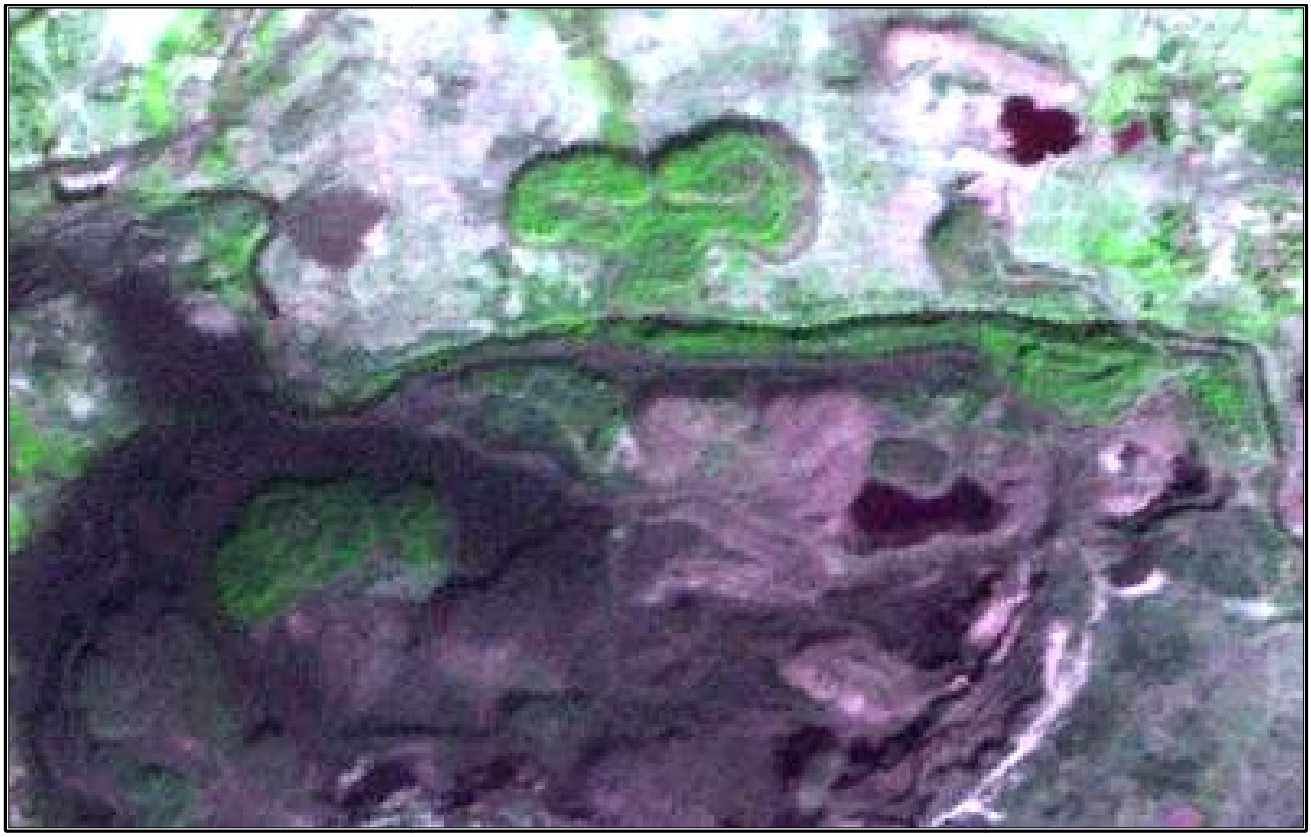
Land Restoration /Reclamation Monitoring of Opencast Coal Mines of Bharat Coking Coal Limited Based On Satellite Data for the Year 2009



CMPDI

A Miniratna Company

Land Restoration /Reclamation Monitoring of Opencast Coal Mines of Bharat Coking Coal Limited based On Satellite Data for the Year- 2009

March-2010

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

CONTENTS

Executive Summary

1.0 Project

Land restoration / reclamation monitoring of two opencast coal mines of Bharat Coking Coal Ltd. (BCCL) 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 14.06 Km^2 of the two projects Viz. Block-II and Muraidih were considered for monitoring during 2009-10; total mined out area is only 5.24 Km^2 (37.26%) of which 1.32 Km^2 area (25.19%) has been planted, 3.17 Km^2 area (60.50%) has been backfilled and 0.75 Km^2 area (14.31%) is under active mining. It is evident from the analysis that 85.69% areas of the OC projects has already been reclaimed and balance 14.31% 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 2009 with respect to the year 2008 in Block-II project, it is evident from the analysis that area of land reclamation has increased from 2.75 Km^2 (Yr. 2008) to 2.88 Km^2 (Yr. 2009). This increase of an area of 0.13 Km^2 of plantation in Block-II is the result of the efforts of the coal company taken up towards environmental protection. Analysis of Muraidih project could not be carried out in the year 2008 due to the non-availability of satellite data at NRSC, Hyderabad.

Table-1

Projectwise Land Reclaimation Status in OC projects of Bharat Coking Coal Ltd (BCCL) based on Satellite data of the Year 2008 and 2009

Sl No.	Projects	Area in Sq Km (*% Calculated in respect of total mined out area*)											
		Leasehold Area	Plantation		OB/ Backfilled		Active Mining Area		Total Mined out Area		Total Reclaimed Area	
			2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
		i	ii		iii		iv		ii+iii+iv		ii+iii	
1	**Block-II**	**8.68**	**0.53**	**0.56**	**2.22**	**2.32**	**0.47**	**0.53**	**3.22**	**3.41**	**2.75**	**2.88**
			16.46	*16.42*	*68.94*	*68.04*	*14.60*	*15.54*			*85.40*	*84.46*
2	**Muraidih***	**5.38**		**0.76**		**0.85**		**0.22**		**1.83**		**1.61**
				41.53		*46.45*		*12.02*				*87.98*
3	**Total**	**14.06**	**0.53**	**1.32**	**2.22**	**3.17**	**0.47**	**0.75**	**3.22**	**5.24**	**2.75**	**4.49**
			16.46	***25.19***	***68.94***	***60.50***	***14.60***	***14.31***			***85.40***	***85.69***

* Analysis for year 2008 could not be carried out for Muraidih project, due to non-availability of satellite data at NRSC, Hyderabad.

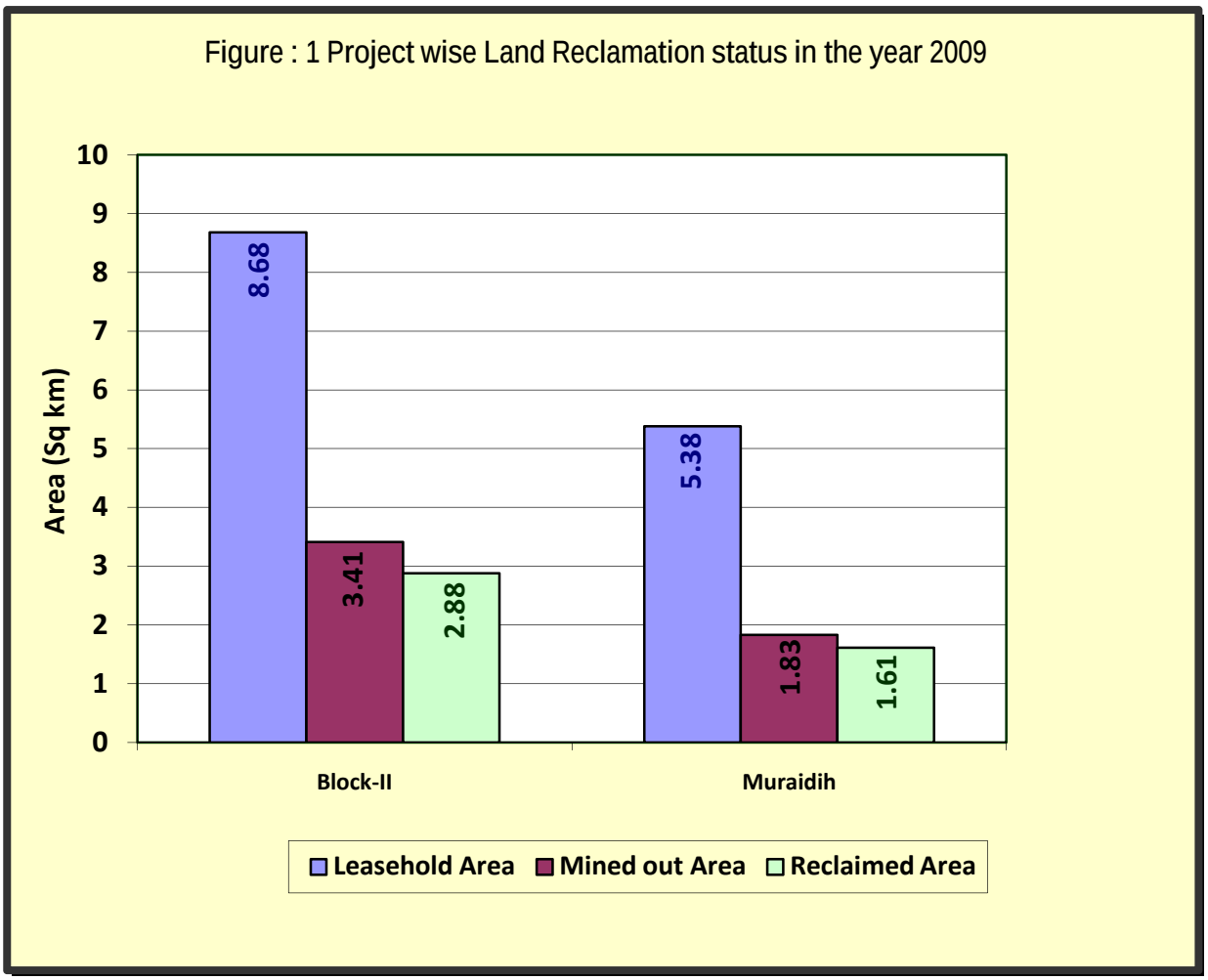


Fig. 1 : **Project wise Land Reclamation Status**

1.0 Background

1.1 All human activities are based on the land which is most scarce natural resource in our country. Per capita land availability in India is the lowest owing to high population density and less land mass. Out of total 329 million hectare (mha) land mass of the country, coal mining is limited to only on 0.10% (0.36mha) area. As per XI Plan, to meet the energy demand of the country, coal production would be raised to 680 million tonnes by the end of the year 2011-12 for which about 40,000 hectare of land would have to be acquired for coal mining projects. It has been envisaged that 85% coal production would be from opencast mines, which causes land degradation due to ground breaking. There is an urgent need to reclaim and restore the mined out land for its productive use for sustainable development of the coal mining. This will not only mitigate environmental degradation, but would also enable coal companies to offer the restored lands to displaced families which would help in creating a more congenial environment for land acquisition in future.

1.2 Keeping above in view, Coal India Ltd. requested Central Mine Planning & Design Institute (CMPDI), Ranchi which has well a equipped remote sensing facilities and capabilities to develop an effective system of surveillance for land reclamation/ restoration for all the opencast coal mines with production of more than 5 million cu. m. per annum (coal + OB taken together) based on remote sensing satellite data, regularly on annual basis for sustainable development of mining operation within command area of CIL and its subsidiaries. The annual land reclamation/restoration status report of all such mines to be put on the website of CIL, (www.coalindia.nic.in), CMPDI (www.cmpdi.co.in) and the concerned coal companies in public domain. Detail report to be submitted to State Pollution Control Board and MoEF and concerned CIL's subsidiaries. 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.

1.3 CMPDI undertook the above assignment, and the present report is embodying the finding of the study carried out during 2009-10 for the two projects for BCCL, viz Block-II and Muraidih.

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

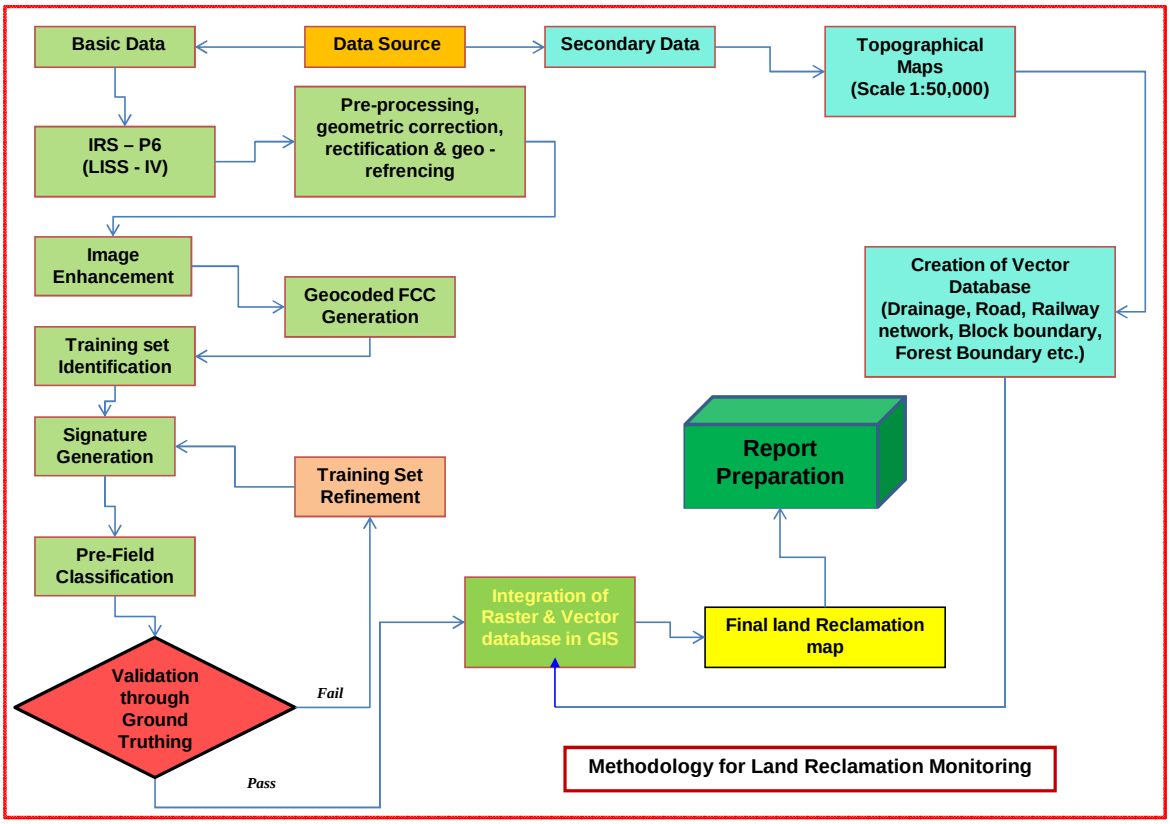


Fig. 2 : *Methodology of Land Reclamation Monotoring*

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 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 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 9.3 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. 9.0 s/w.

- Overlay of Vector data base

  Vector data base is created based on secondary data. Vector layer like drainage, railway line, leasehold boundary, forest boundary etc. are superimposed on the image as vector layer in the Arc GIS database.

- Pre-field map preparation

  Pre-field map is prepared for validation of the classification result

3.3 Ground Truthing:

Selective ground verification of the land use classes are carried out in the field and necessary corrections if required, are incorporated before map finalization.

3.4 Land reclamation database on GIS:

Land reclamation database is created on GIS platform to identify the temporal changes identified from satellite data of different cut - of dates.

4.0 Work Plan

4.1 Opencast projects of BCCL producing more than 5 million cubic m. (Coal + OB together) during the year 2008-09/ 2009 -10 have been taken up for land restoration / reclamation monitoring based on the *RESOURCESAT-1(LISS-IV)* satellite data using ERDAS Imaging digital image processing s/w on GIS platform. Land reclamation monitoring will be carried out regularly on annual basis to assess the progressive status of land restoration / reclamation in the above opencast mines. The report of this study has also been uploaded in the website of CMPDI, CIL & BCCL in public domain.

5.0 Land Reclamation Status in Bharat Coking Coal Ltd.

5.1 Following two OC projects producing more than 5 million cubic m. (Coal + OB together) of Bharat Coking Coal Ltd. have been taken up for land reclamation monitoring on annual basis:

- Block-II
- Muraidih

5.2 Out of the above two projects, Block-II OC has been mapped during the year 2008 & 2009, where as Muraidih OC was mapped for year 2009 only due to the non-availability of satellite data at NRSC for the year 2008.

5.3 Area statistics of different land use class present in OC projects in the year 2009 is given in Table 5.1. Land use maps derived from the satellite data is given in Plate no. 5.1 & 5.2. Changes in land use status are shown in Fig. 5.1 & 5.2.

5.4 Study reveals that 85.69% of mining area has already been reclaimed by BCCL out of which 25.19% area has been revegitated and 60.50% area are backfilled.

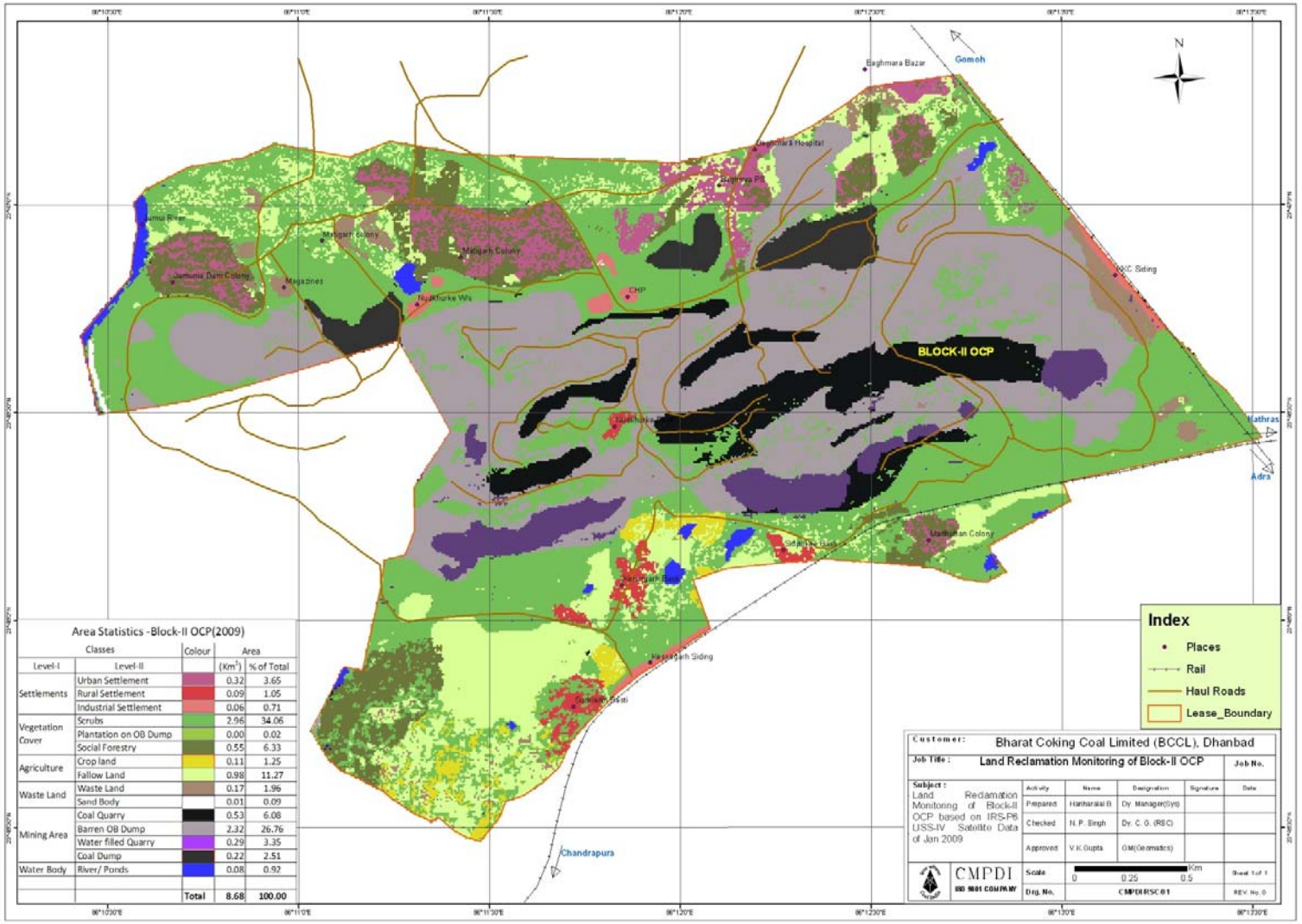
5.5 After analyzing the satellite data of year 2008 vs. 2009 it is evident that plantation carried out on backfilled area, OB dumps as well as under social forestry in Block-II has increased from 0.53 Sq. Km. to 0.56 Sq. Km. This increase of an area of 0.03 Km^2 of plantation in Block-II is the result of the efforts of the coal company taken up towards environmental protection.

TABLE 5.1 : *STATUS OF LAND RECLAMATION IN JHARIA COALFIELD BASED ON SATELLITE DATA OF THE YEAR 2009*

Area in sq.km.

		Block-II OCP		Muraidih OCP	
		Area	%	Area	%
Vegetation Cover	**Scrubs**	2.96	34.06	1.280	23.78
	Social Forestry	0.55	6.33	0.270	4.94
	Plantation on OB/Backfill	0.01	0.02	0.490	9.01
	Total Plantation	**0.56**	**6.35**	**0.760**	**13.95**
	Total Vegetation(A)	**3.52**	**40.41**	**2.040**	**37.73**
Mining Area	**Coal Quarry**	0.53	6.08	0.220	4.03
	Barren OB Dump	2.32	26.76	0.550	10.21
	Barren backfilled area	0.00	0.00	0.300	5.55
	Coal Dump	0.22	2.51	0.160	3.00
	Waterfilled quarry	0.29	3.35	0.050	0.86
	Total Mining Area(B)	**3.36**	**38.70**	**1.280**	**23.65**
Agriculture	**Crop lands**	0.11	1.25	0.110	2.01
	Fallow Land	0.98	11.27	1.270	23.55
	Total Agricultural(C)	**1.09**	**12.52**	**1.380**	**25.56**
Wastelands	**Wastelands**	0.17	1.96	0.260	4.78
	Sand Body	0.01	0.09	0.000	0.00
	Total Wastelands(D)	**0.18**	**2.05**	**0.260**	**4.78**
Settlements	**Urban Settlement**	0.32	3.65	0.260	4.78
	Rural Settlement	0.09	1.05	0.020	0.34
	Industrial Settlement	0.06	0.71	0.040	0.75
	Total Settelements(E)	**0.47**	**5.41**	**0.320**	**5.87**
Waterbodies	**Waterbodies(F)**	**0.08**	**0.92**	**0.130**	**2.42**
	Total(A+B+C+D+E+F)	**8.68**	**100.00**	**5.390**	**100.0**

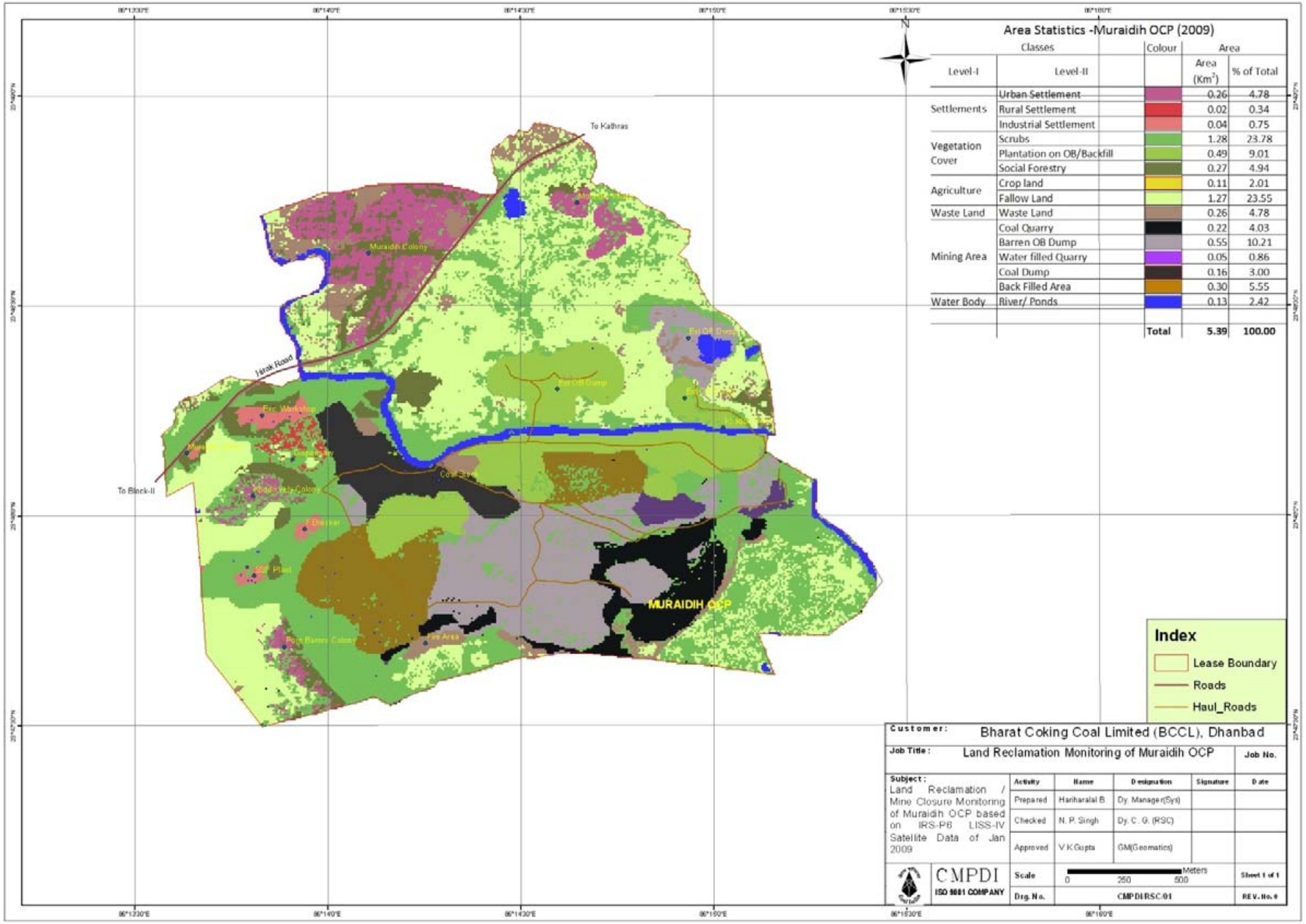
Note : The colour of the classes correspond to the colours on the Land Use Map



Area Statistics -Block-II OCP(2009)

Classes		Colour	Area	
Level-I	Level-II		(Km^2)	% of Total
Settlements	Urban Settlement		0.32	3.65
	Rural Settlement		0.09	1.05
	Industrial Settlement		0.06	0.71
Vegetation Cover	Scrubs		2.96	34.06
	Plantation on OB Dump		0.00	0.02
	Social Forestry		0.55	6.33
Agriculture	Crop land		0.11	1.25
	Fallow Land		0.98	11.27
Waste Land	Waste Land		0.17	1.96
	Sand Body		0.01	0.09
Mining Area	Coal Quarry		0.53	6.08
	Barren OB Dump		2.32	26.76
	Water filled Quarry		0.29	3.35
	Coal Dump		0.22	2.51
Water Body	River/ Ponds		0.08	0.92
		Total	8.68	100.00

Plate 5.1



Area Statistics -Muraidih OCP (2009)
Classes
Colour
Area
Level-I
Level-II
Area (Km²)
% of Total
Settlements
Urban Settlement 0.26 4.78
Rural Settlement 0.02 0.34
Industrial Settlement 0.04 0.75
Vegetation Cover
Scrubs 1.28 23.78
Plantation on OB/Backfill 0.49 9.01
Social Forestry 0.27 4.94
Agriculture
Crop land 0.11 2.01
Fallow Land 1.27 23.55
Waste Land
Waste Land 0.26 4.78
Mining Area
Coal Quarry 0.22 4.03
Barren OB Dump 0.55 10.21
Water filled Quarry 0.05 0.86
Coal Dump 0.16 3.00
Back Filled Area 0.30 5.55
Water Body
River/ Ponds 0.13 2.42
Total 5.39 100.00
N
To Kathras
Jharia Road
To Block-II
MURAIDIH OCP
Index
Lease Boundary
Roads
Haul_Roads
Customer: Bharat Coking Coal Limited (BCCL), Dhanbad
Job Title: Land Reclamation Monitoring of Muraidih OCP
Job No.
Subject: Land Reclamation / Mine Closure Monitoring of Muraidih OCP based on IRS-P6 LISS-IV Satellite Data of Jan 2009
Activity
Name
Designation
Signature
Date
Prepared Hariharalal B Dy. Manager(Sys)
Checked N. P. Singh Dy. C. G. (RSC)
Approved V K Gupta GM(Geomatics)
CMPDI
ISO 9001 COMPANY
Scale
0 250 500 Meters
Sheet 1 of 1
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CMPDI/RSC/01
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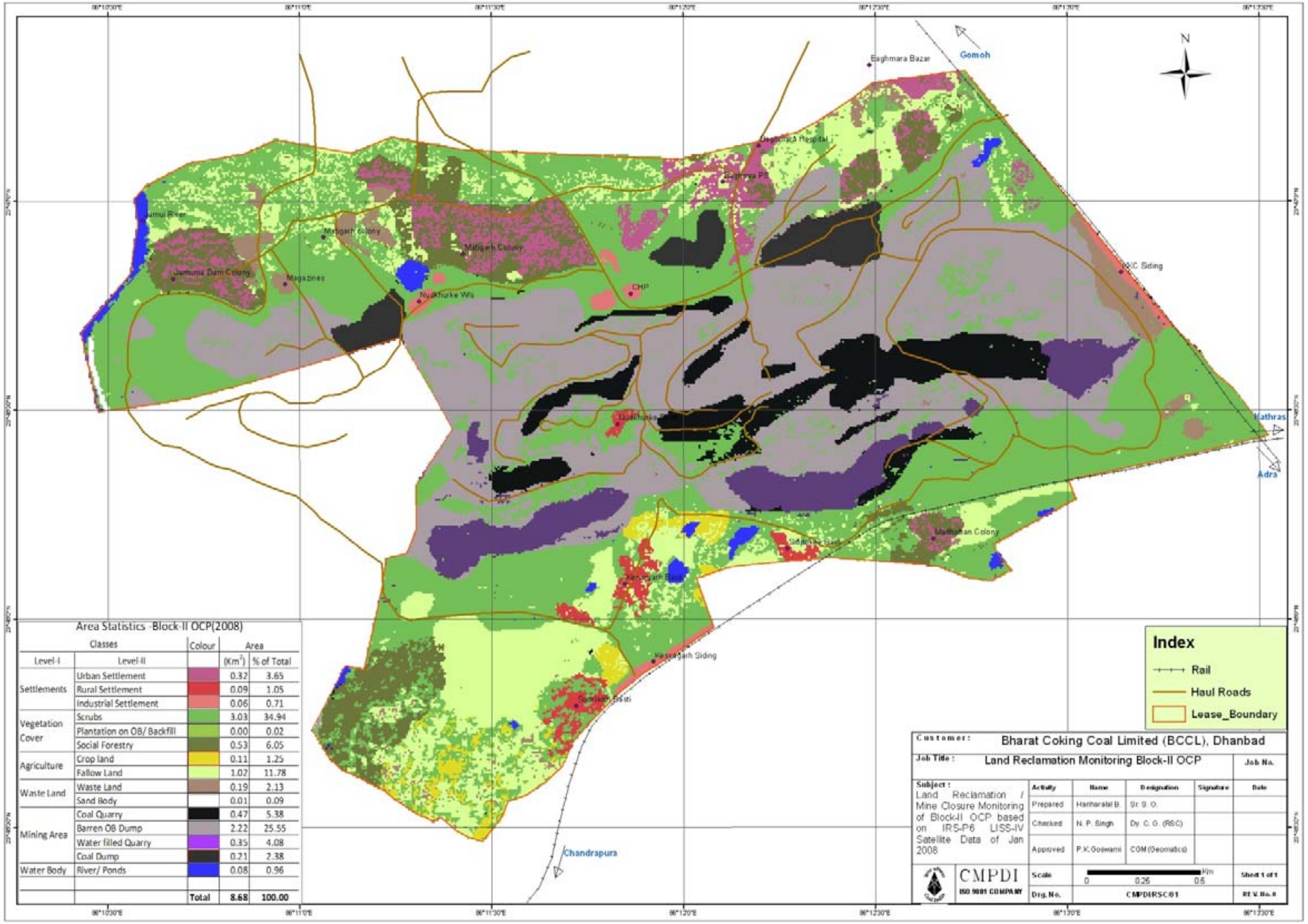
Plate 5.2



Area Statistics -Block-II OCP(2008)

Classes		Colour	Area	
Level-I	Level-II		(Km²)	% of Total
Settlements	Urban Settlement		0.32	3.65
	Rural Settlement		0.09	1.05
	Industrial Settlement		0.06	0.71
Vegetation Cover	Scrubs		3.03	34.94
	Plantation on OB/ Backfill		0.00	0.02
	Social Forestry		0.53	6.05
Agriculture	Crop land		0.11	1.25
	Fallow Land		1.02	11.78
Waste Land	Waste Land		0.19	2.13
	Sand Body		0.01	0.09
Mining Area	Coal Quarry		0.47	5.38
	Barren OB Dump		2.22	25.55
	Water filled Quarry		0.35	4.08
	Coal Dump		0.21	2.38
Water Body	River/ Ponds		0.08	0.96
		Total	8.68	100.00

Plate 5.3

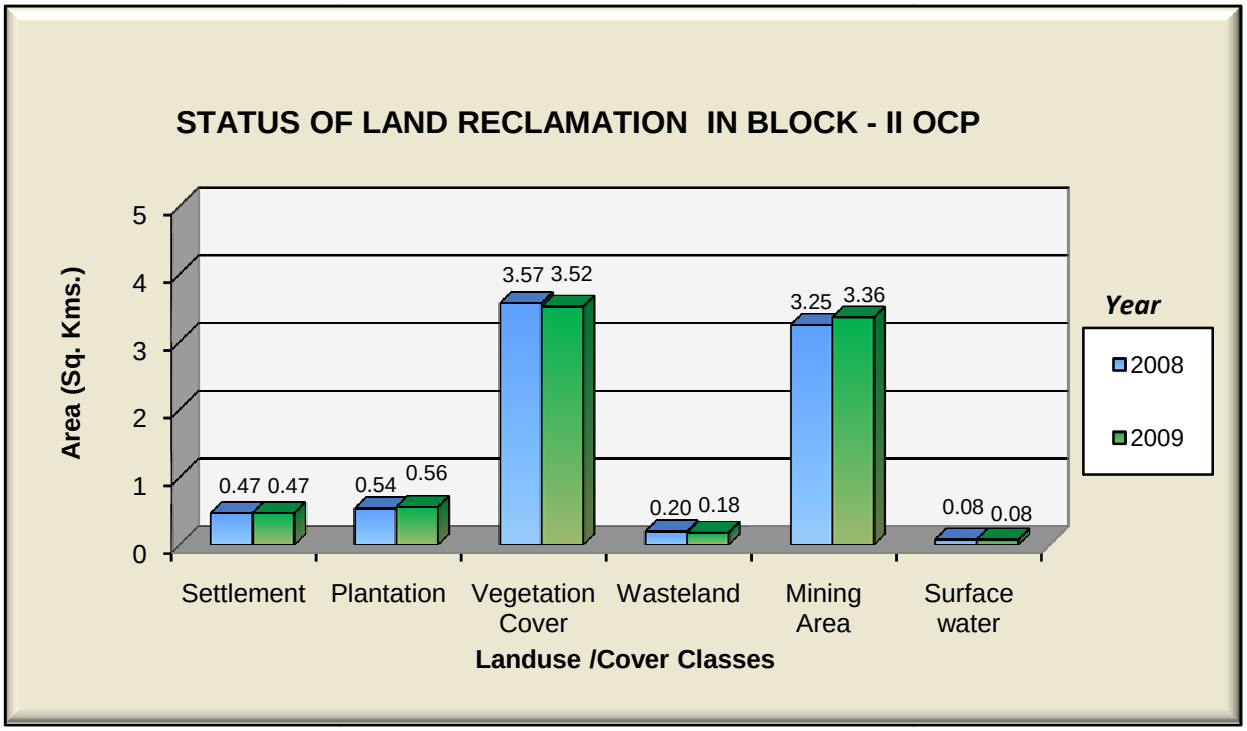


Figure 5.1

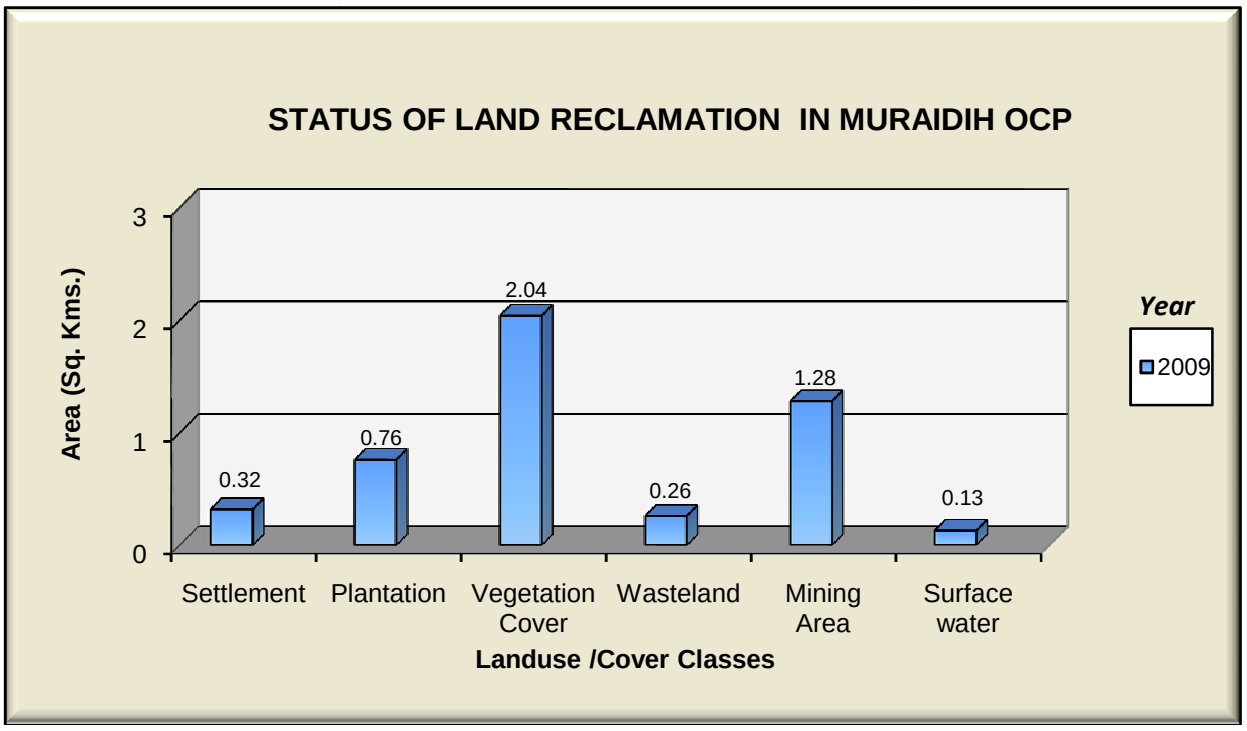


Figure 5.2

Plantation on OB carried out in Muraidih OCP, BCCL

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