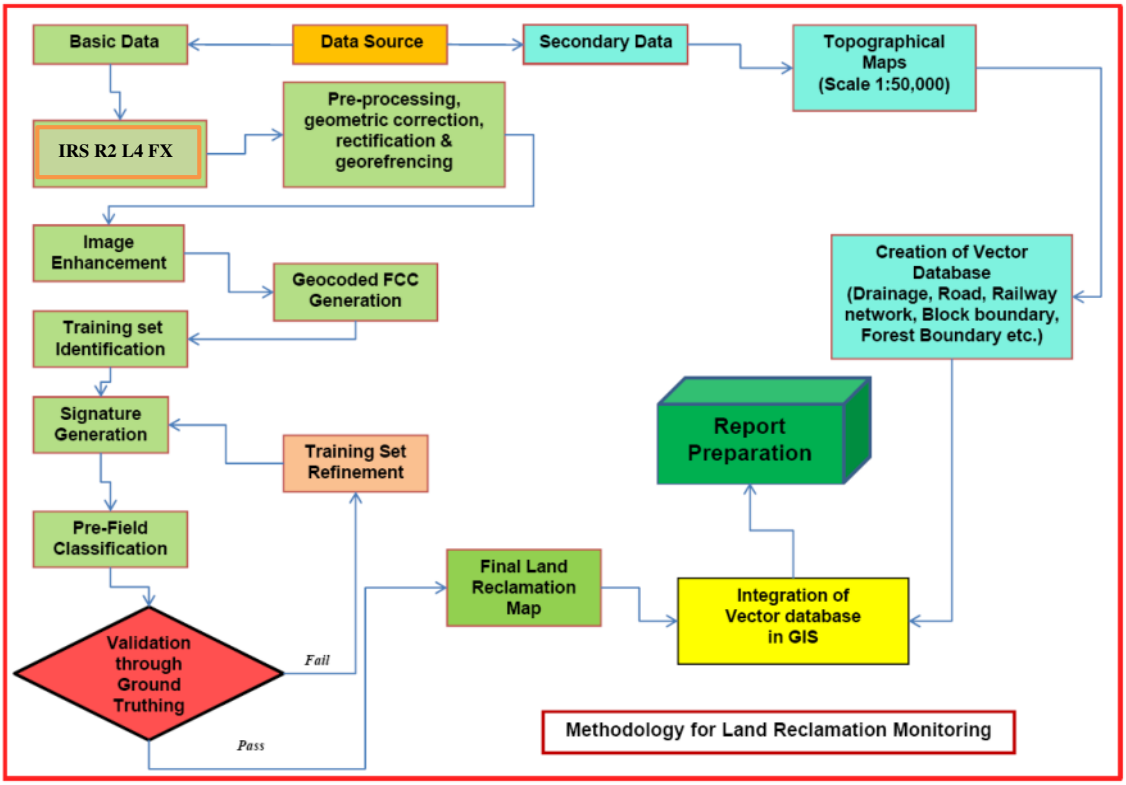


Figure :3 Methodology for Land Reclamation Monitoring

3.1 Data Procurement: After browsing the data quality and date of pass on internet, supply order for data is placed to NRSC or if available downloaded directly from the Bhoonidhi portal. 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 & ArcMap10.8 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 SoI 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 5 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 2024-25:

- Gouri Deep
- Ghonsa
- Kolegaon
- Urdhan
- Chhinda

4.2 Area statistics of different land use class present in the mine leasehold of the above projects for the year 2024 are shown in the Table - 2. Land use maps derived from satellite data of year 2024 are shown in Plate 1 - 5. This time both local grid and UTM grid is used for map preparation along with all essential boundaries shape file such as Quarry limit line, Sump, OB Dump, EC Boundary, Plantation area etc. as per the work order from CIL. Changes in the different land use classes based on satellite data are depicted in Bar Charts in Fig. 4- 8.

4.3 Study reveals that out of total mine leasehold area of 1436.98 Hectare of the 5 projects viz, Gauri Deep, Ghonsa, Kolegaon, Urdhan and Chhinda considered for monitoring during year 2024-25; total excavated area is 374.98 Ha, out of which 25.67 Ha (6.85%) area is under backfilling (Technically Reclaimed) and balance 349.31 Ha (93.15%) area is under active mining. It is evident from analysis that there is no biological reclamation i.e. plantation on backfill. Project wise details area given in Table 1.

4.4 From analysis it is revealed that total area under technical reclamation (area under backfilling) has also increased from 16.29 Ha (5.31%) in the year 2023 to 25.67 Ha (6.85%) area in the year 2024.

4.5 Study indicates that overall the projects of WCL considered for this study indicate increase in technical reclamation i.e. area under backfilling.

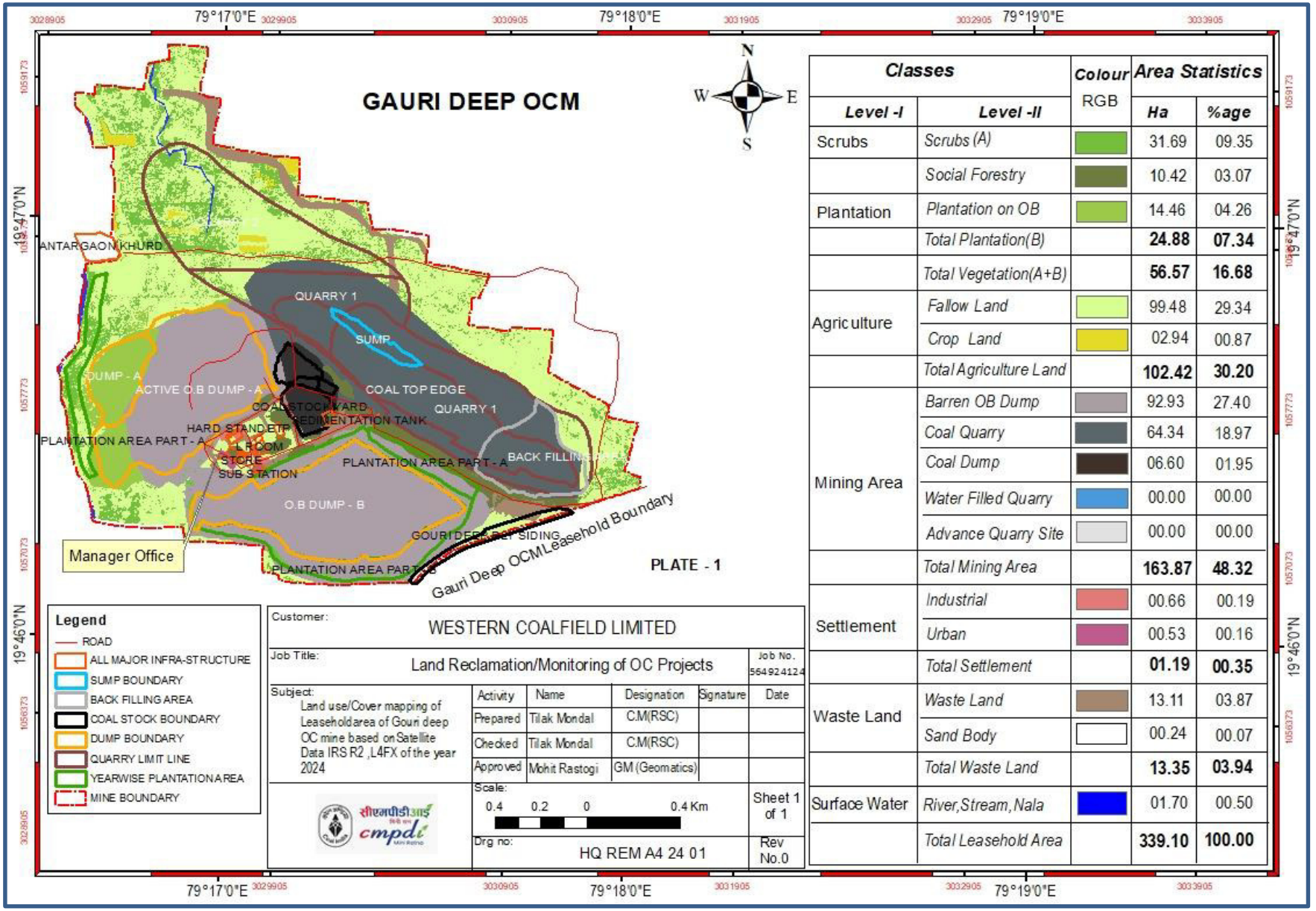
4.6 After analyzing the satellite data of year 2023 vs. 2024 it is evident that total area under plantation (Green cover) carried out under social forestry in above OC mines of WCL has increased from 171.82 Ha (Year 2023) to 223.43 Ha (Year 2024) in the span of one years. This increase of 51.61 Ha area under total plantation in one-year time is due to the sincere efforts made by WCL towards generation of green cover in leasehold area of the 5 opencast projects considered for land reclamation in the year 2024-25.

4.7 Out of 5 projects of WCL, maximum land reclamation has been carried out in Ghonsa OCP (13.41%) followed by Urdhan OCP (12.65%).

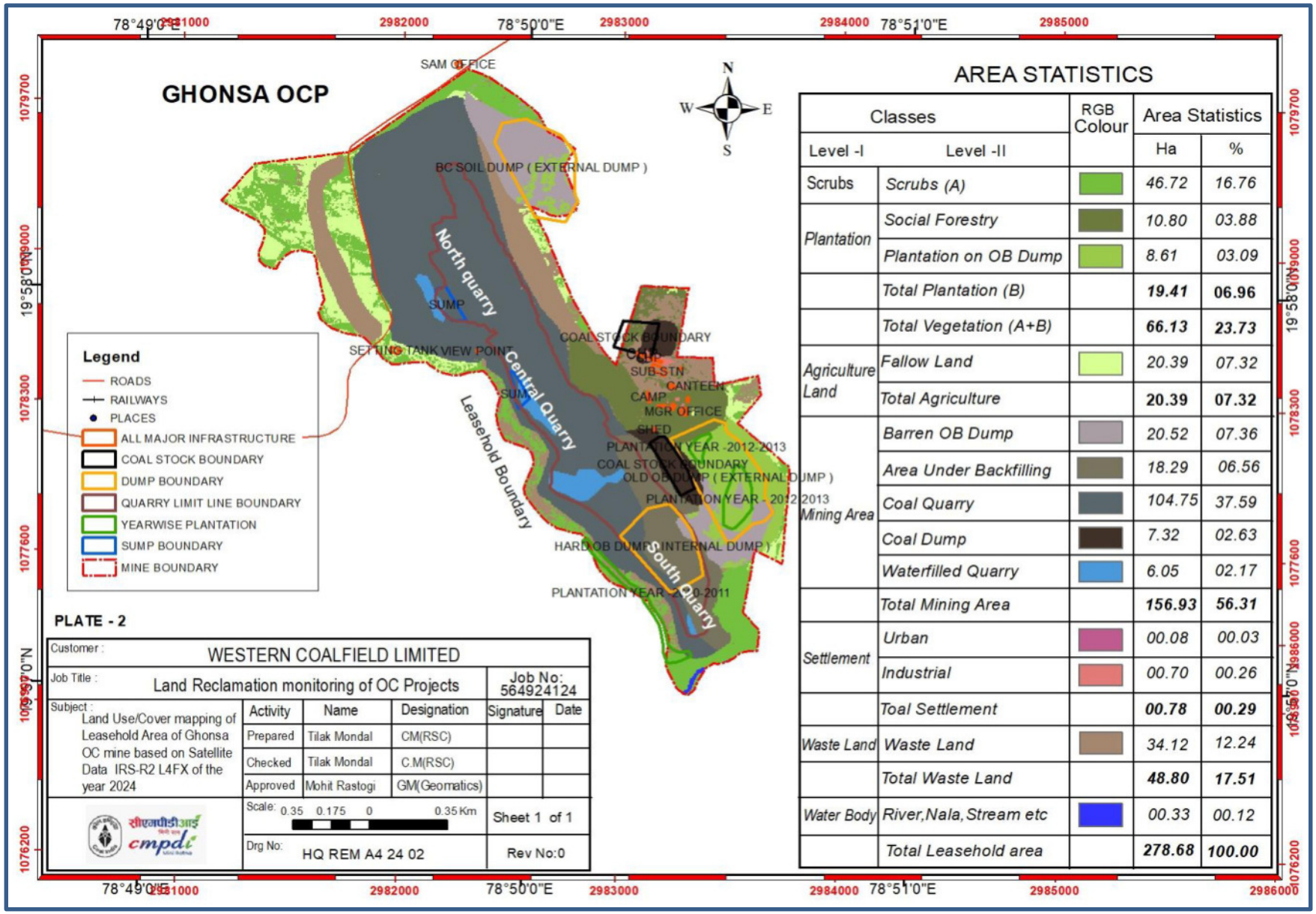
Table 2:
Status of Land Use/Reclamation in OC Mines (<5 M.Cu.M) Of Western Coalfield Ltd based on Satellite Data of the Year 2024

(Area in Hectare)

		Gauri Deep		Ghonsa		Kolegaon		Urdhan		Chhinda		Total	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FORESTS	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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**
SCRUBS	Scrubs	**31.69**	**9.35**	**46.72**	**16.76**	**26.08**	**6.56**	**22.96**	**7.29**	**10.28**	**9.64**	**137.73**	**9.58**
PLANTATION	Social Forestry	10.42	3.07	10.80	3.88	29.70	7.47	11.13	3.53	4.68	4.39	62.05	4.32
	Plantation on OB Dump	14.46	4.26	8.61	3.09	96.67	24.32	15.44	4.90	20.74	19.44	155.92	10.85
	Plantation on Backfill (Biological Reclamation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Plantation	**24.88**	**7.34**	**19.41**	**6.96**	**126.37**	**31.79**	**26.57**	**8.43**	**25.42**	**23.83**	**222.65**	**15.49**
	Total Vegetation	**56.57**	**16.68**	**66.13**	**23.73**	**152.45**	**38.35**	**49.53**	**15.72**	**35.70**	**33.46**	**360.38**	**25.08**
ACTIVE MINING	Coal Quarry	64.34	18.97	104.75	37.59	72.84	18.32	37.04	11.76	25.22	23.64	304.19	21.17
	Coal Dump	6.60	1.95	7.32	2.63	4.71	1.18	12.79	4.06	0.83	0.78	32.25	2.24
	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
	Quarry Filled With Water	0.00	0.00	6.05	2.17	5.23	1.32	1.13	0.36	0.46	0.43	12.87	0.90
	Total Area under *Active Mining*	**70.94**	**20.92**	**118.12**	**42.39**	**82.78**	**20.82**	**50.96**	**16.18**	**26.51**	**24.85**	**349.31**	**24.31**
	Barren OB Dump	92.93	27.40	20.52	7.36	71.49	17.98	76.81	24.38	15.96	14.96	277.71	19.33
	Barren Backfilled Area (Technical Reclamation)	0.00	0.00	18.29	6.56	0.00	0.00	7.38	2.34	0.00	0.00	25.67	1.79
	Total Area	**92.93**	**27.40**	**38.81**	**13.93**	**71.49**	**17.98**	**84.19**	**26.73**	**15.96**	**14.96**	303.38	21.11
	Total Area Under Mine Operation	**163.87**	**48.32**	**156.93**	**56.31**	**154.27**	**38.81**	**135.15**	**42.90**	**42.47**	**39.81**	**652.69**	**45.42**
WASTELANDS	Waste Lands	13.11	3.87	34.12	12.24	44.62	11.22	14.84	4.71	2.35	2.20	109.04	7.59
	Fly Ash Pond / Sand Body	0.24	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.02
	Total Wasteland	**13.35**	**3.94**	**34.12**	**12.24**	**44.62**	**11.22**	**14.84**	**4.71**	**2.35**	**2.20**	**109.28**	**7.60**
WATERBODIES	Reservoir, nallah, ponds	1.70	0.50	0.33	0.12	0.93	0.23	0.00	0.00	0.00	0.00	2.96	0.21
	Total Waterbodies	**1.70**	**0.50**	**0.33**	**0.12**	**0.93**	**0.23**	**0.00**	**0.00**	**0.00**	**0.00**	2.96	0.21
AGRICULTURE	Crop Lands	2.94	0.87	0.00	0.00	0.00	0.00	25.00	7.94	1.56	1.46	29.50	2.05
	Fallow Lands	99.48	29.34	20.39	7.32	42.50	10.69	87.34	27.73	23.54	22.07	273.25	19.02
	Total Agriculture	**102.42**	**30.20**	**20.39**	**7.32**	**42.50**	**10.69**	**112.34**	**35.66**	**25.10**	**23.53**	**302.75**	**21.07**
SETTLEMENTS	Urban Settlement	0.53	0.16	0.08	0.03	0.98	0.25	0.92	0.29	1.06	0.99	3.57	0.25
	Rural Settlement	0.00	0.00	0.00	0.00	0.00	0.00	1.67	0.53	0.00	0.00	1.67	0.12
	Industrial Settlement	0.66	0.19	0.70	0.25	1.77	0.45	0.55	0.17	0.00	0.00	3.68	0.26
	Total Settlement	**1.19**	**0.35**	**0.78**	**0.28**	**2.75**	**0.69**	**3.14**	**1.00**	**1.06**	**0.99**	8.92	0.62
	Grand Total	**339.10**	**100.00**	**278.68**	**100.00**	**397.52**	**100.00**	**315.00**	**100.00**	**106.68**	**100.00**	**1436.98**	**100.00**

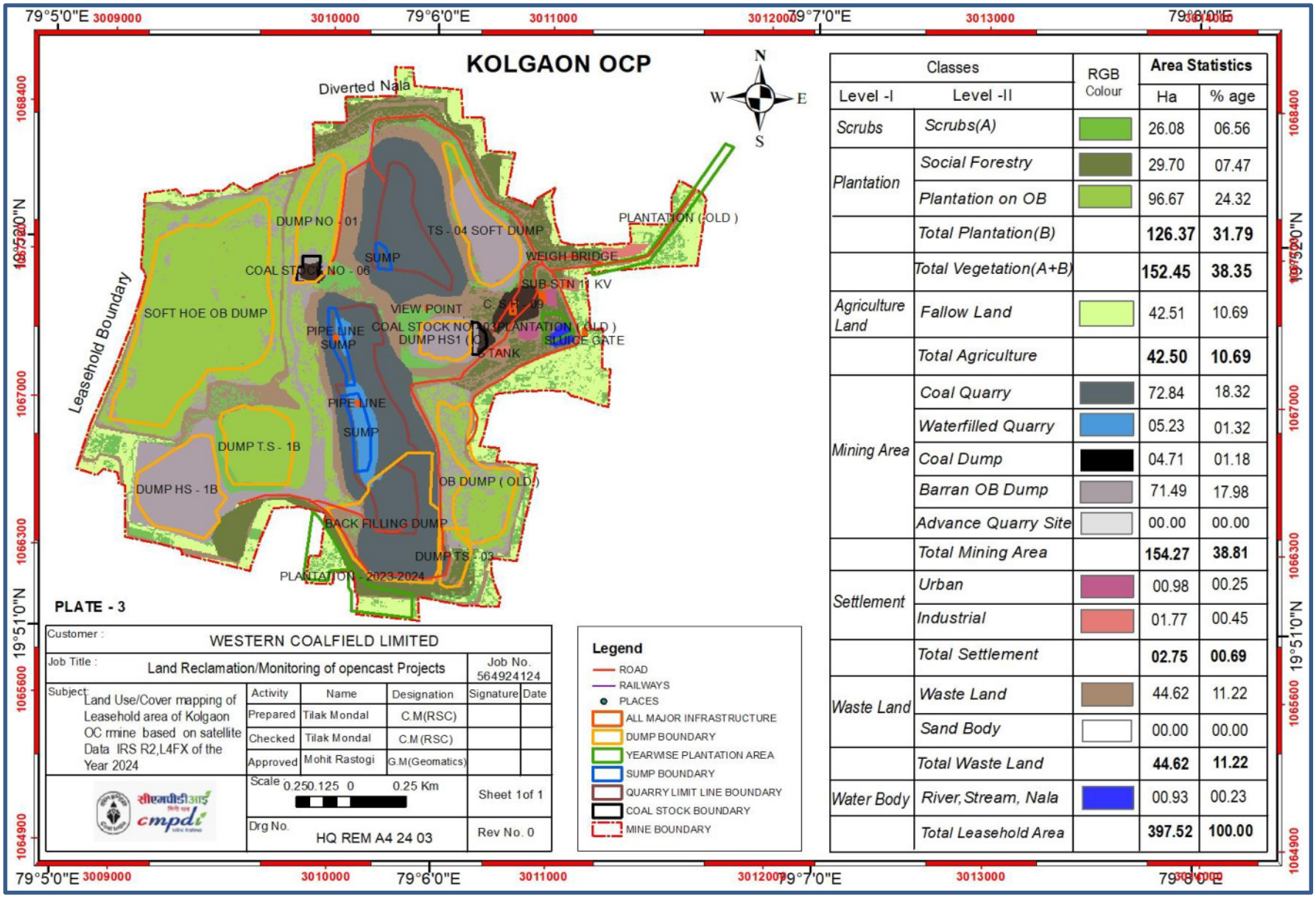


Classes		Colour RGB	Area Statistics	
Level -I	Level -II		Ha	%age
Scrubs	Scrubs (A)		31.69	09.35
	Social Forestry		10.42	03.07
Plantation	Plantation on OB		14.46	04.26
	Total Plantation(B)		**24.88**	**07.34**
	Total Vegetation(A+B)		**56.57**	**16.68**
Agriculture	Fallow Land		99.48	29.34
	Crop Land		02.94	00.87
	Total Agriculture Land		**102.42**	**30.20**
Mining Area	Barren OB Dump		92.93	27.40
	Coal Quarry		64.34	18.97
	Coal Dump		06.60	01.95
	Water Filled Quarry		00.00	00.00
	Advance Quarry Site		00.00	00.00
	Total Mining Area		**163.87**	**48.32**
Settlement	Industrial		00.66	00.19
	Urban		00.53	00.16
	Total Settlement		**01.19**	**00.35**
Waste Land	Waste Land		13.11	03.87
	Sand Body		00.24	00.07
	Total Waste Land		**13.35**	**03.94**
Surface Water	River,Stream,Nala		01.70	00.50
	Total Leasehold Area		**339.10**	**100.00**

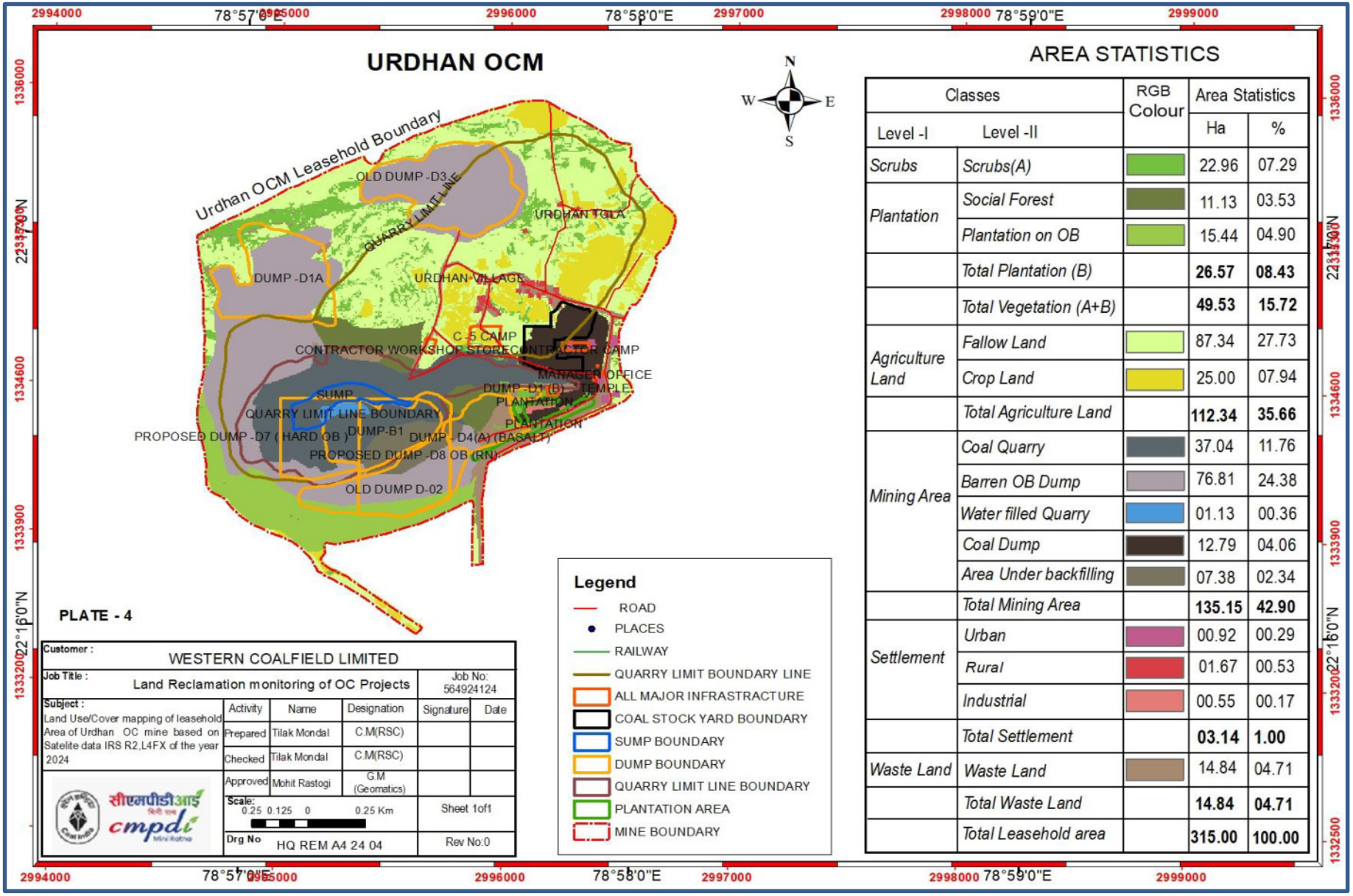


AREA STATISTICS

Classes		RGB Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	*Scrubs (A)*		*46.72*	*16.76*
Plantation	*Social Forestry*		*10.80*	*03.88*
	Plantation on OB Dump		*8.61*	*03.09*
	Total Plantation (B)		***19.41***	***06.96***
	Total Vegetation (A+B)		***66.13***	***23.73***
Agriculture Land	*Fallow Land*		*20.39*	*07.32*
	Total Agriculture		***20.39***	***07.32***
Mining Area	*Barren OB Dump*		*20.52*	*07.36*
	Area Under Backfilling		*18.29*	*06.56*
	Coal Quarry		*104.75*	*37.59*
	Coal Dump		*7.32*	*02.63*
	Waterfilled Quarry		*6.05*	*02.17*
	Total Mining Area		***156.93***	***56.31***
Settlement	*Urban*		*00.08*	*00.03*
	Industrial		*00.70*	*00.26*
	Toal Settlement		***00.78***	***00.29***
Waste Land	*Waste Land*		*34.12*	*12.24*
	Total Waste Land		***48.80***	***17.51***
Water Body	*River,Nala,Stream etc*		*00.33*	*00.12*
	Total Leasehold area		***278.68***	***100.00***



Classes		RGB Colour	Area Statistics	
Level -I	Level -II		Ha	% age
Scrubs	Scrubs(A)		26.08	06.56
Plantation	Social Forestry		29.70	07.47
	Plantation on OB		96.67	24.32
	Total Plantation(B)		**126.37**	**31.79**
	Total Vegetation(A+B)		**152.45**	**38.35**
Agriculture Land	Fallow Land		42.51	10.69
	Total Agriculture		**42.50**	**10.69**
Mining Area	Coal Quarry		72.84	18.32
	Waterfilled Quarry		05.23	01.32
	Coal Dump		04.71	01.18
	Barran OB Dump		71.49	17.98
	Advance Quarry Site		00.00	00.00
	Total Mining Area		**154.27**	**38.81**
Settlement	Urban		00.98	00.25
	Industrial		01.77	00.45
	Total Settlement		**02.75**	**00.69**
Waste Land	Waste Land		44.62	11.22
	Sand Body		00.00	00.00
	Total Waste Land		**44.62**	**11.22**
Water Body	River, Stream, Nala		00.93	00.23
	Total Leasehold Area		**397.52**	**100.00**



AREA STATISTICS

Classes		RGB Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	*Scrubs(A)*		22.96	07.29
Plantation	*Social Forest*		11.13	03.53
	Plantation on OB		15.44	04.90
	Total Plantation (B)		**26.57**	**08.43**
	Total Vegetation (A+B)		**49.53**	**15.72**
Agriculture Land	*Fallow Land*		87.34	27.73
	Crop Land		25.00	07.94
	Total Agriculture Land		**112.34**	**35.66**
Mining Area	*Coal Quarry*		37.04	11.76
	Barren OB Dump		76.81	24.38
	Water filled Quarry		01.13	00.36
	Coal Dump		12.79	04.06
	Area Under backfilling		07.38	02.34
	Total Mining Area		**135.15**	**42.90**
Settlement	*Urban*		00.92	00.29
	Rural		01.67	00.53
	Industrial		00.55	00.17
	Total Settlement		**03.14**	**1.00**
Waste Land	*Waste Land*		14.84	04.71
	Total Waste Land		**14.84**	**04.71**
	Total Leasehold area		**315.00**	**100.00**

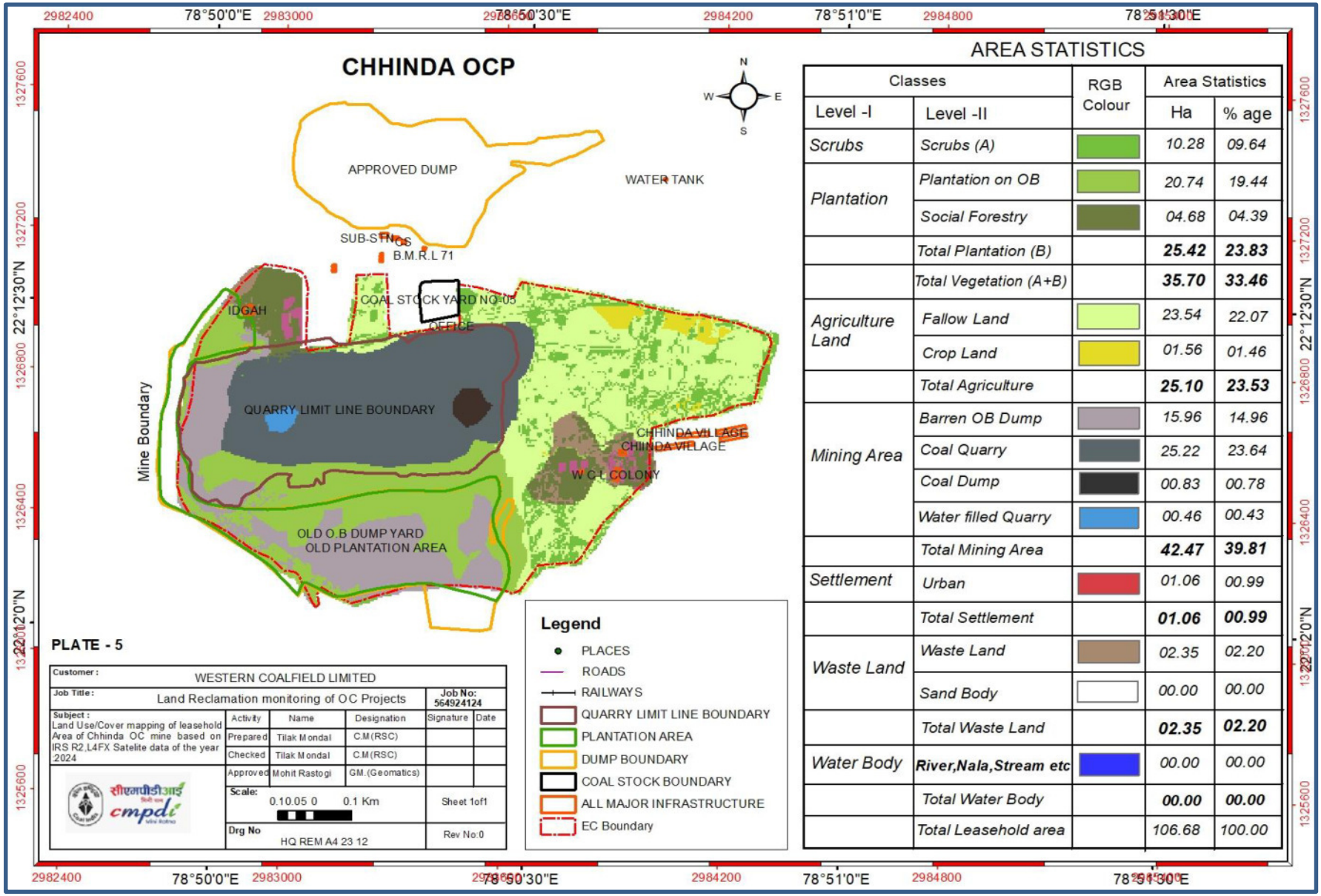


PLATE - 5

Customer:	WESTERN COALFIELD LIMITED				
Job Title:	Land Reclamation monitoring of OC Projects			Job No: 564924124	
Subject: Land Use/Cover mapping of leasehold Area of Chhinda OC mine based on IRS R2,L4FX Satelite data of the year 2024	Activity	Name	Designation	Signature	Date
	Prepared	Tilak Mondal	C.M(RSC)		
	Checked	Tilak Mondal	C.M(RSC)		
	Approved	Mohit Rastogi	GM.(Geomatics)		
	Scale: 0.10.05 0 0.1 Km			Sheet 1of1	
	Drg No HQ REM A4 23 12			Rev No:0	

Legend

- PLACES
- ROADS
- RAILWAYS
- QUARRY LIMIT LINE BOUNDARY
- PLANTATION AREA
- DUMP BOUNDARY
- COAL STOCK BOUNDARY
- ALL MAJOR INFRASTRUCTURE
- EC Boundary

AREA STATISTICS

Classes		RGB Colour	Area Statistics	
Level -I	Level -II		Ha	% age
Scrubs	Scrubs (A)		10.28	09.64
Plantation	Plantation on OB		20.74	19.44
	Social Forestry		04.68	04.39
	Total Plantation (B)		**25.42**	**23.83**
	Total Vegetation (A+B)		**35.70**	**33.46**
Agriculture Land	Fallow Land		23.54	22.07
	Crop Land		01.56	01.46
	Total Agriculture		**25.10**	**23.53**
Mining Area	Barren OB Dump		15.96	14.96
	Coal Quarry		25.22	23.64
	Coal Dump		00.83	00.78
	Water filled Quarry		00.46	00.43
	Total Mining Area		**42.47**	**39.81**
Settlement	Urban		01.06	00.99
	Total Settlement		**01.06**	**00.99**
Waste Land	Waste Land		02.35	02.20
	Sand Body		00.00	00.00
	Total Waste Land		**02.35**	**02.20**
Water Body	River,Nala,Stream etc		00.00	00.00
	Total Water Body		**00.00**	**00.00**
	Total Leasehold area		106.68	100.00

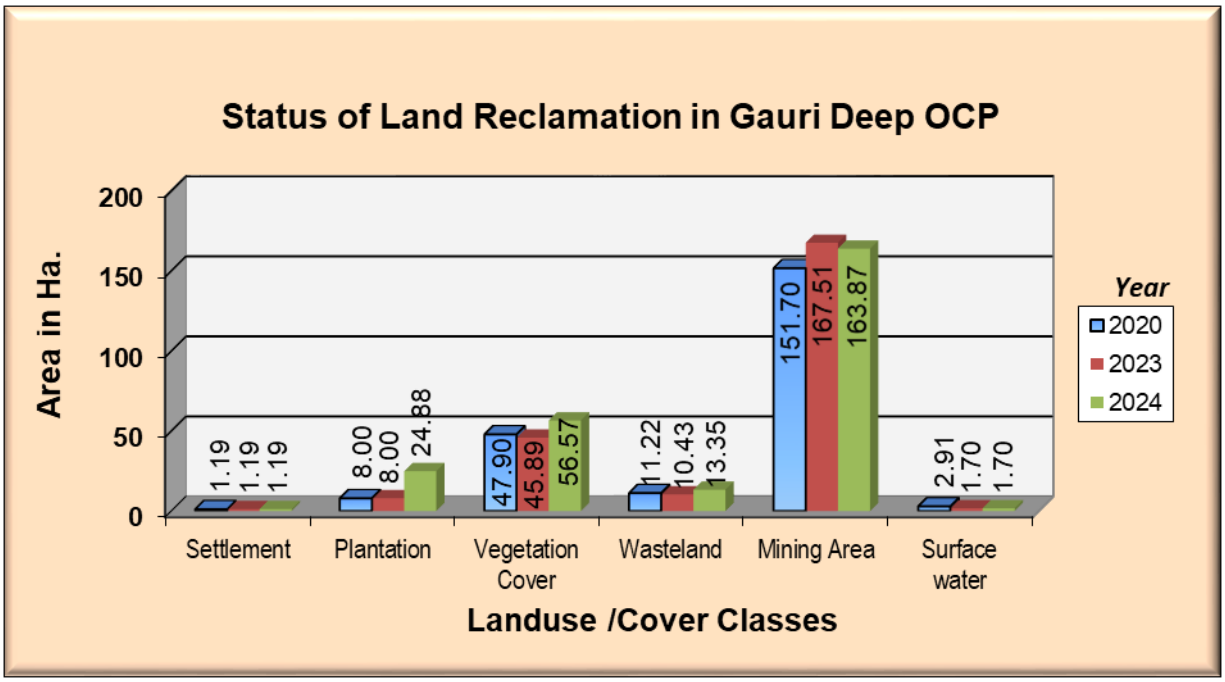


Figure-4

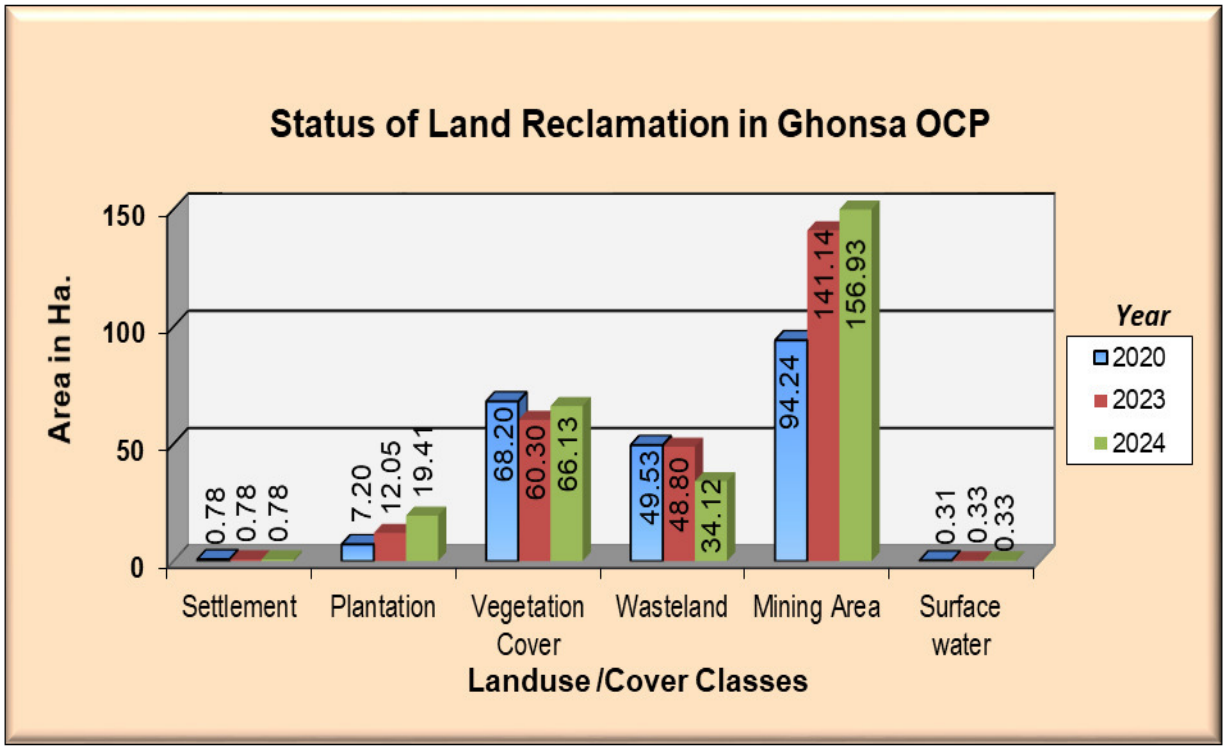


Figure-5

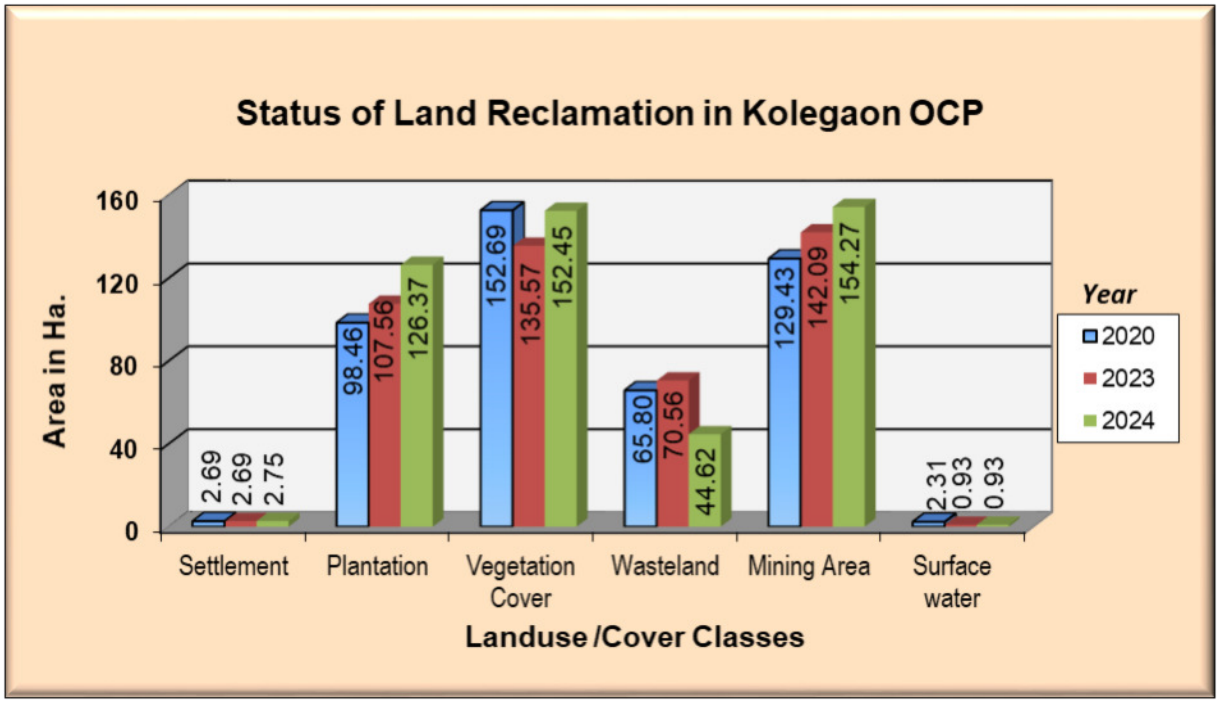


Figure-6

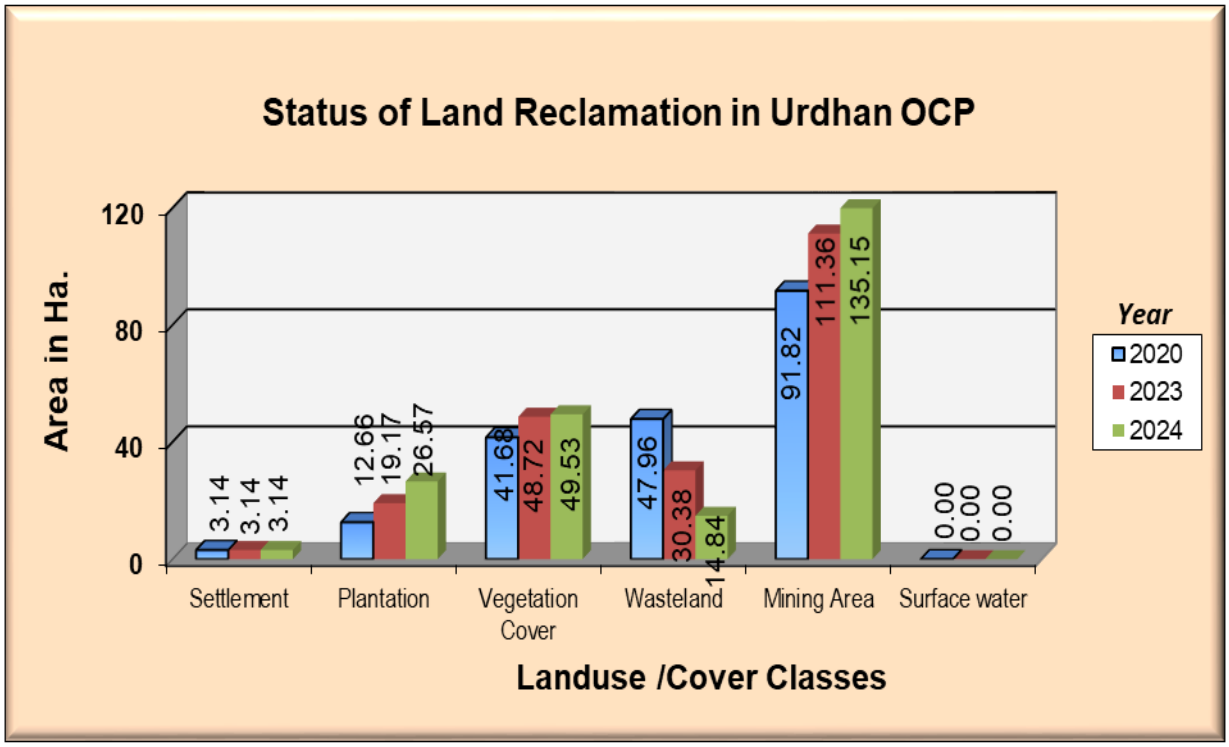


Figure-7

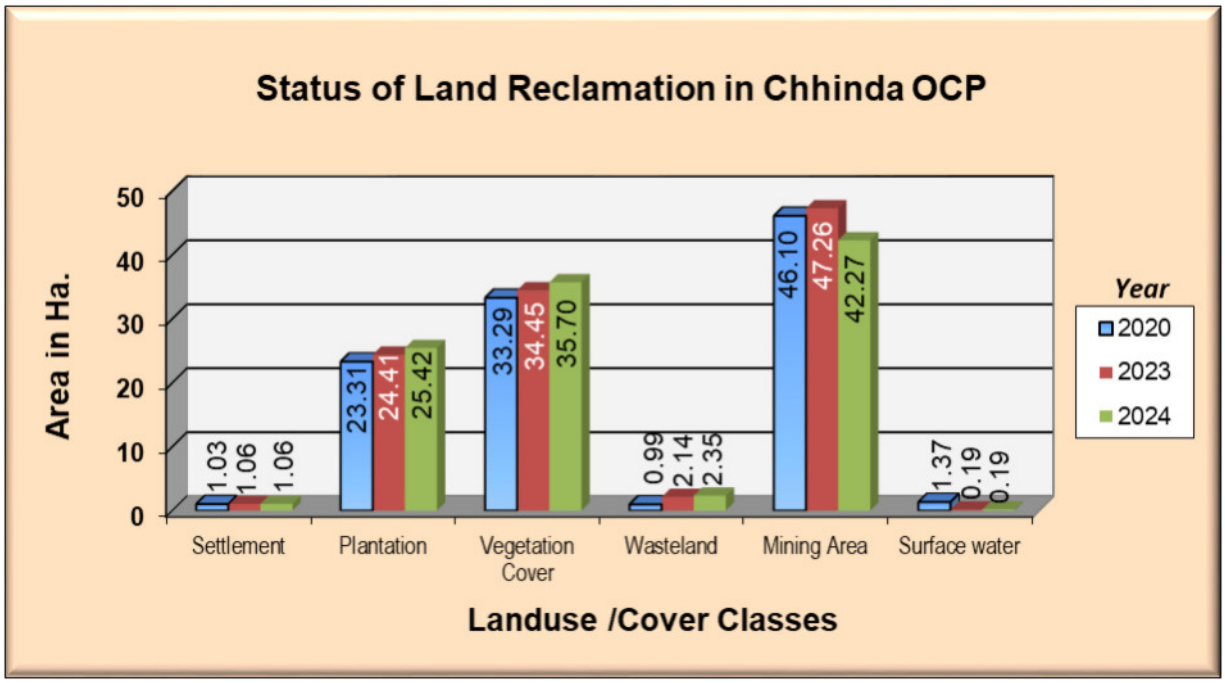
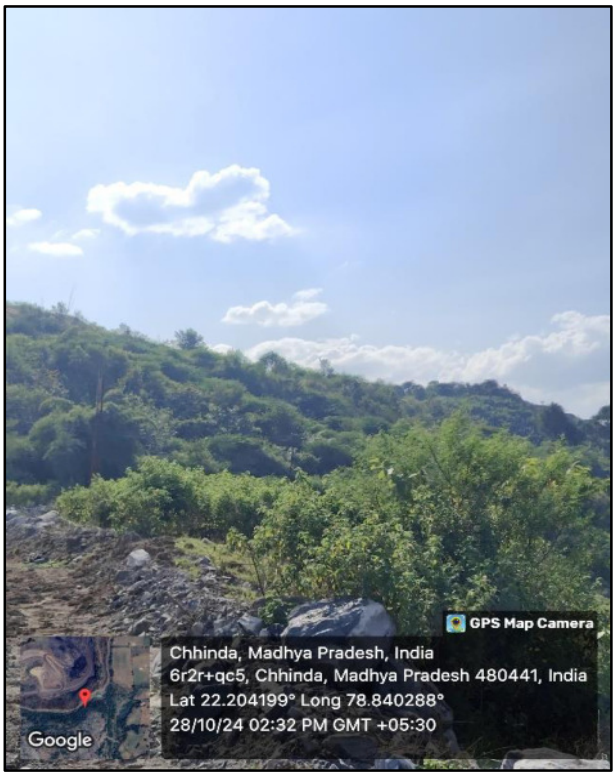

Status of Land Reclamation in Chhinda OCP
Area in Ha.
50
40
30
20
10
0
1.03
1.06
1.06
23.31
24.41
25.42
33.29
34.45
35.70
0.99
2.14
2.35
46.10
47.26
42.27
1.37
0.19
0.19
Settlement
Plantation
Vegetation Cover
Wasteland
Mining Area
Surface water
Landuse /Cover Classes
Year
2020
2023
2024

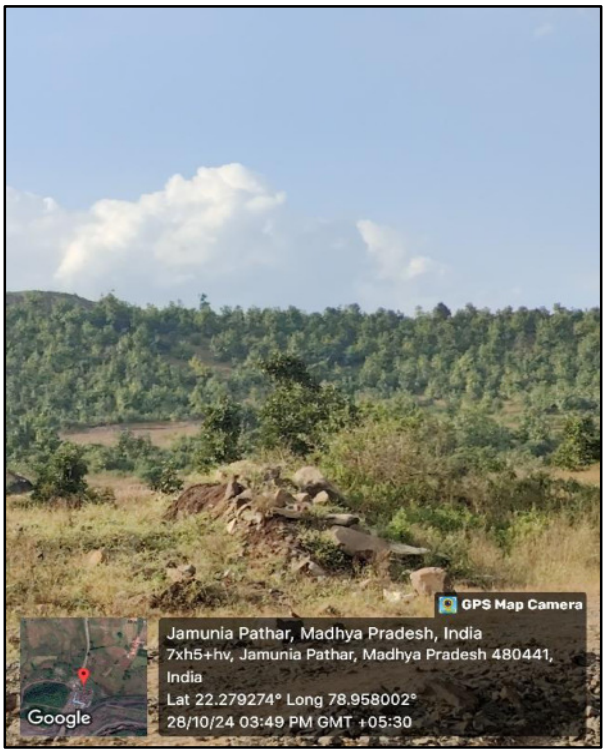
Figure -8

Photograph 1: Plantation under social forestry in Gauri Deep OC Project

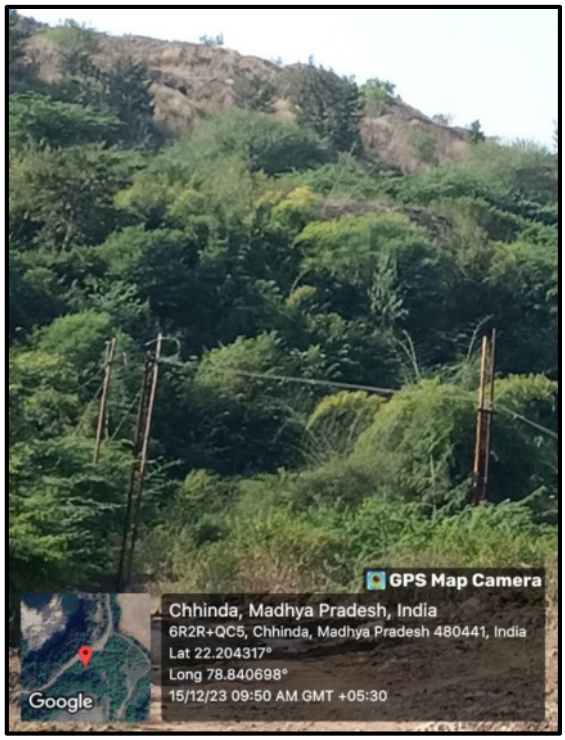


Photograph 2: Plantation on Barren OB in Chhinda OCP

Photograph 3: Social Forestry Plantation in Kolegaon OCP



Photograph 4: Plantation on Barren OB Dump in Urdhan OCP



Photograph 5: Plantation on OB in Chhinda OCP

Note- No recent plantation has been carried out at Ghonsa OCP.

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	पृष्टभूमि
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	तकनिकी पुनरुधार
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 त्रुटियँ।
32	Error	अशुद्धियाँ
33	Curvature	वक्रता
34	Geometric	ज्यामितिक
35	Distortion	विरुपण
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 त्तैयारी
58	Ground Truthing	भू-सत्यापन
59	Ground Information	भू- सुचना
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

Central Mine Planning & Design Institute Ltd.

(A Subsidiary of Coal India Ltd.)

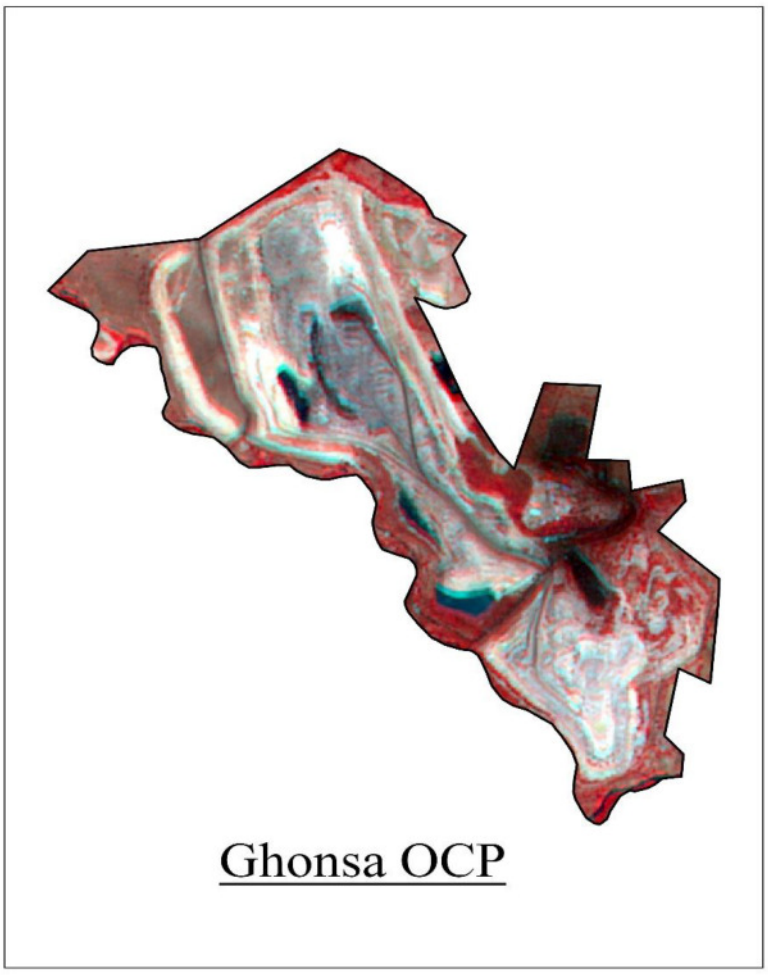
Gondwana Place, Kanke Road, Ranchi 834031, Jharkhand

Phone: (+91) 651 2230001, 2230002, 2230483, FAX (+91) 651 2231447, 2231851

Website : www.cmpdi.co.in, Email : cmpdihq@cmpdi.co.in

वेस्टर्न कोल्फील्ड्स लिमिटेड के ५ मिलियन घन मीटर (कोल + अधिभार) से कम उत्पादन क्षमतावाले ५ खुली खदानों का भूमि पुनरुद्धार हेतु २०२४ के उपग्रह डाटा के आधार पर निगरानी का प्रतिवेदन

Land Restoration / Reclamation Monitoring of 5 opencast projects of Western Coalfield Limited producing less than 5 million Cu. M. (Coal+OB) per annum based on Satellite Data of the Year 2024



Submitted to

WESTERN COALFIELDS LIMITED

वेस्टर्न कोल्फील्ड्स लिमिटेड के ५ मिलियन घन मीटर (कोल + अधिभार) से कम उत्पादन क्षमतावाले ५ खुली खदानों का भूमि पुनरुद्धार हेतु २०२४ के उपग्रह डाटा के आधार पर निगरानी का प्रतिवेदन

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March-2025

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

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(8) Aim of the Report	To prepare land use/cover map of leasehold area of 05 opencast projects based on high resolution satellite data (IRSR2-L4FX) of the year 2024 using digital image processing technique.
(9) Executing Unit	Remote Sensing Cell, Geomatics Division, Central Mine Planning & Design Institute Limited, Gondwana Place, Kanke Road, Ranchi 834008
(10) User Agency	Western Coalfields Ltd., Nagpur, Maharashtra.
(11) Author	1) Swabhiman Dehariya, Asst. Manager (Mining/Geomatics) 2) Tilak Mondal, Chief Manager (E&M /Geomatics)
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कार्यकारी सारांश

१.० परियोजना वेस्टर्न कोल्फील्ड्स लिमिटेड के ५ मिलियन घन मीटर (कोल+ अधिभार) से कम उत्पादन क्षमतावाले ५ खुली खदानों के पुनरुद्धार हेतु वर्ष २०२४ 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 ड्रेनेज), 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 २०२४-२५ में कुल ०५ खुली खदान परियोजनाओं में भूमि सुधार की स्थिति की निगरानी पर विचार किया गया है। (<5 एमसीएम कोयला+ओबी)

- वर्ष २०२४-२५ में भूमि पुनरुद्धार (लैंड रिक्लेमेशन) हेतु चयन किये गए कुल ०५ खुली खदान परियोजनाओं यथा: कोलेगांव, घोंसा, उर्धन, गौरी डीप छिंदा का कुल पट्टाक्षेत्र अथवा माइन लीज होल्ड एरिया १४३६.९८ हेक्टेयर है जिसमें ३७४.९८ हेक्टेयर उत्खनन क्षेत्र के अंतर्गत है तथा २५.६७ हेक्टेयर (६.८५%) क्षेत्र में तकनीकी पुनरुद्धार (बैकफीलिंग) का कार्य प्रगति पर है और शेष ३४९.३१ हेक्टेयर (९३.१५%) क्षेत्र सक्रिय खनन के अन्तर्गत है। विश्लेषण से यह स्पष्ट है कि वर्ष २०२४-२५ के लिए कोई जैविक पुनरुद्धार यानी बैकफिल पर वृक्षारोपण नहीं किया गया 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 २०२४-२५ में ५ 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 २०२३-२४ के १६.५१ हेक्टेयर की तुलना में वर्ष २०२४-२५ में बढ़कर २५.९३ 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 ९.४२ 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।

- तालिका 1.1 में डब्ल्यूसीएल (<5 एमसीएम कोयला+ओबी) की शेष खानों में भूमि पुनरुद्धार (लैंड रिक्लेमेशन) सामूहिक रूप से दर्शाया गया हे।

- कुल वृक्षारोपण (हरित आवरण), बैकफ़िल पर किए गए वृक्षारोपण, बंजर अधिभार डंप पर किए गए वृक्षारोपण, सामाजिक वानिकी के तहत किए वृक्षारोपण के तहत आने वाले क्षेत्र का क्षेत्रफल वर्ष २०२३-२४ में १७१.८२ हेक्टेयर से बढ़कर वर्ष २०२४-२५ में २२३.४३ हेक्टेयर हो गया है।

Executive Summary

1.0 Project

Land restoration / reclamation monitoring of 5 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 5 no. of OC projects have been considered for monitoring the status of land reclamation in the year 2024-25

- Out of the total mine leasehold area of 1436.98 Hectare of the 5 OC projects Viz. Gauri Deep, Ghonsa, Kolegaon, Urdhan, and Chhinda considered for monitoring during the year 2024-25; total excavated area is only 374.98 Ha out of which 25.67 Ha area (6.85%) is under backfilling (Technically Reclaimed) and 349.31 Ha (93.15%) area is under active mining. It is evident from the analysis that there is no biological reclamation i.e. plantation on backfill for the year 2024-25. Project wise details are given in Table-1 & bar chart Fig1.

- On comparing the status of land reclamation carried out for 5 nos of OC projects in year 2024-25 with respect to previous cycle study

in WCL, it is evident from analysis that area under land reclamation has increased from 16.51 Hectares (Yr 2023-24) to 25.93 Hectares (Yr 2024-25) which includes both planation on backfill (Biological Reclamation) and area under backfilling (Technical Reclamation). This increase of 9.42 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.

- Table 1.1 Show the Composite land reclamation status in remaining mines of WCL (<5 MCM Coal+OB) as per clause 2.(ii) of the received work order from CIL.

- Overall, total area under plantation (green cover) carried out on backfill, barren OB dump and plantation under social forestry has gone up from 171.82 Hectares in the year 2023-24 to 223.43 Hectares in the year 2024-25.

Table-1

Project wise Land Reclamation Status in Opencast Projects of WCL (<5 MCM Coal+OB) based on Satellite Data of the year 2024-25

(Area in Hectare)

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, Avenue Plantation Etc.									
1	*2*	*3*		*4*		*5*		*6*		*7*		*8*		*9 (=4+5+8)*		*10 (=5+6+7)*		*11(=4+5)*	
		2023	*2024*	*2023*	*2024*	*2023*	*2024*	*2023*	*2024*	*2023*	*2024*	*2023*	*2024*	*2023*	*2024*	*2023*	*2024*	*2023*	*2024*
1	Gauri Deep	339.10	339.10	0.00	0.00	0.00	0.00	0.00	14.46	8.00	10.42	62.77	70.94	62.77	70.94	8.00	24.88	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			2.36%	7.34%	0.00%	0.00%
2	Ghonsa	278.68	278.68	11.59	18.29	0.00	0.00	5.51	8.61	6.54	10.80	98.39	118.12	109.98	136.41	12.05	19.41	11.59	18.29
				10.54%	13.41%	0.00%	0.00%					89.46%	86.59%			4.32%	6.96%	10.54%	13.41%
3	Kolegaon	397.52	397.52	0.00	0.00	0.00	0.00	83.45	96.67	24.11	29.70	67.64	82.78	67.64	82.78	107.56	126.37	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			27.06%	31.79%	0.00%	0.00%
4	Urdhan	315.00	315.00	4.70	7.38	0.00	0.00	10.15	15.44	9.02	11.13	38.06	50.96	42.76	58.34	19.17	26.57	4.70	7.38
				10.99%	12.65%	0.00%	0.00%					89.01%	87.35%			6.09%	8.43%	10.99%	12.65%
5	Chinda	106.68	106.68	0.00	0.00	0.00	0.00	20.11	20.74	4.30	4.68	23.81	26.51	23.81	26.51	24.41	25.42	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			22.88%	23.83%	0.00%	0.00%
	Total (A)	**1436.98**	**1436.98**	**16.29**	**25.67**	**0.00**	**0.00**	**119.22**	**155.92**	**51.97**	**66.73**	**290.67**	**349.31**	**306.96**	**374.98**	**171.82**	**223.43**	**16.51**	**25.93**
		A		**5.31%**	**6.85%**	**0.00%**	**0.00%**					**94.69%**	**93.15%**			**11.96%**	**15.55%**	**5.38%**	**6.92%**

(%) calculated is in respect to Total Excavated Area as applicable

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”.

Table-1.1

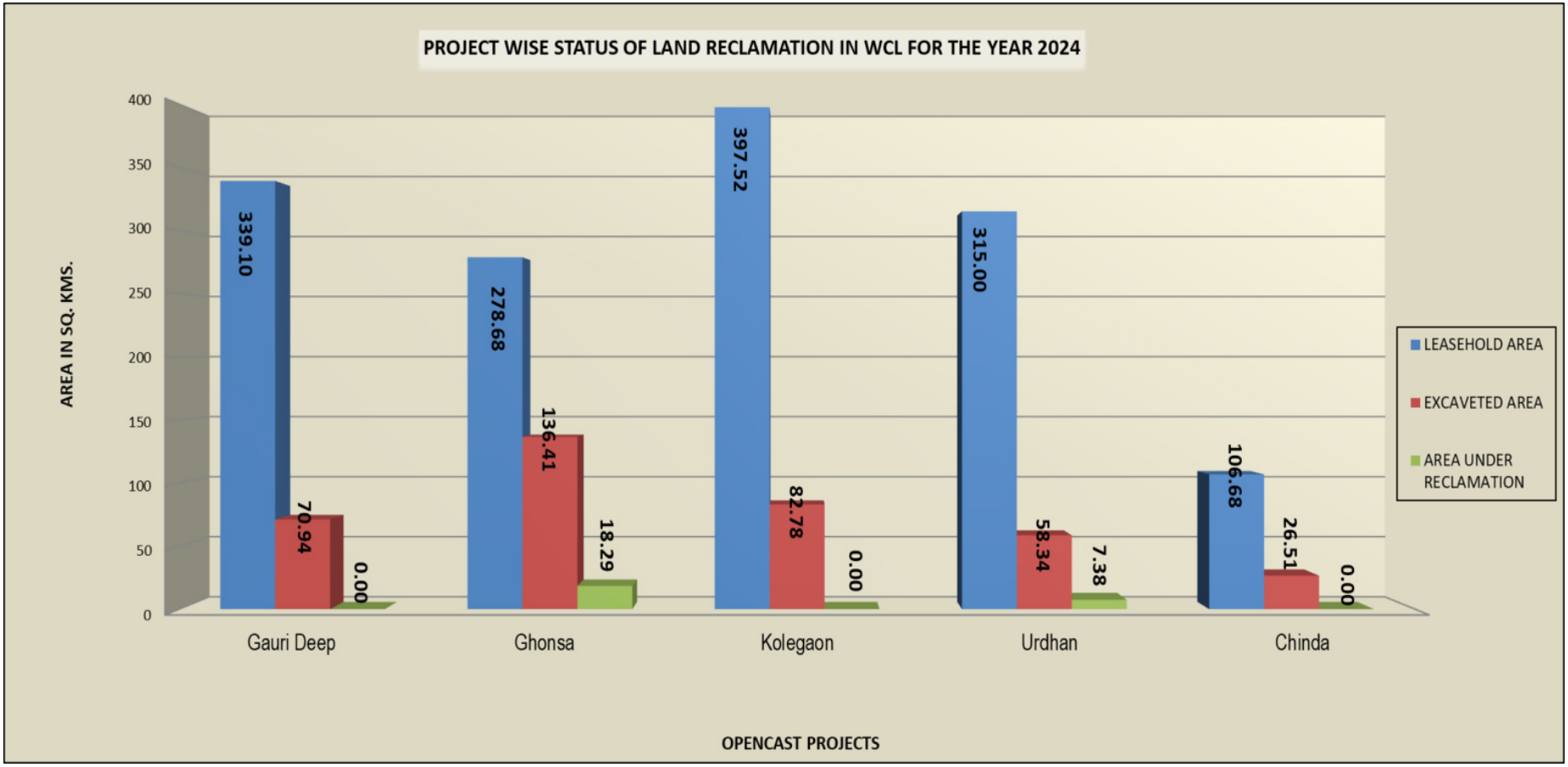
Composite land reclamation status in remaining mines of WCL (<5 MCM Coal+OB) as per clause 2.(ii) of the received work order from CIL

(Area in Hectare)

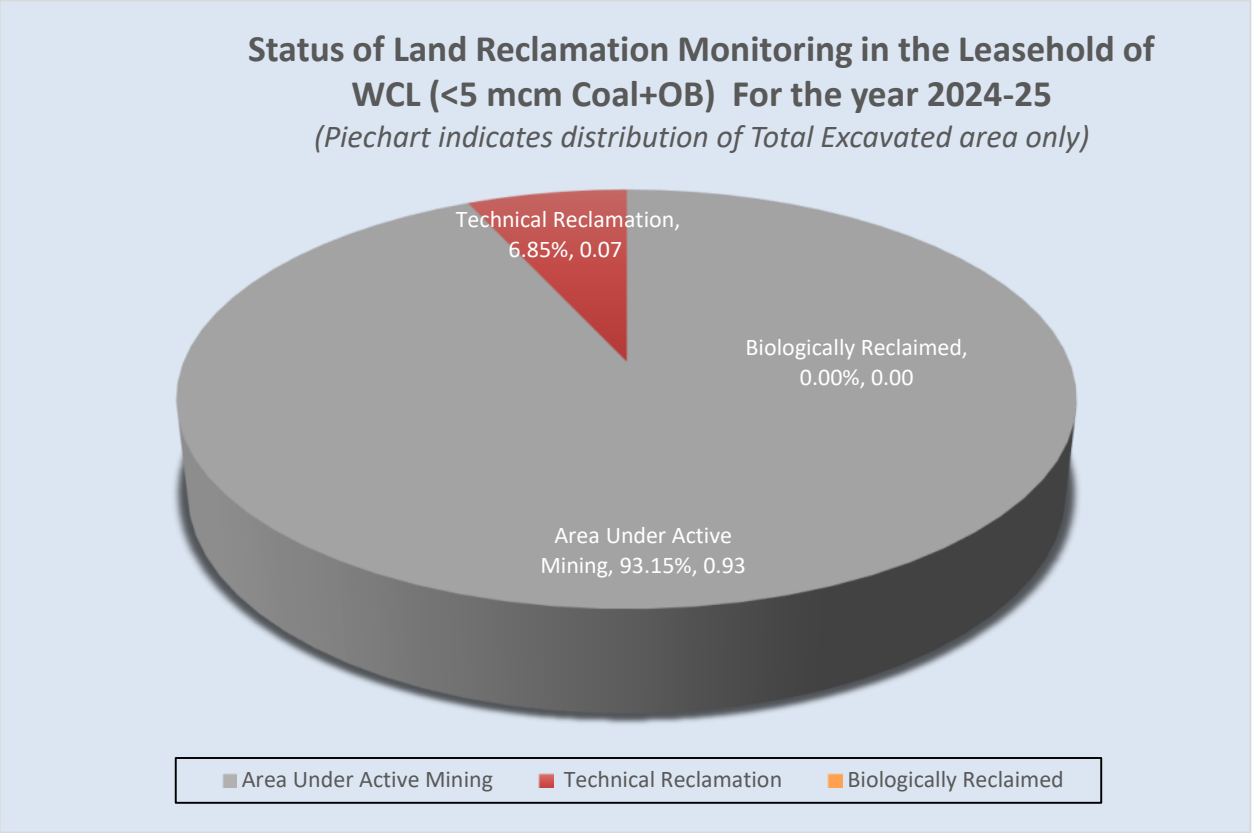
Sl.No.	Cluster No.	Total Leasehold Area		Technical Reclamation		Plantation						Area under Active Mining		Total Excavated Area		Total Area under Plantation (% Green Cover Generated in Leasehold)		Total Area under Reclamation	
						Biological		Other Plantations											
				Area under Backfilling		Plantation on Excavated / Backfilled Area		Plantation on External OB Dumps		Social Forestry, Avanue Plantation Etc.									
1	*2*	*3*		*4*		*5*		*6*		*7*		*8*		*9 (=4+5+8)*		*10 (=5+6+7)*		*11(=4+5)*	
		2022	*2023*	*2022*	*2023*	*2022*	*2023*	*2022*	*2023*	*2022*	*2023*	*2022*	*2023*	*2022*	*2023*	*2022*	*2023*	*2022*	*2023*
6	Padmapur OC **	829.00	829.00	59.00	65.00	28.00	28.00	214.00	221.00	83.00	83.00	118.00	112.00	205.00	205.00	325.00	332.00	87.00	93.00
				28.78%	31.71%	13.66%	13.66%					57.56%	54.63%			39.20%	40.05%	42.44%	45.37%
	TOTAL (B)	**829.00**	**829.00**	**59.00**	**65.00**	**28.00**	**28.00**	**214.00**	**221.00**	**83.00**	**83.00**	**118.00**	**112.00**	**205.00**	**205.00**	**325.00**	**332.00**	**87.00**	**93.00**
				28.78%	**31.71%**	**13.66%**	**13.66%**					**57.56%**	**54.63%**			**39.20%**	**40.05%**	**42.44%**	**45.37%**
		2019	*2022*	*2019*	*2022*	*2019*	*2022*	*2019*	*2022*	*2019*	*2022*	*2019*	*2022*	*2019*	*2022*	*2019*	*2022*	*2019*	*2022*
7	Singhori OC	425.04	425.04	0.00	0.00	0.00	0.00	0.00	0.00	4.59	7.63	26.82	50.56	26.82	50.56	4.59	7.63	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			1.08%	1.80%	0.00%	0.00%
8	Makardhokra -II OC	258.23	258.23	44.61	57.75	2.90	0.00	58.76	47.14	2.57	2.57	6.91	0.00	54.42	57.75	64.23	49.71	47.51	57.75
				81.97%	100.00%	5.33%	0.00%					12.70%	0.00%			24.87%	19.25%	87.30%	100.00%
9	New Sethia OC	144.45	144.45	25.99	30.65	23.58	18.92	6.80	7.01	9.53	10.15	40.81	41.65	90.38	91.22	39.91	36.08	49.57	49.57
				28.76%	33.60%	26.09%	20.74%					45.15%	45.66%			27.63%	24.98%	54.85%	54.34%
10	Ghugus OC	1020.00	1020.00	267.70	258.74	55.38	73.22	135.00	136.64	84.91	125.20	35.77	26.89	358.85	358.85	275.29	335.06	323.08	331.96
				0.00%	72.10%	0.00%	20.40%					0.00%	7.49%			26.99%	32.85%	0.00%	92.51%
11	Pimpalgaon OC	451.87	451.87	13.33	13.34	0.00	0.00	136.11	149.76	80.32	79.62	46.25	54.23	59.58	67.57	216.43	229.38	13.33	13.34
				0.00%	19.74%	0.00%	0.00%					0.00%	80.26%			47.90%	50.76%	0.00%	19.74%
	TOTAL (C)	**2299.59**	**2299.59**	**351.63**	**360.48**	**81.86**	**92.14**	**336.67**	**340.55**	**181.92**	**225.17**	**156.56**	**173.33**	**590.05**	**625.95**	**600.45**	**657.86**	**433.49**	**452.62**
				59.59%	**57.59%**	**13.87%**	**14.72%**					**26.53%**	**27.69%**			**26.11%**	**28.61%**	**73.47%**	**72.31%**
		2018	*2021*	*2018*	*2021*	*2018*	*2021*	*2018*	*2021*	*2018*	*2021*	*2018*	*2021*	*2018*	*2021*	*2018*	*2021*	*2018*	*2021*
12	Shivpuri OC	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%
13	Ghorawar OC	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%
14	Barkuhi OC	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%
15	Ambara OC	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 (D)	**2031.96**	**2031.96**	**109.22**	**149.04**	**28.49**	**40.23**	**48.01**	**48.61**	**50.24**	**58.47**	**110.57**	**117.80**	**248.28**	**307.07**	**126.74**	**147.31**	**137.71**	**189.27**
				43.99%	**48.54%**	**11.47%**	**13.10%**					**44.53%**	**38.36%**			**6.24%**	**7.25%**	**55.47%**	**61.64%**
	***GRAND TOTAL (A+B+C+D)**	**6597.53**	**6597.53**	**536.14**	**600.19**	**138.35**	**160.37**	**717.90**	**766.08**	**367.13**	**433.37**	**675.80**	**752.44**	**1350.29**	**1513.00**	**1224.01**	**1360.60**	**674.71**	**760.82**
				39.71%	**39.67%**	**10.25%**	**10.60%**					**50.05%**	**49.73%**			**18.55%**	**20.62%**	**49.97%**	**50.29%**

**Grand Total (A+B+C+D) is the composite value of all 15 mines of WCL covered in 3 years cycle of Land Reclamation Monitoring* *(% is calculated with respect to Excavated Area as applicable)*

** The Land Reclamation Monitoring for this mine was previously conducted under the category of more than 5 MTY capacity. For normalized calculations, the data from this mines has been converted from Sq.Kms to Ha.



Flg.1: Land Reclamation Status in OC projects producing less than 5mcm (Coal +OB) of WCL in the Year 2024



Flg.2: Land Reclamation Status of Total Excavated area in OC projects of WCL (<5 MCM Coal+OB) in the Year 2024

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^3 per annum (coal + OB taken together per annum) based on remote sensing satellite data regularly on annual basis and less than 5 million m^3 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. Again the above work order has been renewed vide letter no. CIL/ ENV/11463 dated 03.07.2024 for a period of 3 more years for 2024-25, 2025-26 and 2026-27. 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 & 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 2024 carried out for the 5 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. Bhoonidhi Portal of ISRO alongside 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-3. Following steps are involved in land reclamation /restoration monitoring:

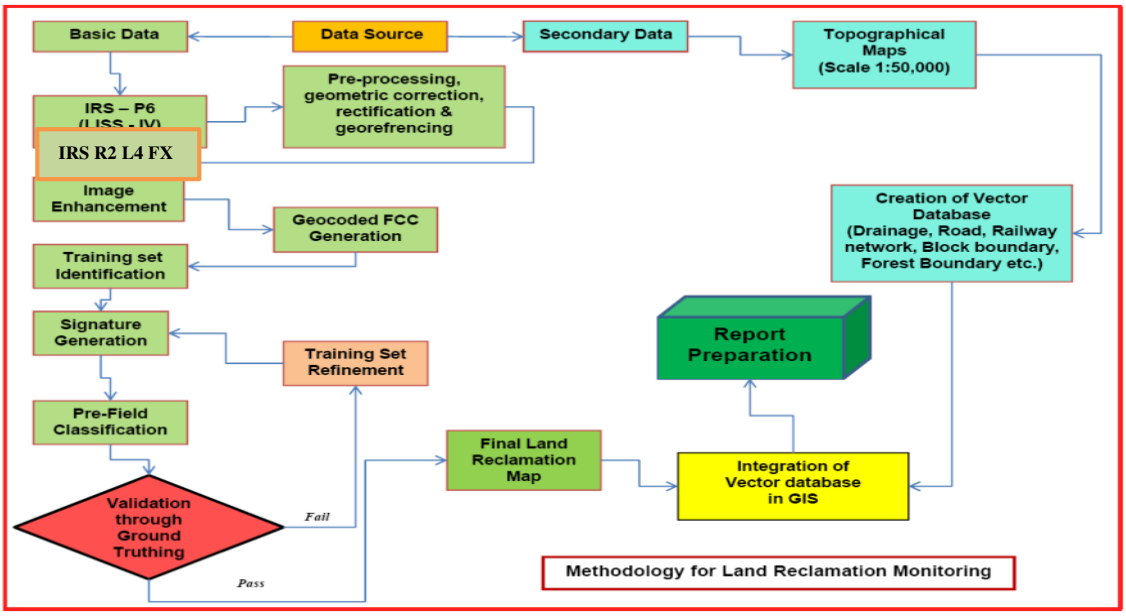


Figure :3 Methodology for Land Reclamation Monitoring

3.1 Data Procurement: After browsing the data quality and date of pass on internet, supply order for data is placed to NRSC or if available downloaded directly from the Bhoonidhi portal. 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 & ArcMap10.8 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 SoI 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 5 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 2024-25:

- Gouri Deep
- Ghonsa
- Kolegaon
- Urdhan
- Chhinda

4.2 Area statistics of different land use class present in the mine leasehold of the above projects for the year 2024 are shown in the Table - 2. Land use maps derived from satellite data of year 2024 are shown in Plate 1 - 5. This time both local grid and UTM grid is used for map preparation along with all essential boundaries shape file such as Quarry limit line, Sump, OB Dump, EC Boundary, Plantation area etc. as per the work order from CIL. Changes in the different land use classes based on satellite data are depicted in Bar Charts in Fig. 4- 8.

4.3 Study reveals that out of total mine leasehold area of 1436.98 Hectare of the 5 projects viz, Gauri Deep, Ghonsa, Kolegaon, Urdhan and Chhinda considered for monitoring during year 2024-25; total excavated area is 374.98 Ha, out of which 25.67 Ha (6.85%) area is under backfilling (Technically Reclaimed) and balance 349.31 Ha (93.15%) area is under active mining. It is evident from analysis that there is no biological reclamation i.e. plantation on backfill. Project wise details area given in Table 1.

4.4 From analysis it is revealed that total area under technical reclamation (area under backfilling) has also increased from 16.29 Ha (5.31%) in the year 2023 to 25.67 Ha (6.85%) area in the year 2024.

4.5 Study indicates that overall the projects of WCL considered for this study indicate increase in technical reclamation i.e. area under backfilling.

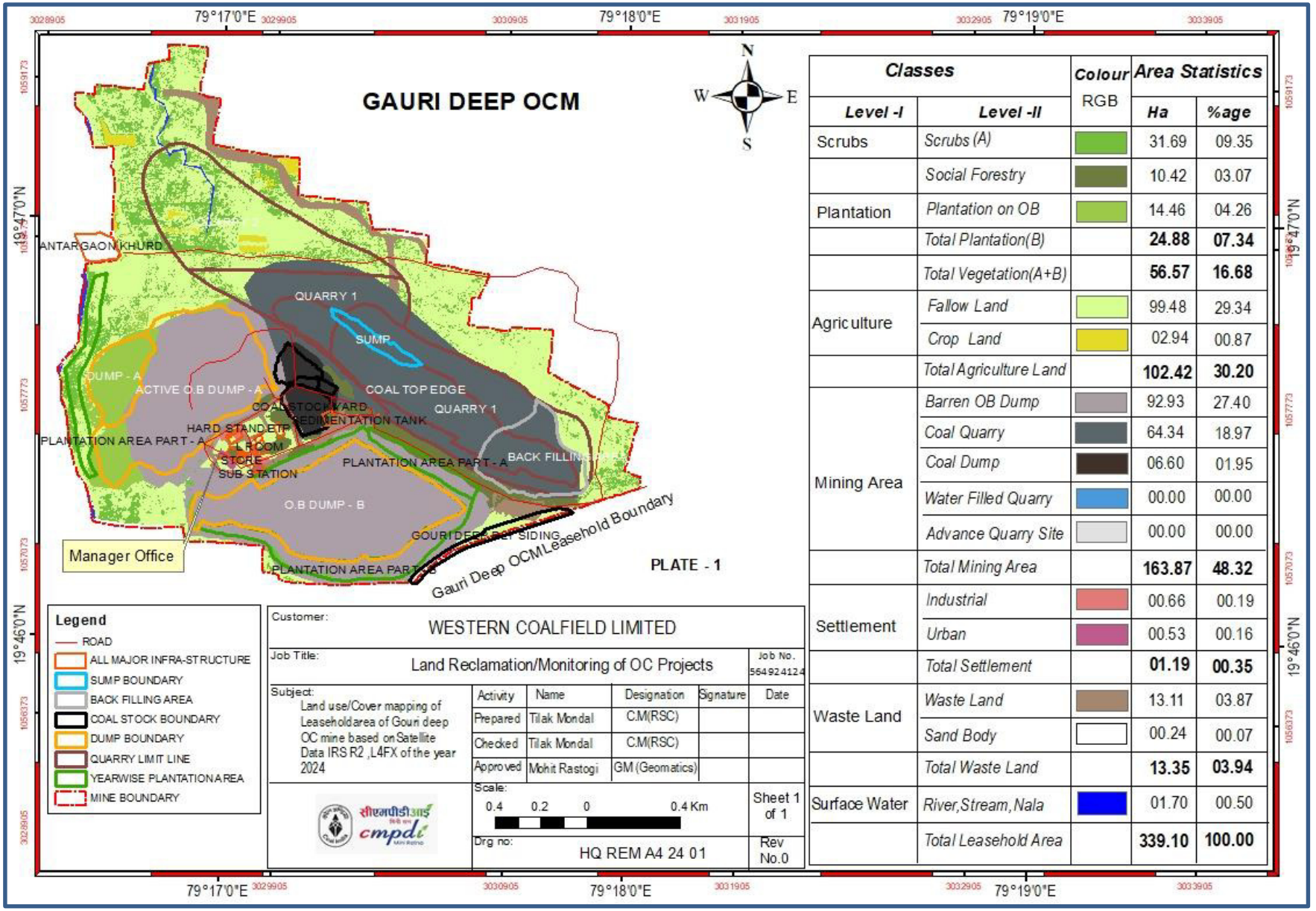
4.6 After analyzing the satellite data of year 2023 vs. 2024 it is evident that total area under plantation (Green cover) carried out under social forestry in above OC mines of WCL has increased from 171.82 Ha (Year 2023) to 223.43 Ha (Year 2024) in the span of one years. This increase of 51.61 Ha area under total plantation in one-year time is due to the sincere efforts made by WCL towards generation of green cover in leasehold area of the 5 opencast projects considered for land reclamation in the year 2024-25.

4.7 Out of 5 projects of WCL, maximum land reclamation has been carried out in Ghonsa OCP (13.41%) followed by Urdhan OCP (12.65%).

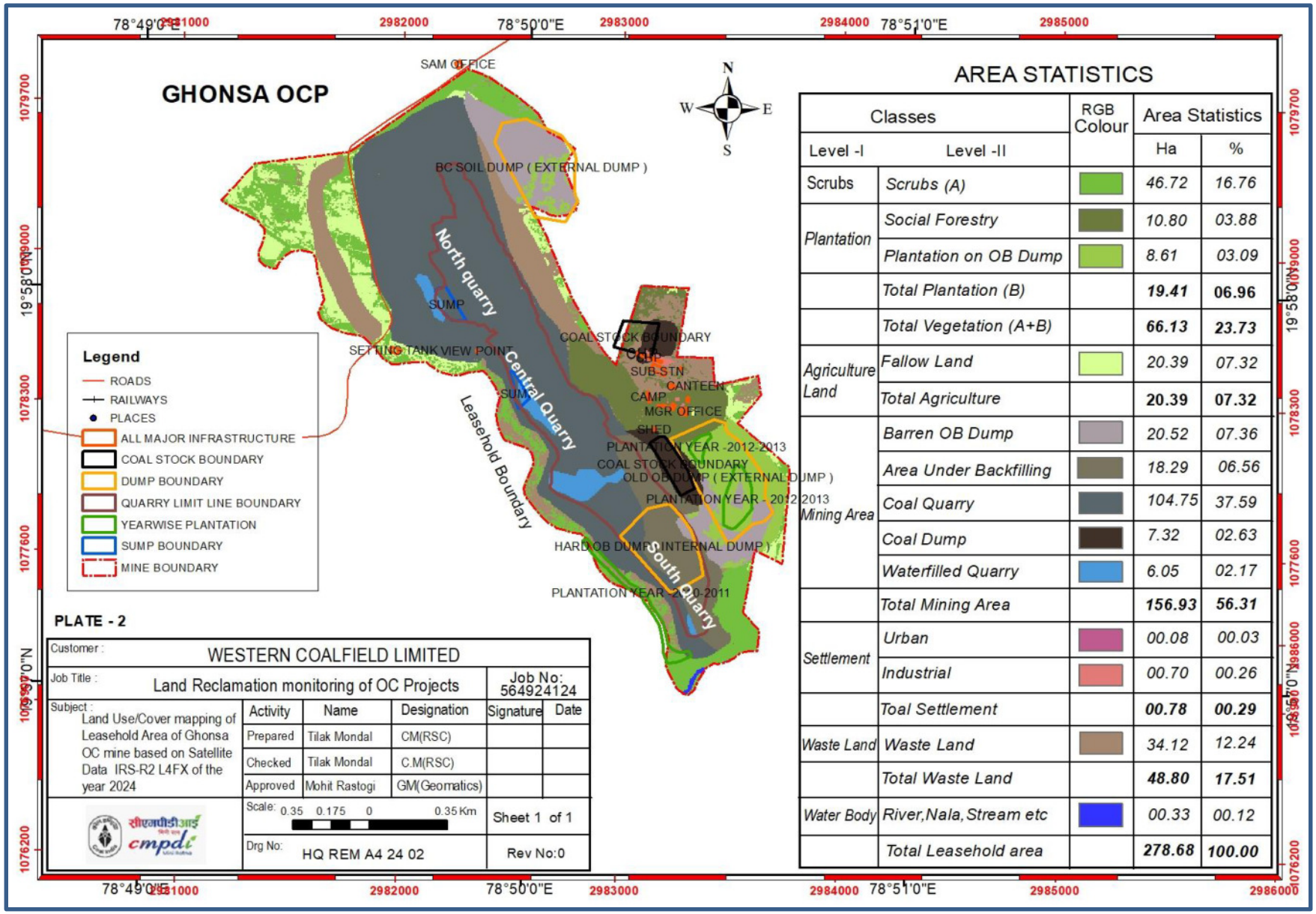
Table 2:
Status of Land Use/Reclamation in OC Mines (<5 M.Cu.M) Of Western Coalfield Ltd based on Satellite Data of the Year 2024

(Area in Hectare)

		Gauri Deep		Ghonsa		Kolegaon		Urdhan		Chhinda		Total	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FORESTS	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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**
SCRUBS	Scrubs	**31.69**	**9.35**	**46.72**	**16.76**	**26.08**	**6.56**	**22.96**	**7.29**	**10.28**	**9.64**	**137.73**	**9.58**
PLANTATION	Social Forestry	10.42	3.07	10.80	3.88	29.70	7.47	11.13	3.53	4.68	4.39	62.05	4.32
	Plantation on OB Dump	14.46	4.26	8.61	3.09	96.67	24.32	15.44	4.90	20.74	19.44	155.92	10.85
	Plantation on Backfill (Biological Reclamation)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Plantation	**24.88**	**7.34**	**19.41**	**6.96**	**126.37**	**31.79**	**26.57**	**8.43**	**25.42**	**23.83**	**222.65**	**15.49**
	Total Vegetation	**56.57**	**16.68**	**66.13**	**23.73**	**152.45**	**38.35**	**49.53**	**15.72**	**35.70**	**33.46**	**360.38**	**25.08**
ACTIVE MINING	Coal Quarry	64.34	18.97	104.75	37.59	72.84	18.32	37.04	11.76	25.22	23.64	304.19	21.17
	Coal Dump	6.60	1.95	7.32	2.63	4.71	1.18	12.79	4.06	0.83	0.78	32.25	2.24
	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
	Quarry Filled With Water	0.00	0.00	6.05	2.17	5.23	1.32	1.13	0.36	0.46	0.43	12.87	0.90
	Total Area under *Active Mining*	**70.94**	**20.92**	**118.12**	**42.39**	**82.78**	**20.82**	**50.96**	**16.18**	**26.51**	**24.85**	**349.31**	**24.31**
	Barren OB Dump	92.93	27.40	20.52	7.36	71.49	17.98	76.81	24.38	15.96	14.96	277.71	19.33
	Barren Backfilled Area (Technical Reclamation)	0.00	0.00	18.29	6.56	0.00	0.00	7.38	2.34	0.00	0.00	25.67	1.79
	Total Area	**92.93**	**27.40**	**38.81**	**13.93**	**71.49**	**17.98**	**84.19**	**26.73**	**15.96**	**14.96**	303.38	21.11
	Total Area Under Mine Operation	**163.87**	**48.32**	**156.93**	**56.31**	**154.27**	**38.81**	**135.15**	**42.90**	**42.47**	**39.81**	**652.69**	**45.42**
WASTELANDS	Waste Lands	13.11	3.87	34.12	12.24	44.62	11.22	14.84	4.71	2.35	2.20	109.04	7.59
	Fly Ash Pond / Sand Body	0.24	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.02
	Total Wasteland	**13.35**	**3.94**	**34.12**	**12.24**	**44.62**	**11.22**	**14.84**	**4.71**	**2.35**	**2.20**	**109.28**	**7.60**
WATERBODIES	Reservoir, nallah, ponds	1.70	0.50	0.33	0.12	0.93	0.23	0.00	0.00	0.00	0.00	2.96	0.21
	Total Waterbodies	**1.70**	**0.50**	**0.33**	**0.12**	**0.93**	**0.23**	**0.00**	**0.00**	**0.00**	**0.00**	2.96	0.21
AGRICULTURE	Crop Lands	2.94	0.87	0.00	0.00	0.00	0.00	25.00	7.94	1.56	1.46	29.50	2.05
	Fallow Lands	99.48	29.34	20.39	7.32	42.50	10.69	87.34	27.73	23.54	22.07	273.25	19.02
	Total Agriculture	**102.42**	**30.20**	**20.39**	**7.32**	**42.50**	**10.69**	**112.34**	**35.66**	**25.10**	**23.53**	**302.75**	**21.07**
SETTLEMENTS	Urban Settlement	0.53	0.16	0.08	0.03	0.98	0.25	0.92	0.29	1.06	0.99	3.57	0.25
	Rural Settlement	0.00	0.00	0.00	0.00	0.00	0.00	1.67	0.53	0.00	0.00	1.67	0.12
	Industrial Settlement	0.66	0.19	0.70	0.25	1.77	0.45	0.55	0.17	0.00	0.00	3.68	0.26
	Total Settlement	**1.19**	**0.35**	**0.78**	**0.28**	**2.75**	**0.69**	**3.14**	**1.00**	**1.06**	**0.99**	8.92	0.62
	Grand Total	**339.10**	**100.00**	**278.68**	**100.00**	**397.52**	**100.00**	**315.00**	**100.00**	**106.68**	**100.00**	**1436.98**	**100.00**

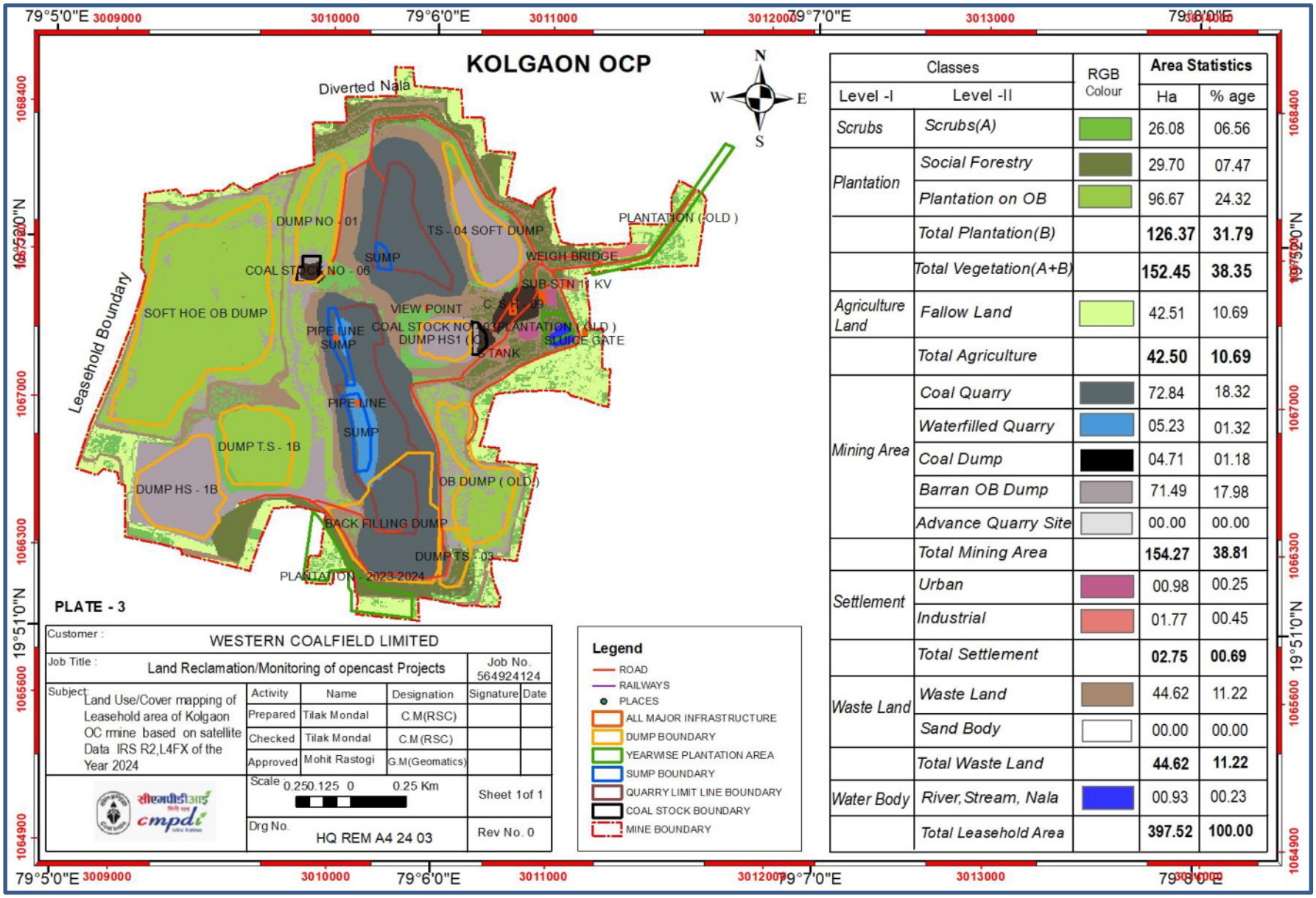


Classes		Colour RGB	Area Statistics	
Level -I	Level -II		Ha	%age
Scrubs	Scrubs (A)		31.69	09.35
	Social Forestry		10.42	03.07
Plantation	Plantation on OB		14.46	04.26
	Total Plantation(B)		**24.88**	**07.34**
	Total Vegetation(A+B)		**56.57**	**16.68**
Agriculture	Fallow Land		99.48	29.34
	Crop Land		02.94	00.87
	Total Agriculture Land		**102.42**	**30.20**
Mining Area	Barren OB Dump		92.93	27.40
	Coal Quarry		64.34	18.97
	Coal Dump		06.60	01.95
	Water Filled Quarry		00.00	00.00
	Advance Quarry Site		00.00	00.00
	Total Mining Area		**163.87**	**48.32**
Settlement	Industrial		00.66	00.19
	Urban		00.53	00.16
	Total Settlement		**01.19**	**00.35**
Waste Land	Waste Land		13.11	03.87
	Sand Body		00.24	00.07
	Total Waste Land		**13.35**	**03.94**
Surface Water	River,Stream,Nala		01.70	00.50
	Total Leasehold Area		**339.10**	**100.00**

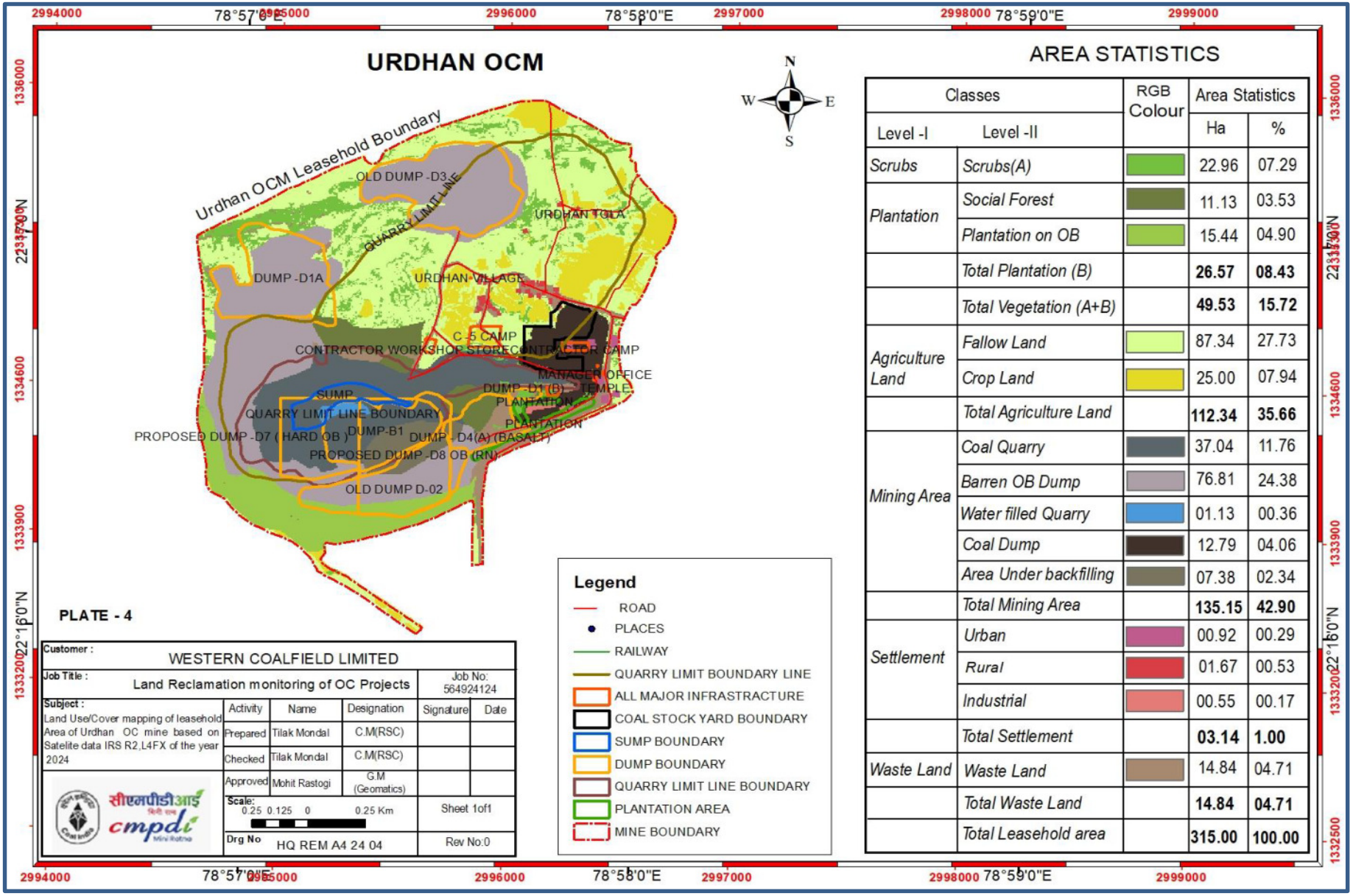


AREA STATISTICS

Classes		RGB Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	*Scrubs (A)*		46.72	16.76
Plantation	*Social Forestry*		10.80	03.88
	Plantation on OB Dump		8.61	03.09
	Total Plantation (B)		**19.41**	**06.96**
	Total Vegetation (A+B)		**66.13**	**23.73**
Agriculture Land	*Fallow Land*		20.39	07.32
	Total Agriculture		**20.39**	**07.32**
Mining Area	*Barren OB Dump*		20.52	07.36
	Area Under Backfilling		18.29	06.56
	Coal Quarry		104.75	37.59
	Coal Dump		7.32	02.63
	Waterfilled Quarry		6.05	02.17
	Total Mining Area		**156.93**	**56.31**
Settlement	*Urban*		00.08	00.03
	Industrial		00.70	00.26
	Toal Settlement		**00.78**	**00.29**
Waste Land	*Waste Land*		34.12	12.24
	Total Waste Land		**48.80**	**17.51**
Water Body	*River,Nala,Stream etc*		00.33	00.12
	Total Leasehold area		**278.68**	**100.00**

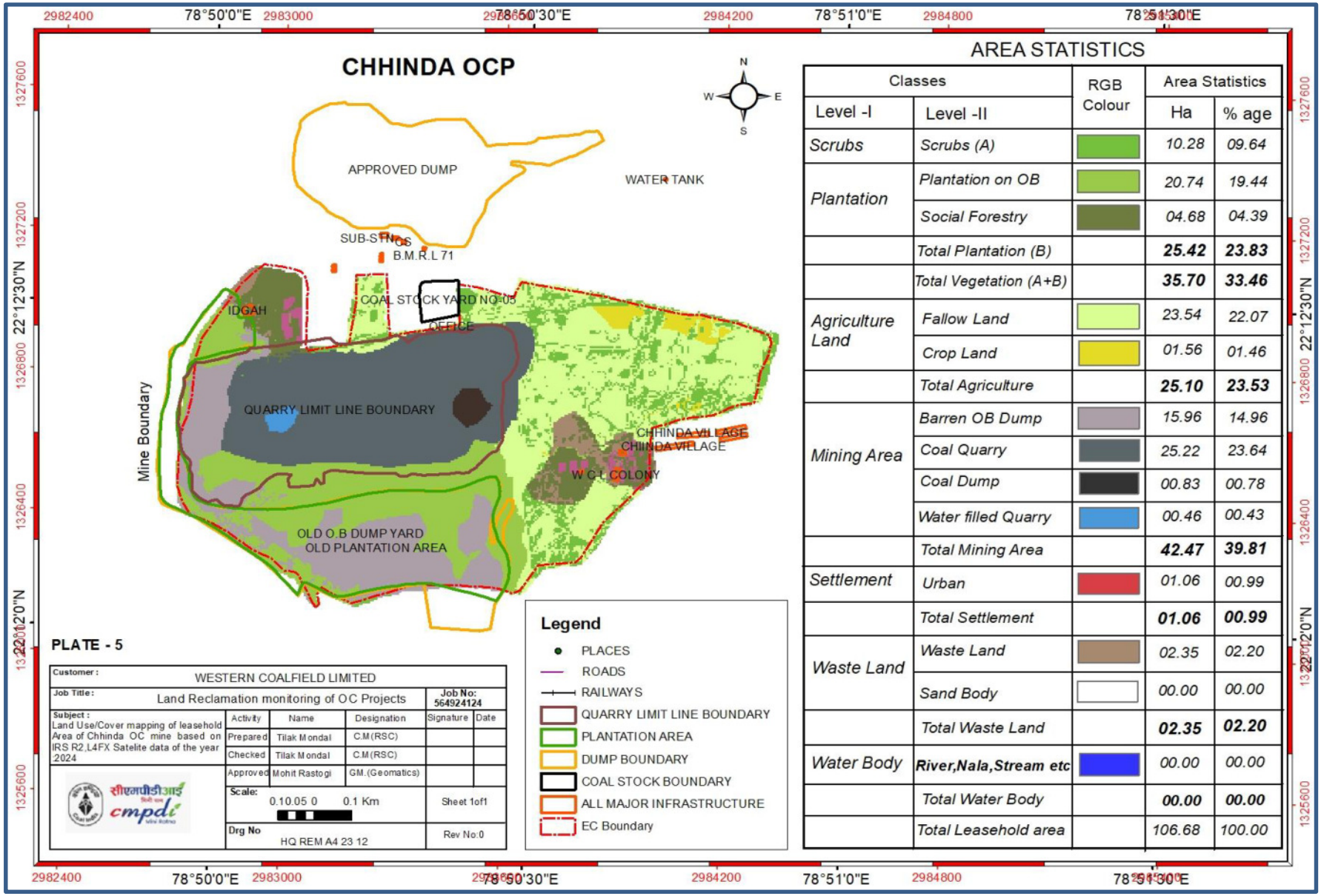


Classes		RGB Colour	Area Statistics	
Level -I	Level -II		Ha	% age
Scrubs	Scrubs(A)		26.08	06.56
Plantation	Social Forestry		29.70	07.47
	Plantation on OB		96.67	24.32
	Total Plantation(B)		**126.37**	**31.79**
	Total Vegetation(A+B)		**152.45**	**38.35**
Agriculture Land	Fallow Land		42.51	10.69
	Total Agriculture		**42.50**	**10.69**
Mining Area	Coal Quarry		72.84	18.32
	Waterfilled Quarry		05.23	01.32
	Coal Dump		04.71	01.18
	Barran OB Dump		71.49	17.98
	Advance Quarry Site		00.00	00.00
	Total Mining Area		**154.27**	**38.81**
Settlement	Urban		00.98	00.25
	Industrial		01.77	00.45
	Total Settlement		**02.75**	**00.69**
Waste Land	Waste Land		44.62	11.22
	Sand Body		00.00	00.00
	Total Waste Land		**44.62**	**11.22**
Water Body	River, Stream, Nala		00.93	00.23
	Total Leasehold Area		**397.52**	**100.00**



AREA STATISTICS

Classes		RGB Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	Scrubs(A)		22.96	07.29
Plantation	Social Forest		11.13	03.53
	Plantation on OB		15.44	04.90
	Total Plantation (B)		**26.57**	**08.43**
	Total Vegetation (A+B)		**49.53**	**15.72**
Agriculture Land	Fallow Land		87.34	27.73
	Crop Land		25.00	07.94
	Total Agriculture Land		**112.34**	**35.66**
Mining Area	Coal Quarry		37.04	11.76
	Barren OB Dump		76.81	24.38
	Water filled Quarry		01.13	00.36
	Coal Dump		12.79	04.06
	Area Under backfilling		07.38	02.34
	Total Mining Area		**135.15**	**42.90**
Settlement	Urban		00.92	00.29
	Rural		01.67	00.53
	Industrial		00.55	00.17
	Total Settlement		**03.14**	**1.00**
Waste Land	Waste Land		14.84	04.71
	Total Waste Land		**14.84**	**04.71**
	Total Leasehold area		**315.00**	**100.00**



AREA STATISTICS

Classes		RGB Colour	Area Statistics	
Level -I	Level -II		Ha	% age
Scrubs	Scrubs (A)		10.28	09.64
Plantation	Plantation on OB		20.74	19.44
	Social Forestry		04.68	04.39
	Total Plantation (B)		**25.42**	**23.83**
	Total Vegetation (A+B)		**35.70**	**33.46**
Agriculture Land	Fallow Land		23.54	22.07
	Crop Land		01.56	01.46
	Total Agriculture		**25.10**	**23.53**
Mining Area	Barren OB Dump		15.96	14.96
	Coal Quarry		25.22	23.64
	Coal Dump		00.83	00.78
	Water filled Quarry		00.46	00.43
	Total Mining Area		**42.47**	**39.81**
Settlement	Urban		01.06	00.99
	Total Settlement		**01.06**	**00.99**
Waste Land	Waste Land		02.35	02.20
	Sand Body		00.00	00.00
	Total Waste Land		**02.35**	**02.20**
Water Body	River,Nala,Stream etc		00.00	00.00
	Total Water Body		**00.00**	**00.00**
	Total Leasehold area		106.68	100.00

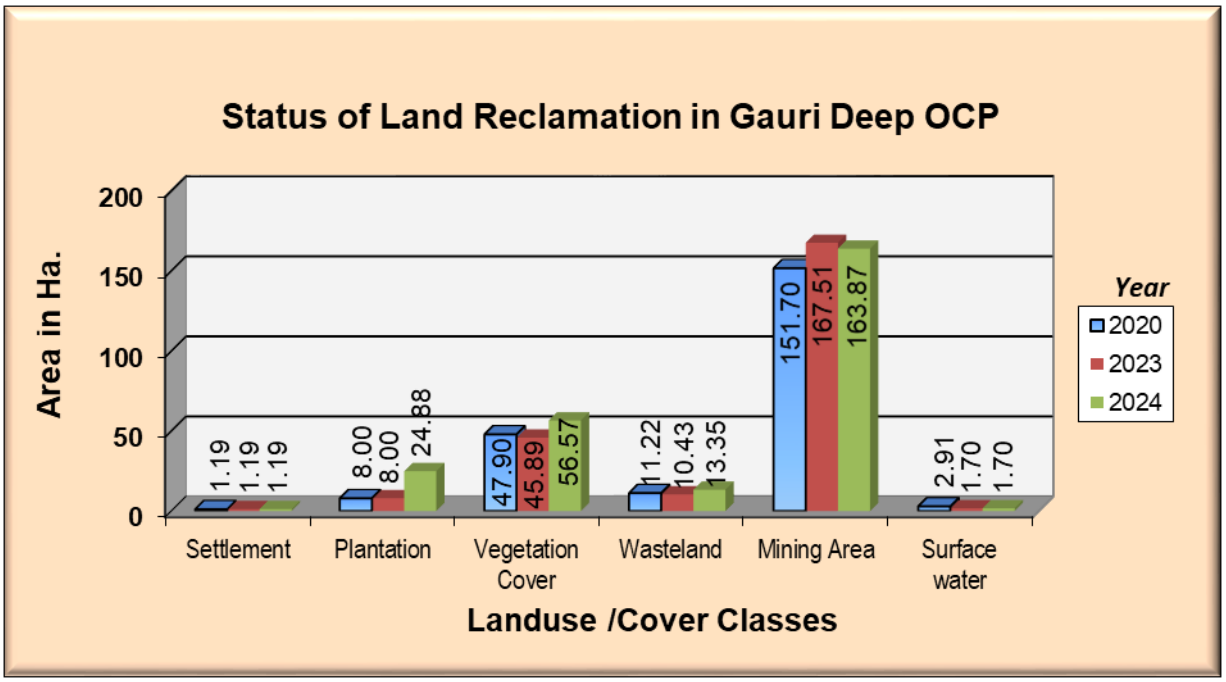


Figure-4

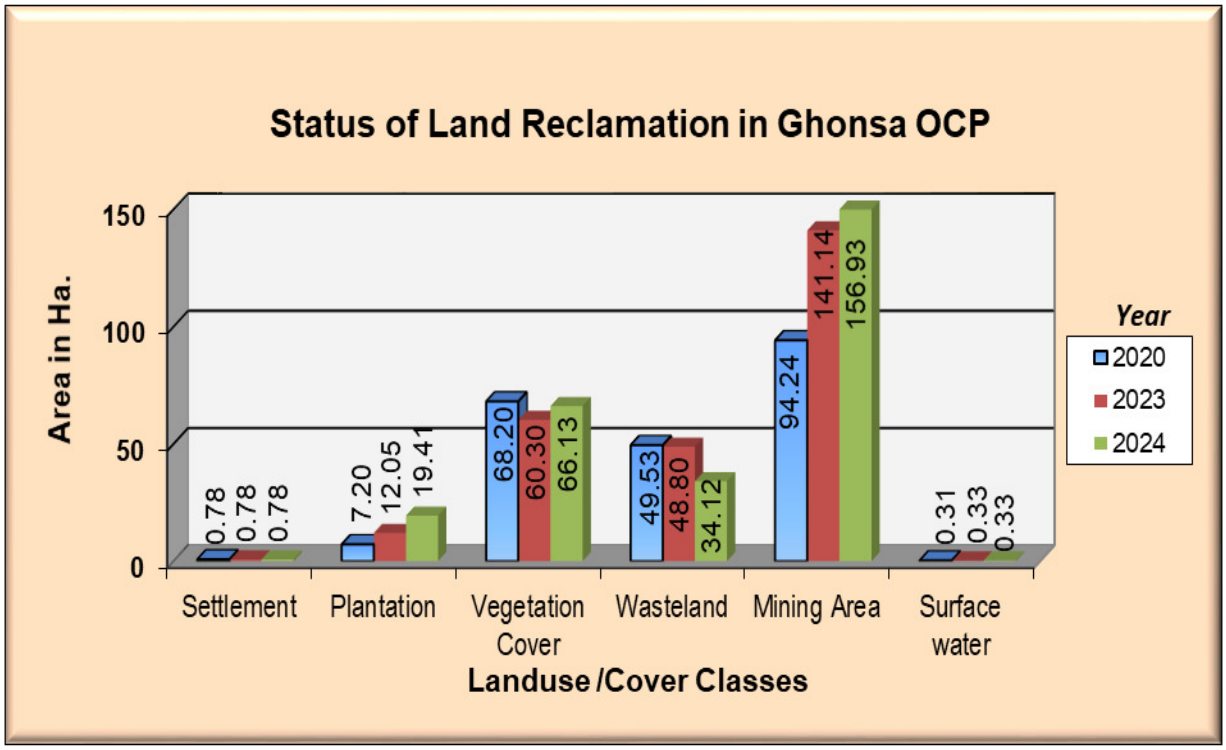


Figure-5

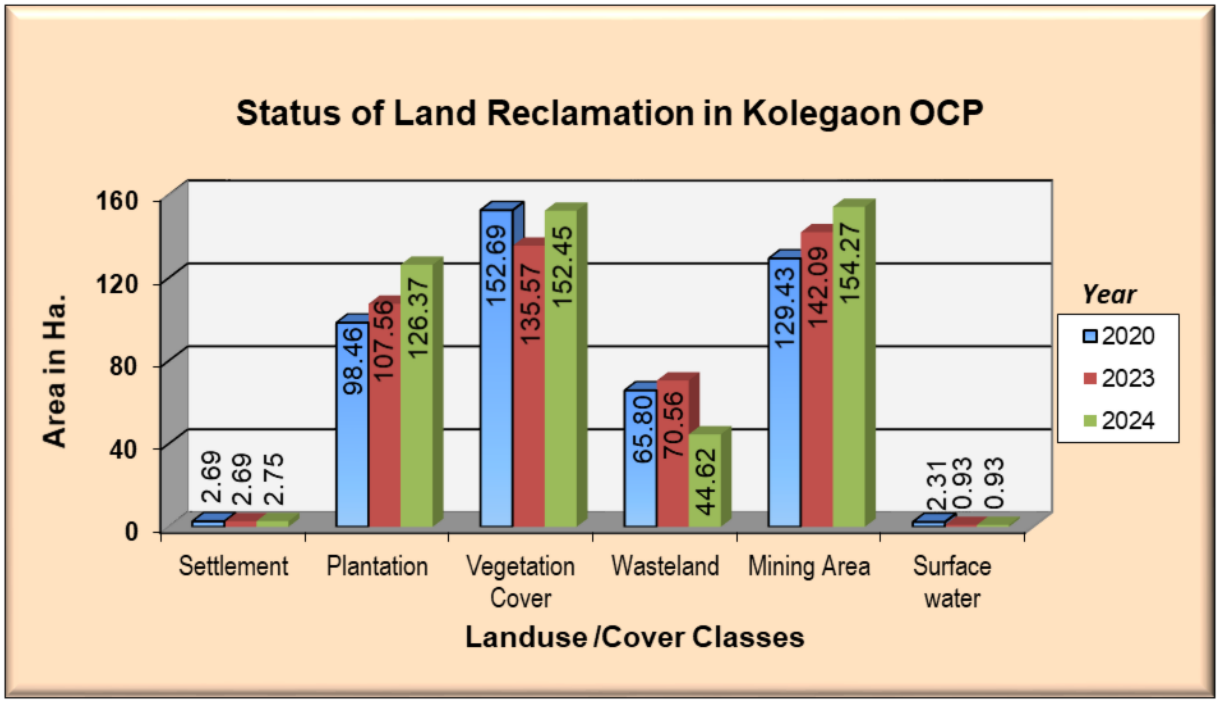


Figure-6

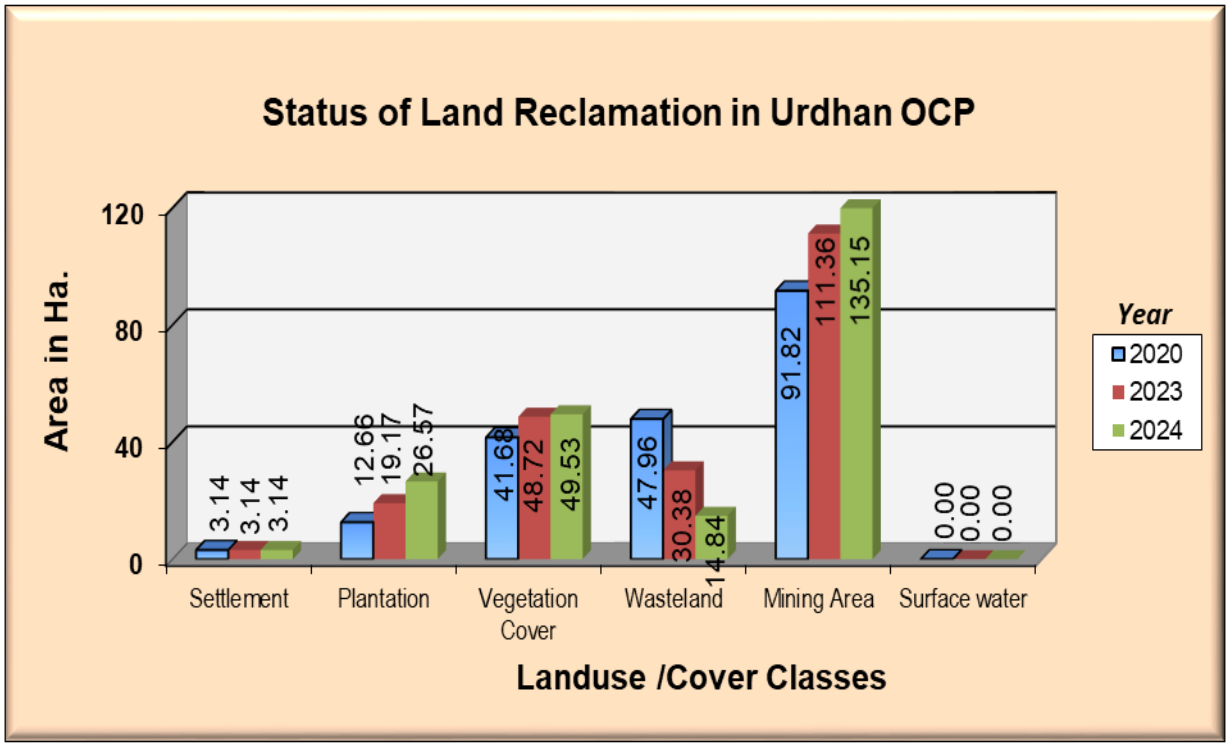


Figure-7

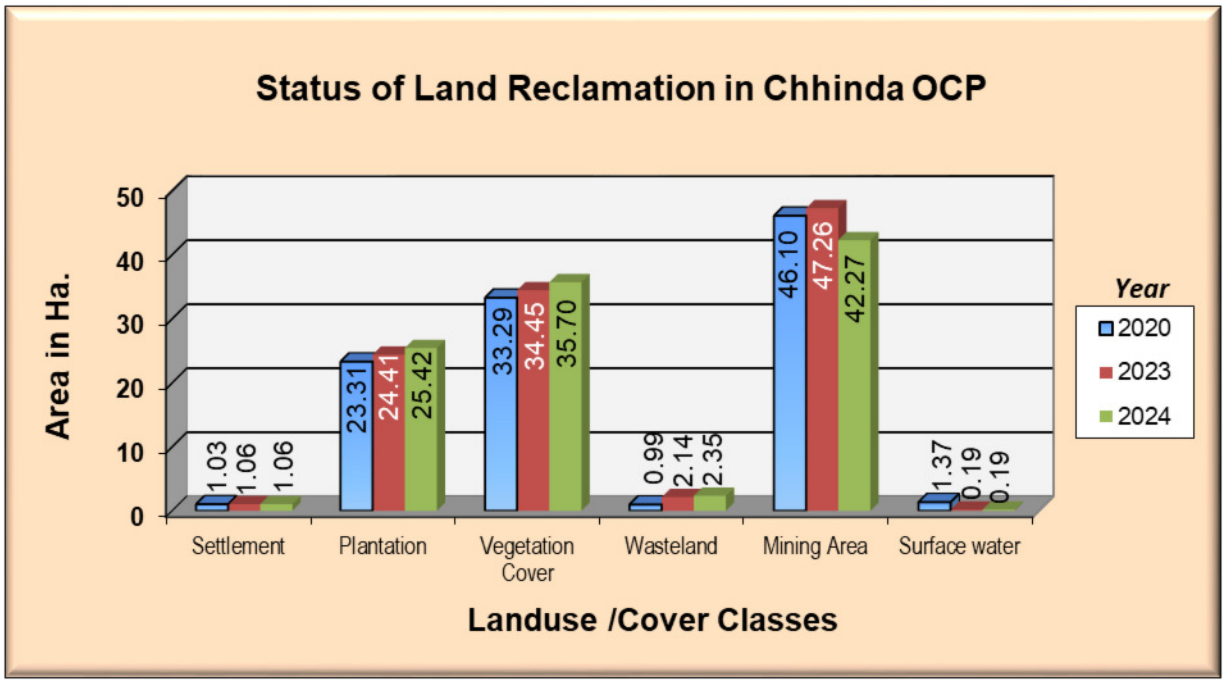
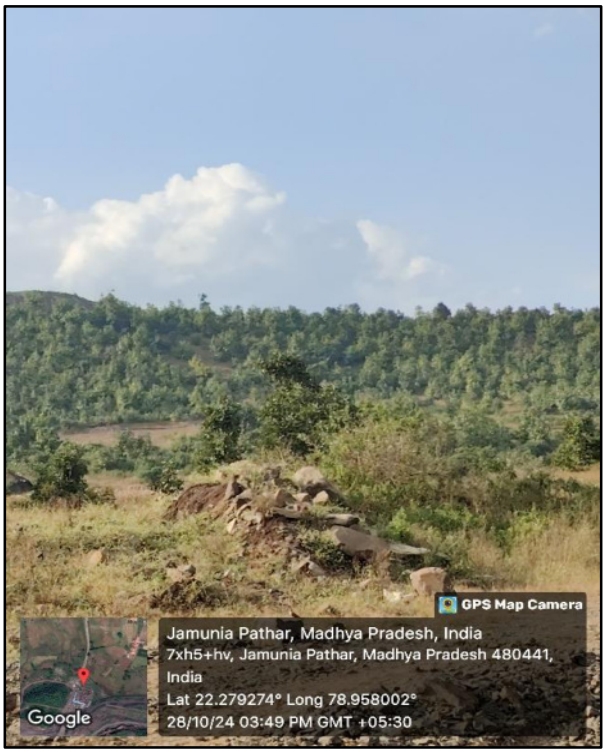

Status of Land Reclamation in Chhinda OCP
Area in Ha.
50
40
30
20
10
0
1.03
1.06
1.06
23.31
24.41
25.42
33.29
34.45
35.70
0.99
2.14
2.35
46.10
47.26
42.27
1.37
0.19
0.19
Settlement
Plantation
Vegetation Cover
Wasteland
Mining Area
Surface water
Landuse /Cover Classes
Year
2020
2023
2024

Figure -8

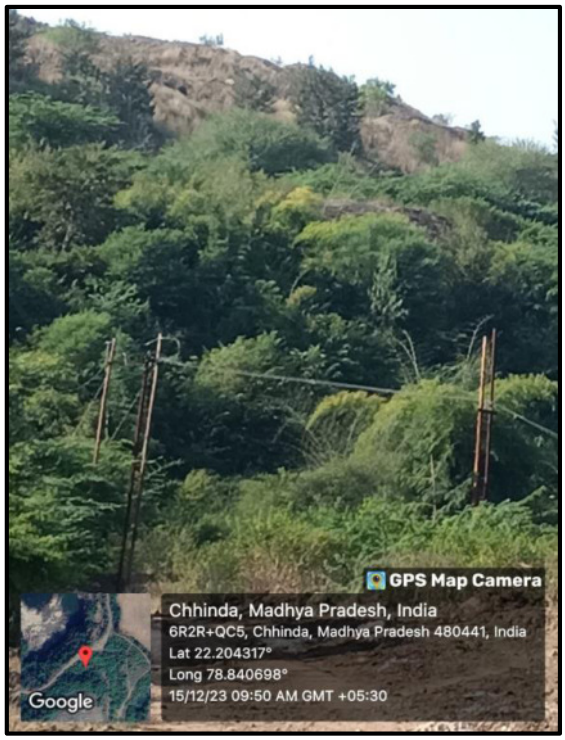
Photograph 1: Plantation under social forestry in Gauri Deep OC Project

Photograph 2: Plantation on Barren OB in Chhinda OCP

Photograph 3: Social Forestry Plantation in Kolegaon OCP



Photograph 4: Plantation on Barren OB Dump in Urdhan OCP



Photograph 5: Plantation on OB in Chhinda OCP

Note- No recent plantation has been carried out at Ghonsa OCP.

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	पृष्टभूमि
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	तकनिकी पुनरुधार
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 त्रुटियँ।
32	Error	अशुद्धियाँ
33	Curvature	वक्रता
34	Geometric	ज्यामितिक
35	Distortion	विरुपण
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 त्तैयारी
58	Ground Truthing	भू-सत्यापन
59	Ground Information	भू- सुचना
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

Central Mine Planning & Design Institute Ltd.

(A Subsidiary of Coal India Ltd.)

Gondwana Place, Kanke Road, Ranchi 834031, Jharkhand

Phone: (+91) 651 2230001, 2230002, 2230483, FAX (+91) 651 2231447, 2231851

Website : www.cmpdi.co.in, Email : cmpdihq@cmpdi.co.in