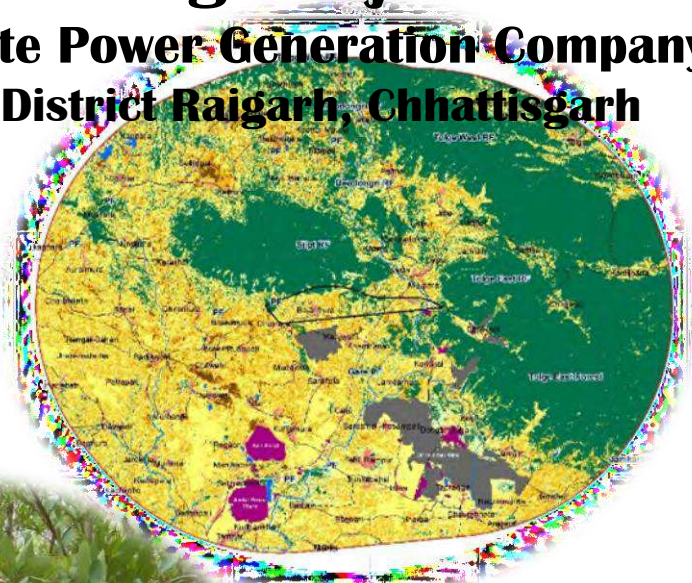# Annexure-IV

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report

for

Gare Pelma Sector – III, Coal Mining Project

Chhattisgarh State Power Generation Company

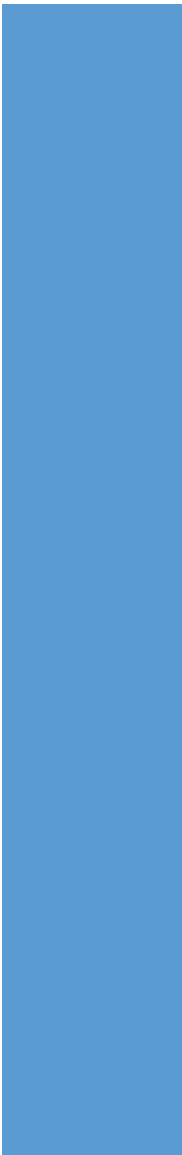## Tehsil Tamnar, District Raigarh, Chhattisgarh

February, 2020

Prepared By

GREENCINDIA CONSULTING PRIVATE LIMITED
607-611, Level-V, Shopprix Mall,
Sector-V, Vaishali, Ghaziabad-201010 (U.P.)

Table of Content

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

Introduction
& Project Details

1. INTRODUCTION

1.1 INTRODUCTION

Chhattisgarh State Electricity Board was formed in accordance with the section 5 of the Electricity Supply Act 1948 as per the notification published in the gazette of the Government of Chhattisgarh dated 15 November 2000. Chhattisgarh State Electricity Board (CSEB) became functional w.e.f. 01.12.2000. Chhattisgarh State Electricity Board has been recognized into five companies in accordance with the provisions contained in the section 1331-134 of Electricity Act 2003 by the govt. of Chhattisgarh. Thus Chhattisgarh State Power Generation Company limited w.e.f. 01.01.2009.

Ministry of Coal, Govt. of India has allotted the Gare-Pelma Sector-III Coal Block to Chhattisgarh State Power Generation Company Limited (CSPGCL), Raipur in Mand Raigarh coalfield. Mand-Raigarh coalfield is named on Mand River in Raigarh district of Chhattisgarh State. It extends over an area of about 3700 Sq. K.M. and constitutes almost the central part of the Son-Mahanadi Basin lies between Hasdo-Arand coalfield in the northwest separated by basement high & IB valley coalfield in southeast. Korba coalfield lies in the West.

1.2 LOCATION OF COAL BLOCK

Gare Sector III Block is located in the south-eastern part of the Mand-Raigarh coalfield. The coal block is located at Dholnara, Bajarmuda, Khamriya, Karwahi and Milupara villages of Tamnar Tehsil, Raigarh District Chattisgarh State. It is located about 15km east of the Tehsil town of Tamnar and 45km northeast of the district headquarter, Raigarh.

Gare Sector III is bounded by latitude 22°06'23.55" N and 22°10'3704" N and longitude 83°26'22.18" E and 83°31'19.00" E. It is covered by the Survey of India Toposheet No. 64 N/8 and 64N/12 on 1: 5000 scales of Mand-Raigarh Coalfield. The total areas of the coal block are 688.969 Hectare as per coordinate given by Ministry of Coal.

1.3 ACCESSIBILITY/COMMUNICATION

Mand-Raigarh coalfield is well connected by National Highway No. 200 from Bilaspur and State Highway No. 1 from Raigarh. Dharamjaygarh - Kharsia State Highway No. 23 also passes through the coalfield. Gare Sector III is connected with the district headquarter, Raigarh, located about 45km southwest by an all weathered road via Tamnar joining S.H.1 at Punjipatra at a distance of about 23km from Raigarh. The accessibility within the sub-block is restricted during monsoon and also due to presence

of nalas and Protected Forest. Raigarh is nearest railhead on the Howrah-Mumbai line of the South East Central Railway.
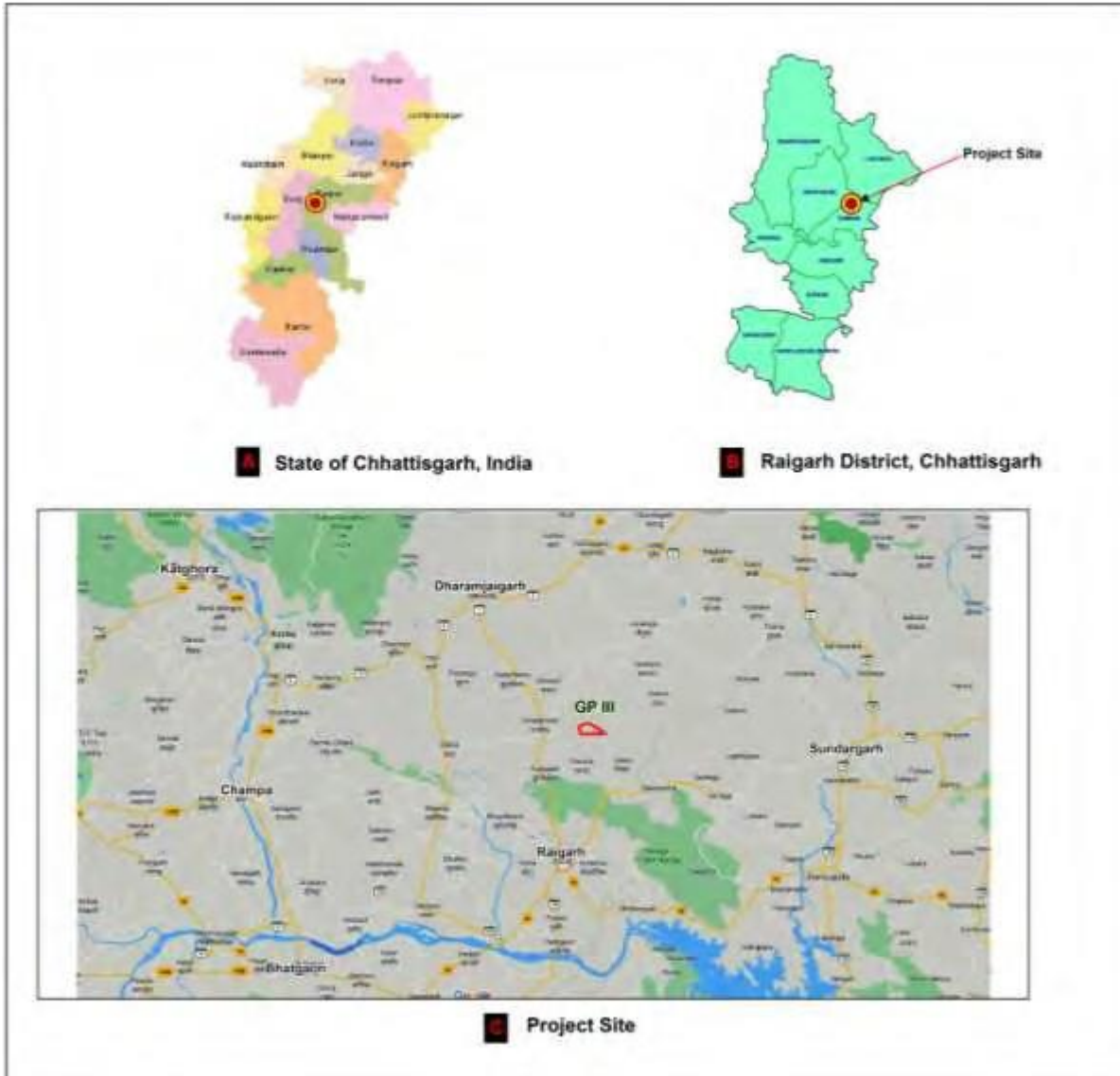
Figure1.1: Location of Project Site

Table1.1: Co-ordinates of Project Site

Point	Latitude	Longitude
A	22°10'24.363'' N	83°27'48.422'' E
B	22°10'49.891'' N	83°27'26.624'' E
A'	22°10'25.840'' N	83°28'08.398'' E
B'	22°10'56.953'' N	83°27'47.866'' E
C	22°10'24.363'' N	83°27'48.422'' E
D	22°10'24.363'' N	83°27'48.422'' E
E	22°10'24.363'' N	83°27'48.422'' E

Source: Project Layout Plan by CSPGCL

Figure 1.2: Co-ordinates of Project Site

1.4 NATURE OF THE PROJECT

The project is a mechanized open-cast/underground coal mining project and is classified as Category-A" Mining Project by the Ministry of Environment & Forests, New Delhi as per the EIA Notification dated 14th September, 2006. The coal block is allotted to M/s Chhattisgarh State Power Generation Company Raipur.

1.5 SIZE OF THE PROJECT

Gare Pelma coal Project & its pit head coal washery is spread over an area of 629.538 ha. The consist of Private land (388.379 ha), Government land (43.432), Reserved forest (114.028), Protected Forest (25.585), Orange Forest (25.489) Chote Jhad Jungle (24.442) and Bade Jhad ke jungle (32.625).

The proposed project in an integrated mechanized coal mine (Peak capacity @6.5 MTPA & rated capacity @5 MTPA)having a pit head washery of raw coal input of capacity 5 MTPA.

The total geological reserves are estimated as 210.20 Mte (Consisting of 141.50 Mte proved & 68.70 Mte Indicated Reserves). The corresponding Overburden has been estimated as 293.50 Mcum at an average stripping ratio of 3.10 cum/t. The grade of the coal as per the Geological Report is A to G. The weighted average quality of opencast project (OCP) is expected of Grade ‗G'and that of underground project (UGP) as ‗D'.

1.6 STUDY AREA

The land use report will describe the study area which covers a circular area of 10 km radius taken from the boundary of the project site. There are 90-100 villages/ settlements comes in buffer zone (10km).

The nearest railway station is Raigarh at a distance of 32.2 km in SSW direction and nearest commercial airport Swami Vivekananda International Airport, Raipur is at a distance of 209.2 km SW from project Site. The nearest city is Raigarh is at distance of 31.0km SSW from project site. **Table 1.2** shows the description of the infrastructure

Table 1.2 Vicinity of the of Area

Parameters of the Features	Description of Features	Distance (km)	Direction
Nearest Railway Station	Raigarh	32.2	SSW
Nearest Airport	Swami Vivekananda International Airport	209.2	SW
Nearest National Highway	NH216	32.9	SSW
Nearest Town / Taluka HQ	Tamnar	9.5	SSW
Nearest Road	Village Road	Inside Project Site	-
Nearest Settlement	Bajramuda, Dholnara & Milupara	Inside Project Site	-
Nearest Major Water Body	Kelo River	Inside Project Site	-

Source: (i) LISS IV Satellite Imagery of Study Area, 2019; (ii) SOI Toposheet Map Sheet No. 64N/7, 64N/8, 64N/11 & 64N/12, First Edition, 1975, Published under direction of Surveyor General of India, printed on 1975; (iii) Site Visit Conducted by GreencIndia Consulting Private Limited, 2019 & (iv) Google Platform.

Although the core/buffer zone doesn't fall in any National Park, wildlife sanctuary, wildlife corridor, tiger reserve, elephant reserves or biosphere reserve, there are a number of Reserve Forest and Protected Forests in the study area, which are enlisted below in **Table 1.3**.

Table 1.3: Distance and Direction of Forests from Project Site

Sl. No.	Name of Forest	Type of Forest	Distance (in km)	Direction
1	Silot RF	Reserved Forest (Dense Mixed Jungle)	Inside Project Site Boundary	N
2	Tolge West RF	Reserved Forest (Dense Mixed Jungle)	4.5	NE
3	Tolge East RF	Reserved Forest (Dense Mixed Jungle)	0.2	E

Sl. No.	Name of Forest	Type of Forest	Distance (in km)	Direction
4	Rampur PF	Protected Forest (Open Mixed Jungle)	3.4	N
5	Deodongar RF	Reserved Forest (Open Mixed Jungle)	3.7	N
6	Jamkhani RF	Reserved Forest (Dense Mixed Jungle)	9.9	SE
7	Gare PF	Dense Mixed Jungle	2.2	S
8	PF	Open Mixed Jungle	Inside Project Site Boundary	SW
9	PF	Open Mixed Jungle	0.6	SW

Source: i) LISS IV Satellite Imagery of Study Area, 2019; (ii) SOI Toposheet Map Sheet No. 64N/7, 64N/8, 64N/11 & 64N/12, First Edition, 1975, Published under direction of Surveyor General of India, printed on 1975; (iii) Site Visit Conducted by GreencIndia Consulting Private Limited, 2019.

1.7 TOPOGRAPHY AND DRAINAGE

The core zone and 10 km radius buffer zone is covered in the Toposheet Nos. 64N/7, 64N/8, 64N/11 & 64N/12. Topography of the study area is provided in **Figure 1.3**.

The study area is undulating topography with several forest covered mounds as well as flat land. The core zone has the elevation contour values in the range of 260m-400m above MSL. Approximately 30% of the core zone is covered by forest area in Northern part of project site.

The buffer zone (10 km radius from lease boundary) is mostly undulated terrain exhibiting hills, hill remnants, valley and plains. Elevation of the buffer zone varies from 238m – 633m above MSL. About 50% of the buffer zone is covered by reserved and protected forests. Elevation map of the study area is provided in **Figure 1.4**.

Water bodies refer to the collection of water in any ditches or manmade storages like ponds, lakes, tanks, reservoirs etc. In the study areas these water bodies are present in very small patches near some settlements in the whole study area except Northern part. Major River Kelo passed towards East from the project site boundary and NE to SSE of the study area.
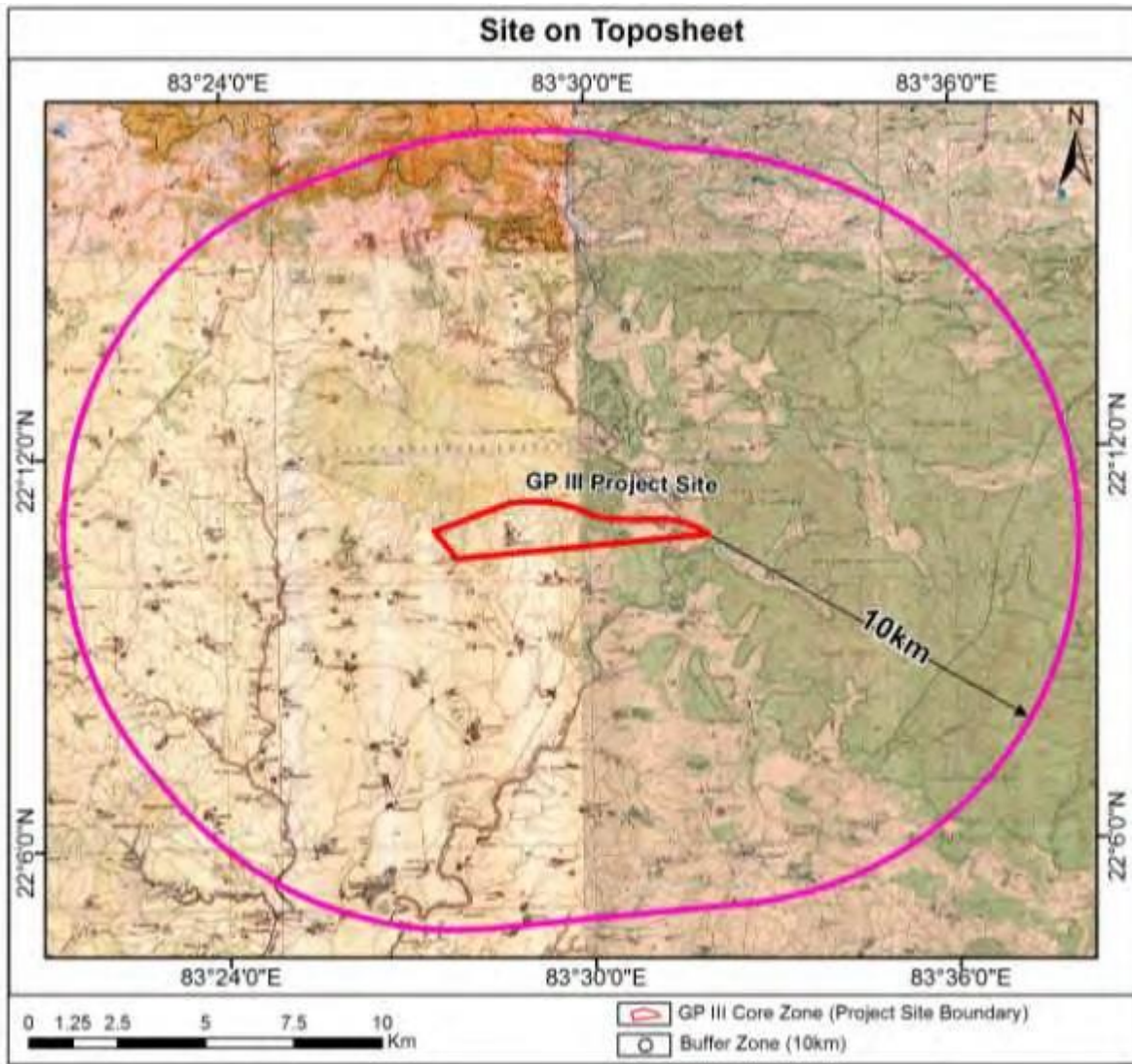
Figure 1.3: Topography of the Study Area

1.8   OBJECTIVES OF THE STUDY

The present study is taken up to conduct Baseline Survey Environment, Landuse/landcover Study and Flora Fauna Study of project area of Gare-Pelma Sector-III Coal Block, Dist. Raigarh The objective of this study is as follows:

➢ To identify and assess the impact of the mine on the environment and its various components viz., air, water, noise, soil in the core and buffer zone of the GP III project site..

➢ To assess the nature and distribution of vegetation, Flora & Fauna in and around the project site within the study area;

➢ Study of the Land use/Land cover within the core zone and buffer zone (study area);

1.9 APPROACH

A participatory and consultative approach was followed for executing the assignment on Biodiversity and Ecological Assessment of the Gare Pelma Sector III coal Mines Projects. A team of experts have visited the project area and conducted the ecological survey. Meetings were also held during the ecological survey with forest officials and local community. Forest working plan, census handbook, gazetteer and other records related to ecology of the region were also collected.

ELEVATION MAP (GPIII- STUDY AREA)

83°24'0"E   83°30'0"E   83°36'0"E

22°12'0"N

22°6'0"N
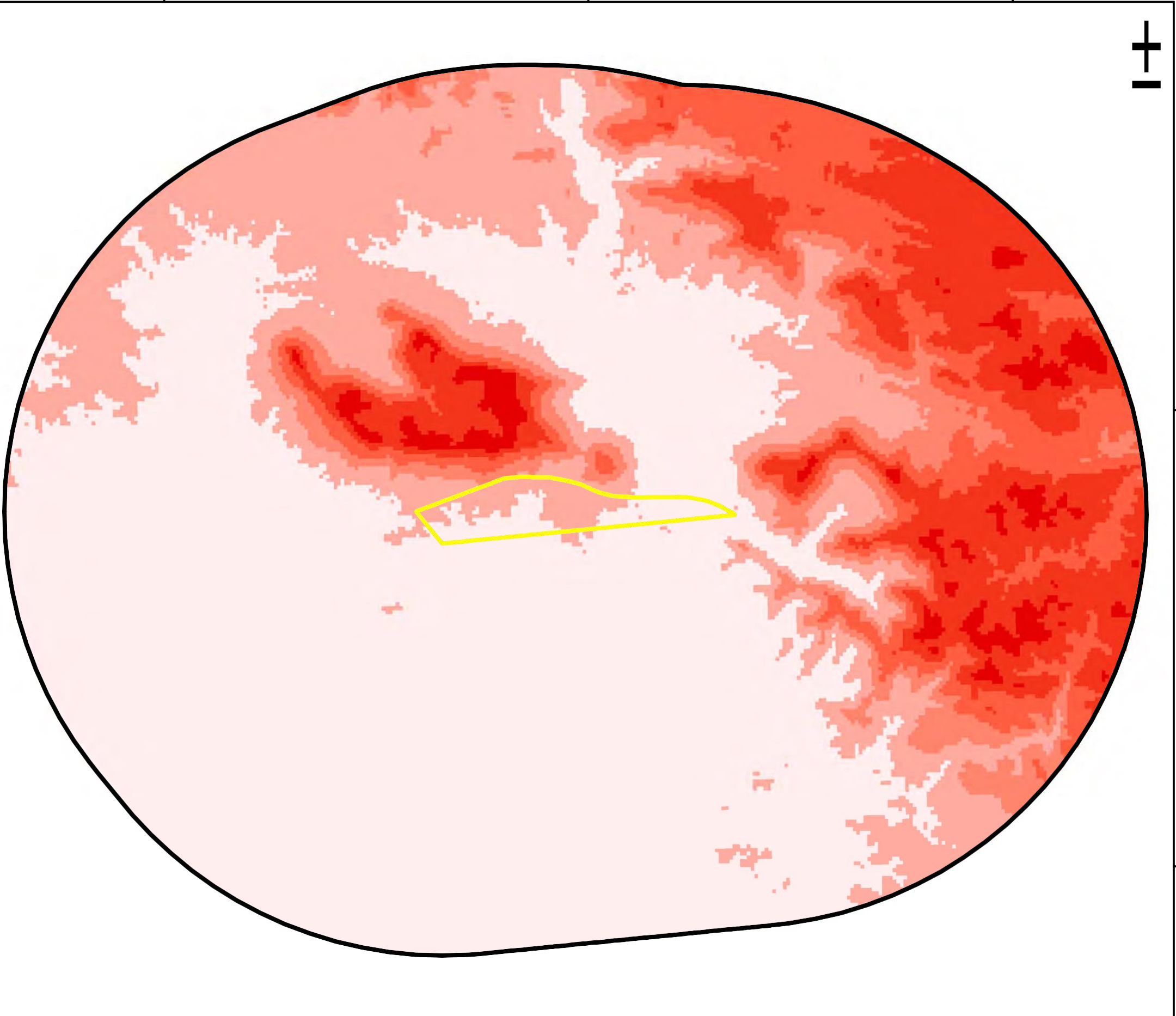
Source:
Google Satellite Imagery, 2018
Digital Elevation Model (SRTM)

Legend

GP III Project Site
Study Area

Elevation (in m)
- 238 - 303.8
- 303.9 - 369.7
- 369.8 - 435.5
- 435.6 - 501.3
- 501.4 - 567.2
- 567.3 - 633

Scale: 1:1,00,000

0   1.5   3   6   9
Km

Project:

GARE-PELMA SECTOR- III COAL BLOCK
TEHSIL- TAMNAR, DISTRICT- RAIGARH, CHHATTISGARH

CHHTTISGARH STATE POWER GENERATION COMPANY LIMITED

P R E P A R E D B Y

GREENCINDIA CONSULTING PVT. LTD.
Ghaziabad, Uttar Pradesh
(An ISO:9001 QMS, ISO: 14001 EMS & OHSAS: 18001 H&S MS Certified by BSI)
QCI-NABET Accreditate Environment Consultant
Certificate No.
NABET/EIA/1619/RA0058

Project Site

Environment Baseline Study

2. ENVIRONMENT BASELINE STUDY

2.1 INTRODUCTION

This chapter deals with the description of existing environmental setting of the project area. Project study area boundary forms a distance of 10 km from the periphery of the proposed site. Environmental baseline data includes the physical and biological data. The baseline data collected has been utilized to establish baseline quality of various environmental parameters.

2.2 DESCRIPTION OF ENVIRONMENT

2.2.1 Climate

The climate of this district is characterized by a hot dry summer and well distributed rainfall in the southwest monsoon season. The cold season from December to February is followed by the hot season from March to mid-June. The period from mid- June to September constitutes the southwest monsoon season. The succeeding period lasting till the end of November is the post monsoon or retreating monsoon season.

2.2.2 Rainfall

Records of rainfall in the district are available for 4 stations for very long periods. The average annual rainfall in the district is 1619.7 mm. The total normal annual rainfall is 1639.2 mm at Raigarh. The monsoon rainfall is 1523.5 mm. The rainfall in the district increases from the southwest towards the northeast and varies from 1445.8 mm. at Sarangarh to 1726.6 mm. at Jashpurnagar. About 87 per cent of the annual rainfall in the district is received during the southwest monsoon months, June to September, July being the wettest month. There are on the average 78 rainy days (i.e. days with rainfall of 2.5 mm or more) in a year in the district. This number varies from 68 at Sarangarh to 92 at Jashpurnagar. The heaviest rainfall in 24 hours recorded at any station in the district was 360.9 mm at Raigarh on 10th July, 1958.

2.2.3 Temperature

There are two meteorological observatories in the district, one at Raigarh and the other at Jashpurnagar. The observatory at Jashpurnagar has started very recently. So the records of the observatory at Raigarh may be taken as representative of the meteorological conditions in the district in general. Temperatures begin to increase rapidly from about the beginning of March. May is usually the hottest month with the mean daily maximum temperature at 45.8°C and the mean daily minimum at 28.9 °C. The heat in May and the early part of June till the onset of the monsoon are trying. The onset of the monsoon by about mid-June brings some relief as the temperatures decrease appreciably. In September due to breaks in the monsoon which are not uncommon, the day temperatures increase slightly and this increase continues in

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

October. The temperatures begin to decrease rapidly after October. December and January are generally the coldest months with the mean daily maximum at 28.4°C and the mean daily minimum at 13.5°C. The district is sometimes affected by cold waves in association with passing western disturbances across north India and then the minimum temperature drops dorm to about 7°C.

2.2.4   Humidity

The relative humidity is high during the southwest monsoon season, generally exceeding 75 per cent. The humidity decreases in the post-monsoon season. The air is fairly dry in the cold season. The driest part of the year is the summer season when the relative humidity in the afternoon is less than 25 percent.

2.2.5   Cloudiness

Skies are mostly heavily clouded or overcast during the monsoon season. In the latter half of the summer and during the post monsoon season cloudiness is moderate. The skies are mostly clear or lightly clouded during the rest of the year.

2.2.6   Winds

Winds are generally light with some strengthening in force during the late summer and monsoon seasons. The winds blow generally from directions between north and east during the post monsoon and winter months and early summer. Southwester lies and westerly begin to blow from April-May and during the southwest monsoon season these predominate. The normal monthly Temperature rainfall, humidity and average wind speed of Raigarh dist. is given in **Table 2.1**.

Table 2.1: Average Metrology data - Raigarh IMD Station

Month	Average Temperature (°C)	Average Rainfall (mm)	Humidity (%)	Average Wind Speed (kmph)
August -18	27	213.17	51.0	10.0
September -18	27	77.55	75.0	8.20
October -18	29	10.2.0	55.0	6.60
November -18	27	0.40	47.0	5.20
December -18	22	98.60	49.0	6.40
January -19	23	26.30	39.0	5.50
February -19	27	16.30	34.0	6.90
March-19	32	14.50	28.0	8.80
April-19	38	9.60	20.0	9.60
May-19	40	1.00	22.0	10.40
June -19	37	161.90	44.0	11.90
July-19	30	493.20	74.0	13.40

August -19	28	758.20	83.0	10.40

Source- Data from INDIA METEOROLOGICAL DEPARTMENT.

2.2.7 Special Weather Phenomena

During the monsoon season depressions from the Bay of Bengal move across the district or its neighborhood causing widespread heavy rain and gusty winds. Storms and depressions from the Bay of Bengal during October also occasionally reach the district or its neighborhood and affect the weather. Thunderstorms occur in the summer and monsoon seasons. Fogs are occasionally experienced during winter.

2.3 STUDY AREA & STUDY PERIOD

As mentioned in work order, study was conducted in area within a distance of 10km from periphery of the Project site. Baseline data for environmental attributes like landuse, ambient air, water, soil, noise, ecology and biodiversity data etc. were collected as per schedule. The study was conducted during the post-monsoon season.

2.4 METHODOLOGY

Baseline data of environmental attributes like ambient air, water, soil, meteorology, noise, ecology, socio-economic condition is collected as per the standard Terms of Reference stipulated by MoEF&CC. The primary data are collected from site monitoring. In case primary data is not possible to be collected due to long term data needs, the secondary data collected from published sources and State agencies are used after validation and updation using appropriate statistical technique prior to use. The methodology adopted for study is given below

2.5 PRIMARY DATA COLLECTION

The primary data collection is a pre-requisite for an Environment Impact Assessment Study in order to provide a description of the status and trends of environmental factors against which the predicted changes can be compared and evaluated in terms of importance. Wherever possible, the primary data are interpreted with site conditions and secondary data. The data collected is mentioned in **Table 2.2**.

Table 2.2: Methodology for Sample Collection & Analysis

Sl. No	Component	Primary Data				
		Frequency of Sampling	No. of Locations	Parameters	Instrument	Method
1.	Ambient Air Quality	24 hourly samples twice a week for 3-	4	PM_{10}	Respirable Dust Samplers (APM 460 BL) with gas attachment	Gravimetric
				$PM_{2.5}$		West & Gaek
				SO_2		Jacobs &

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

Sl. No	Component	Primary Data				
		Frequency of Sampling	No. of Locations	Parameters	Instrument	Method
		months				Hochheiser
				NO$_2$	Fine Particle Sample	-
				CO	NDIR	Infrared Analysis
2.	Noise Level	Different intervals of time for 24 hours	4	Leq for day time and Leq for night time	Integrated sound level meter.	Measurements were taken following CPCB's procedure
3.	Water Quality	Once in study period	4GW & 4 SW samples	Physical, chemical and heavy metals	Spectro-photometer Atomic Absorption Spectro-photometer, Flame Photometer	Titrametric, gravimetric, photometric, AAS
4.	Soil Quality	Once in study period	4 samples	Physico-chemical characteristics	Kjeldal Nitrogen, PH meter, conductivity meter, hydrometer	Gravimetric, photometric
5.	Ecology	Once in study period	Study Area	Flora, fauna	Field data collection	Quadrant method

Source: On-site monitoring/sampling by EEPL

2.6 SOIL QUALITY

The quality of soil is rather dynamic and can affect the sustainability and productivity of land use. It is the end product of soil degradative or conserving processes and is controlled by chemical, physical, and biological components of a soil and their interactions (Papendick and Parr, 1992). Indicators, however, will vary according to the location and the level of sophistication at which measurements are likely to be made (Riley, 2001). Therefore, it is not possible to develop a single short list which is suitable for all purposes. Syers et al. (1995) also emphasized the range of likely indicators rather than the use of a single indicator.

Indicator	Soil function

Indicator	Soil function
Soil organic matter (SOM)	Soil structure, stability, nutrient retention; soil erosion Carter, 2002)
Physical: soil aggregate stability, infiltration and bulk density	Retention and mobility of water and nutrients; habitat for macro and micro fauna (Bengtsson, 1998; Swift et al., 2004)
Chemical: pH, extractable soil nutrients, N-P-K and base cationsCa Mg & K	Soil biological and chemical activity thresholds; plant available nutrients and potential for N and P as well as loss of Ca, g & K (Doran and Jones, 1996a; Drinkwater et al., 1996)
Biological: microbial biomass C and N; potentially mineralizable N	Microbial catalytic potential and repository for C and N; soil productivity and N supplying potential (Cadisch and Giller, 1997; Doran and Jones, 1996b)

2.6.1   Characteristics of the Soil in the Study Area

Soil of the study area can be classified into three categories viz. i) Red soils, ii) Alluvial soils and iii) Lateritic soils.

Red soil has limited distribution in the north-western part of the area. They are the red coloured sedentary soils found mainly on laterite supporting Sal vegetation. They are also found along the margins of small hills base of vegetation. They are free from calcium carbonate (CaCO3), low in Base Exchange capacity and a highly unsaturated base.

The alluvial soils have wide distribution in the eastern, central and south-eastern parts of the area. They are grouped according to Damodar - Rajmahal riverine, Damodar flatlands, Damodar highlands etc. The older alluvium amongst them is unaffected by floods and siltation whereas the younger or never alluvium, found mostly in Damodar flatland areas are enriched by silt deposition during floods.

The laterite soilhas wide distribution in the central, western and southwestern parts of the area. Such soils are distinguished from the red soils by the occurrence of ferruginous concretions in a definite layer.

According to textural type, soils of the area can be classified as following types – a) Sandy, b) Sandy loam, c) Loam, d) Sandy clay loam and f) clay. Clay, clay dominated loam and loam is mostly confined to the flood plain of the Damodar and other small river valleys. The area as a whole is covered by loam and sandy loam.

For studying soil quality, 6 samples were collected from the study area by random grid method of 10 m x 10 m grid by ramming a core-cutter into the soil up to a depth of 90 cm. Composite samples have been collected from each grid, by mixing of eight sub-samples and reducing the weight to approximately 500 gm by conning and quartering method. The samples were packed in polyethylene bags and assigned a number. The collected samples were air dried at room temperature in the laboratory and lightly

crushed with mortar-pastle and passed through 2 mm sieve. The soil samples were analyzed for the physico-chemical properties by standard procedure as presented in **Table 2.3**.

Table 2.3: Analytical Technique for Soil Sample

Sl. No.	Parameters	Analytical Method	Reference
1	Texture	Sieve analysis & Hygro meter	-
2	Moisture Content	Gravimetric	Department of Agriculture & Co-operation, Govt. of India Page No. 76-77:2011
3	pH	pH meter	IS2720- Part 26, 1987 by pH meter
4	Conductivity (1:2)	Conductivity meter	Department of Agriculture & Co-operation, Govt. of India Page No. 81-82:2011
5	Organic Matter	Black method	IS2720-(Part 22),1972, Reaffirmed 2001
7	Organic Carbon	Calculation	IS2720-(Part-22),1972, Reaffirmed 2001 (By calculation)
8	Potassium	Flame Photometric	TM-S/13
9	Phosphorus	Spectrophotometric	TM-S/11
10	Nitrogen	Distillation & Titration	TM-S/17
11	Infiltration Rate		TM-S/40
12	Bulk Density	Sand replacement, core cutter	TM-S/34
13	Porosity		TM-S/33

The soil quality as analysed from the collected samples and their locations shown in **Table 2.4** & **Figure 2.1**.

Table 2.4: Soil Sampling Location and Results of Soil Testing

Parameters	Project Site (S1)	Naya Rampur (S2)	Bajarmuda (S3)	Kolam (S4)
Texture	Sandy Loam	Silty Clay	Silty Clay	Silty Clay Lome
Clay (%)	15	43	41	38
Silt (%)	28	45	41	51
Sand (%)	57	12	18	11
Bulk density (g/cm^3)	1.29	1.12	1.24	1.23
Moisture content (%)	7.5	6.8	7.1	8.2
Infiltration Rate (%)	2.54	3.41	2.87	2.59
pH	6.7	7.3	6.1	7.1

Parameters	Project Site (S1)	Naya Rampur (S2)	Bajarmuda (S3)	Kolam (S4)
EC (μmhos /cm)	147	154	162	149
Organic Carbon (%)	2.09	2.71	2.78	2.17
Available N (kg/ha)	387.1	429.2	413.6	741.6
Available P (kg/ha)	1.57	1.85	1.29	1.09
Available K (kg/ha)	288.3	198.4	241.9	318.4

Source: On-site monitoring/sampling by EEPL
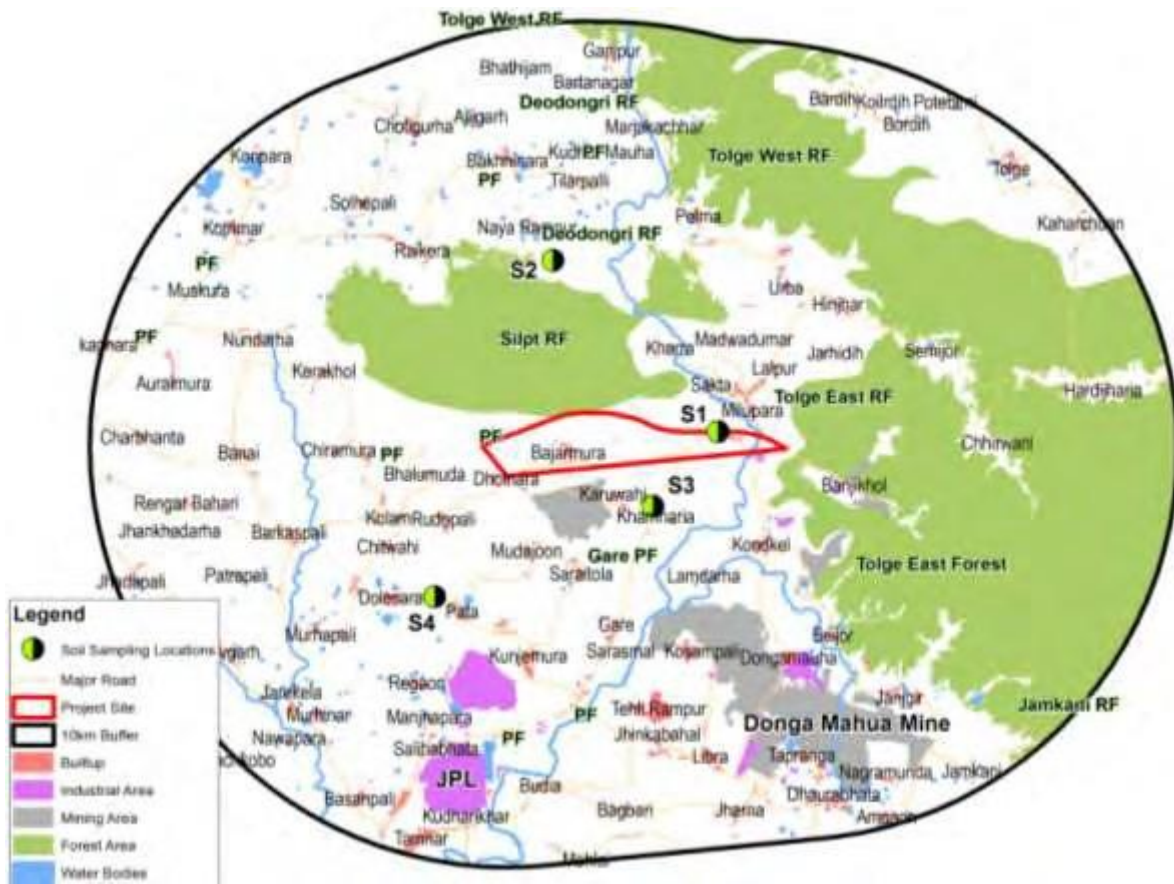
Figure 2.1: Soil Sampling Locations

Standard Classification of Soil as per Indian Council of Agriculture Research, New Delhi is presented below in **Table 2.5**.

Table 2.5: Standard Classification of Soil

S. No.	Soil Test	Classification
1.	pH	<4.5 Extremely acidic 4.51- 5.50 Very strongly acidic 5.51-6.0 moderately acidic 6.01-6.50 slightly acidic 6.51-7.30 Neutral 7.31-7.80 slightly alkaline

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

S. No.	Soil Test	Classification
		7.81-8.50 moderately alkaline 8.51-9.0 strongly alkaline 9.01 very strongly alkaline
2	Salinity Electrical Conductivity (mmhos/cm) (1 ppm = 640 mmho/cm)	Up to 1.00 Average 1.01-2.00 harmful to germination 2.01-3.00 harmful to crops (sensitive to salts)
3	Organic Carbon	Up to 0.2: very less 0.21-0.4: less 0.41-0.5 medium, 0.51-0.8: on an average sufficient 0.81-1.00: sufficient >1.0 more than sufficient
4	Nitrogen (Kg/ha)	Up to 50 very less 51-100 less 101-150 good 151-300 Better >300 sufficient
5	Phosphorus (Kg/ha)	Up to 15 very less 16-30 less 31-50 medium, 51-65 on an average sufficient 66-80 sufficient >80 more than sufficient
6	Potash (Kg/ha)	0 -120 very less 120-180 less 181-240 medium 241-300 average 301-360 better >360 more than sufficient

Source: Handbook of Agriculture, Indian Council of Agriculture Research, New Delhi

2.6.2 Observation & Interpretation

Moisture: Soil moisture is important for hydrological, biological and biogeochemical processes. The field moisture of all the samples range between 6.8% at S2 (Naya Rampur) to 8.2% at near S4 (Kolam). Comparatively forest area soil is found to have higher soil moisture as because plantation roots hold more water. The moisture content of the study area,however, remains lower than the wilting point (refer **Figure 2.2**).
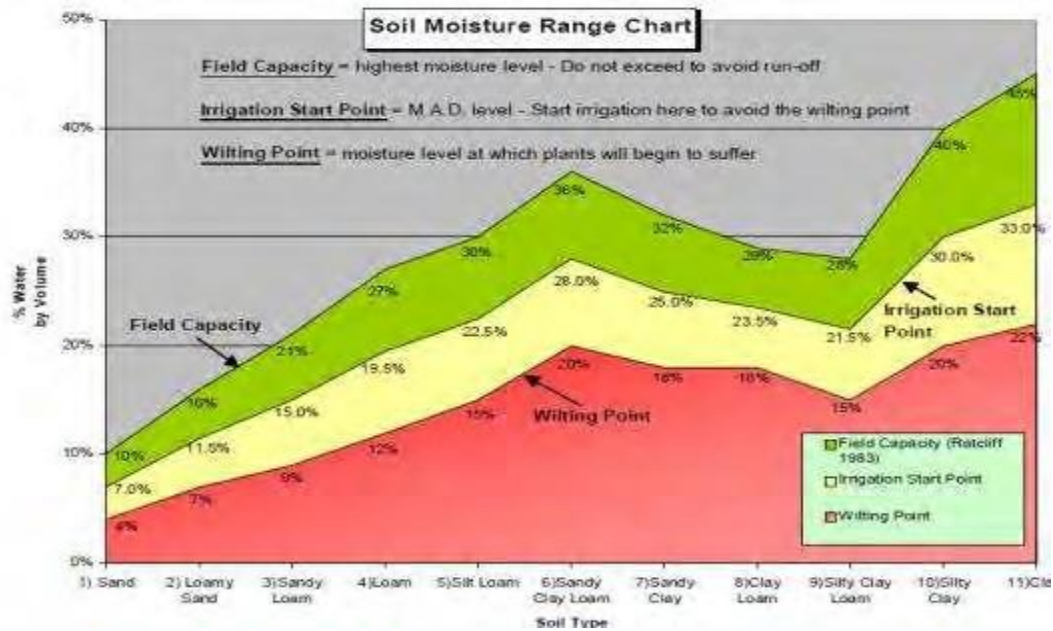
Figure 2.2: Soil moisture Range Diagram

Bulk Density: Bulk density of a soil is a dynamic property that varies with the soil structural conditions. In general, it increases with profile depth, due to changes in organic matter content, porosity and compaction. It is required for gaseous exchange, such as high bulk density would pose restriction to the growth of deeper-rooted plants and may be one of the reasons of cessation of plant growth (Ghose et al., 2004). Bulk density of the study area ranges between 1.12 gm/cm^3 at S2 (Naya Rampur) to 1.29 gm/cm^3 at S1 (Project site). A normal range of bulk densities for clay is 1.0 to 1.6 mg/m^3 and a normal range for sand is 1.2 to 1.8 mg/m^3 with potential root restriction occurring at $\geq$ 1.4 mg/m^3 for clay and $\geq$1.6 mg/m^3 for sand. Bulk density of a soil is a dynamic property that varies with the soil structural conditions. In general, it increases with profile depth, due to changes in organic matter content, porosity and compaction.

Infiltration Rate: Infiltration rate is dependent on soil texture (percentage of sand, silt, and clay) and clay mineralogy. Water moves more quickly through the large pore spaces in a sandy soil than it does through the small pores of a clay soil, especially if the clay is compacted and has little or no structure or aggregation. Infiltration rate of the study area ranges between minimum 2.54 cm/hr at S1 (project site) to maximum 3.41 cm/hr at S1 (Naya Rampur).

Soil organic matter affects infiltration through its positive effect on the development of stable soil aggregates, or crumbs. Highly aggregated soil has increased pore space and infiltration. Soils high in organic matter also provide good habitat for soil biota, such as earthworms, that through their burrowing activities, increase pore space and create continuous pores linking surface to subsurface soil layers.

Soil Texture: According to the study of soil texture, the soil of the study area varies from silty Sandy Loam (S1), silty Clay (S2 – S3) and silty Clay Loam (S4). Loam soil is ideal for

growing crops because it retains nutrients well and retains water while still allowing the water to flow freely. These soils allow for better water penetration than clays, better water holding capacity and better nutrient retention than sands and silts, and more of the soil moisture and nutrients available to the plants than in clays.

Electrical Conductivity: The electrical conductivity of soil is actually a measure of salinity. Excessively high salinity can affect plants in the following ways: Specific toxicity of a particular ion (such as Sodium), higher osmotic pressure around the roots prevents an efficient water absorption by the plant. Some plants are more susceptible to electrical conductivity than others and each species has an electrical conductivity threshold, beyond which yield decreases. In the study area soil conductivity varies between 147 μmhos /cm at S1(Project site) to 162 μmhos/cm at near S3 (Bajarmuda).

pH: The pH value recorded in the study area varies from 6.1 at S3 (Bajarmuda) to 7.3 at S2 (Naya Rampur), which are "Slightly Alkaline to moderate alkaline" as per ICAR report. Forest soil pH found lowest in the selected monitoring locations among the study area and slightly acidic in nature. Naturally acidic soils are most commonly found in areas where soils were formed from acid forming parent material, forest soils, mining sites containing pyritic (iron and elemental sulfur [SO]) minerals. Soil acidity in the seeding zone is becoming a problem on some cropland soils because of N fertilization. Alkaline soils have a high saturation of base cations (K^+, Ca^{2+}, Mg^{2+} and Na^+). This is due to an accumulation of soluble salts which are classified as either saline soil or alkaline soil.

Phosphorus: Phosphorus is the key content which plays an important role in the photosynthesis, respiration, energy storage and transfer, cell division, cell enlargement and several other properties in the living plant. Available Phosphorus ranges between 1.09 kg/ha at S4 (Kolam) site to 1.85 kg/ha at S2 (Naya Rampur). As per ICAR classification the phosphorus in the study area present is classified as "less" to "medium".

Potassium: Potassium is an essential plant nutrient and is required in large amounts for proper growth and reproduction of plants. Potassium is considered second only to nitrogen, when it comes to nutrients needed by plants, and is commonly considered as the "quality nutrient." It affects the plant shape, size, color, taste and other measurements attributed to healthy produce. Potassium content in the study area ranges between 198.4 kg/ha at S2 (Naya Rampur) to 318.4 kg/ha at S4 (Kolam). As per ICAR classification the potassium in the study area present is classified as "very less".

Nitrogen: Nitrogen is important because it is a major component of chlorophyll, the compound by which plants use sunlight energy to produce sugars from water and carbon dioxide during photosynthesis. It is also a major component of amino acids. Soil nitrogen exists in three general forms: organic nitrogen compounds, ammonium (NH_4^+) ions and nitrate (NO_3^-) ions. The majority of plant-available nitrogen is in the inorganic forms NH_4^+ and NO_3^- (sometimes called mineral nitrogen). Nitrogen content

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

in the surface soil of the study area varies between 387.1 kg/ha at S1 (Project Site) to 541.6 kg/ha at S4 (Kolam). As per ICAR classification the nitrogen in the study area present as "less" to "good" in the study area.

Organic Carbon: The organic matter of the soil has its origin in the decay of dead plants and animals Researches on soil and plants have received considerable impetus in connection with the role of organic matter in regulating the growth of plants. But it must be remembered that all organic matters are not beneficial to higher plants. In the coastal region soil organic matter also rise by soil salt. The soil organic matter plays an important role as the store house of plants nutrients. In the study area organic matter varies between the 2.09% at S1 (Project site) to 2.78% at near S3 (Bajarmuda). As per ICAR classification the organic matter found in the study area is "less" to "on an average sufficient".

Sampling Code: S1

Name of Site: Near Project Site

Sampling Code: S2

Name of Site: Naya Rampur

Sampling Code: S3   **Name of Site:** Bajarmuda

Sampling Code: N4   **Name of Site:** Kolam

2.7   WATER ENVIRONMENT

2.7.1   Water Quality

Four ground water and three surface water samples were collected and analyzed for physico-chemical, heavy metals and bacteriological parameters in order to assess the effect of industrial and agriculture activities. The sampling locations are shown in **Figure 2.3**. The samples were analyzed as per the procedures specified in 'Standard Methods for the Examination of Water and Wastewater' published by American Public Health Association (APHA) and IS 10500. Samples for physico-chemical analysis were collected in polyethylene and glass bottle and preserved as per standard procedure (APHA 22nd edtn.). Samples collected for metal content were acidified with 1ml HNO_3. Samples for bacteriological analysis were collected in sterilized bottles.

Table 2.6: Standard Operating Procedures (SOP) For Water & Wastewater Sampling and Analysis

Sl. No	Parameter	Sample collection	Sample Size	Storage/ preservation
1	pH	Grab sampling, Plastic /glass container	50 ml	On site analysis

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

Sl. No	Parameter	Sample collection	Sample Size	Storage/ preservation
2	Electrical Conductivity	Grab sampling, Plastic /glass container	50 ml	On site parameter
3	Total Dissolved Solids	Grab sampling, Plastic /glass container	100 ml	Refrigeration,can be stored for 7 days
4	Oil & Grease	Wide mouth glass container	500 ml	Add HCl to pH>2, refrigeration, 28 days
5	Hardness	Grab sampling, Plastic /glass container	100 ml	Add HNO_3 to pH<2, refrigeration; 6 months
6	Chlorides	Grab sampling,Plastic / glass container	50 ml	Not required; 28 days
7	Sulphates	Grab sampling, Plastic /glass container	100 ml	Refrigeration; 28 days
8	Sodium, Potassium	Plastic container	100 ml	Not required; 6 months
9	Nitrates	Plastic containers	100 ml	Refrigeration; 48 hrs
10	Alkalinity	Plastic/ glass containers	100 ml	Refrigeration; 14 days
11	Heavy Metals	Plastic/ Glass rinsed with 1+1 HNO_3	500 ml	HNO_3 to pH>2; Grab sample; 6 months

Source: Standard Methods for the Examination of Water and Wastewater, Published By APHA, 22nd Edition, 2012

The analytical procedures are described in **Table 2.7.** The error in ion-balance computation, considering the relationship between the total cations (Ca^{2+}, Mg^{2+}, Na^+, K^+) and the total anions (NO_3^-, SO_4^{2-}, HCO_3^- and Cl^-) for each set of complete analyses of water sample, is observed to be within the range of acceptability ($\pm 3\%$) used in most laboratories (Appelo and Postama 2005 and APHA 22nd edtn).

Table 2.7: Analytical Procedure

Sl. No.	Parameters	Analytical Method	Reference
1	pH	pH meter	IS : 3025 (Part-11)
2	Turbidity	Nephelometer	IS : 3025 (Part-10)
3	Conductivity (at 25 C)	Conductivity meter	APHA 22st edition, 2510 B:2012
4	Total Dissolve Solids	Gravimetric	IS : 3025 (Part-16)
5	Alkalinity as $CaCO_3$	Titrimetrically	IS : 3025 (Part-23)
7	Total Hardness as $CaCO_3$	Titrimetrically	IS : 3025 (Part-21)
8	Calcium as Ca	Titrimetrically	IS : 3025 (Part-40)
9	Magnesium as Mg	Calculation	APHA 22st edition,3500 Mg B:2012
10	Sodium	Flame Photometric	APHA 22st edition, 3500 Na

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

Sl. No.	Parameters	Analytical Method	Reference
			B:2012
11	Potassium	Photometric	APHA 22st edition,3500 K-B:2012
12	Chloride as Cl	Argenometric	IS : 3025 (Part-32)
13	Sulphate as SO_4	Tubidimetric	IS : 3025 (Part-24)
14	Nitrate as NO_3	Spectro photometric	IS : 3025 (Part-34)
15	Phosphate	Spectrophotometric	IS : 3025 (Part-31)
16	Fluoride as F	Ion-meter	APHA 22st edition,4500 F-D:2012
17	Phenolic compound as C_6H_5OH	Spectrophotometric	IS : 3025 (Part-43)
18	Cyanide	Spectrophotometric	IS : 3025 (Part-27)
19	Dissolve Oxygen	Winkler Method	IS:3025 (Part-38), Reaffirmed 2009
20	Oil & Grease	Gravimetric	IS:3025 (Part 39), 1991 (Reaffirmed 2003)
21	Arsenic	AAS	IS : 3025 (Part-37)
22	Cadmium	AAS	IS : 3025 (Part-41)
23	Total Chromium	AAS	IS : 3025 (Part-52)
24	Iron	AAS	IS:3025 (Part-53), Reaffirmed 2009
25	Copper	AAS	IS : 3025 (Part-42)
26	Lead	AAS	IS : 3025 (Part-47)
27	Manganese	AAS	IS : 3025 (Part-59)
28	Mercury	AAS	IS : 3025 (Part-48)
29	Zinc	AAS	IS : 3025 (Part-49)
30	Total Coliform	MPN Method	IS : 1622 : 1981

2.7.2   Onsite Measurement

pH, temperature and conductivity were analyzed at the time of sample collection. For dissolved oxygen, samples were collected in standard BOD bottle and fixed the oxygen by manganese oxide and alkaline iodide immediately after collection of the sample.

2.7.2.1   Ground Water Quality

Groundwater is the major source of drinking water in the area. Besides, it is an important source of water for the agricultural and the industrial sector. The villages in the study area have used bore-well, as most of the residents of these villages make use of this water for drinking, agricultural and other domestic uses. Therefore, bore-well water have been considered for sampling. The results of the water quality monitored during the study period are given in **Table 2.8**.

Table 2.8: Result of Ground Water Analysis

Sl. No	Parameters	Unit	Code of Sampling Sites				IS 10500:2012	
			GW 1	GW 2	GW 3	GW 4	Acceptable limits	Permissible limits
			Project Site	Naya Rampur	Bajarmuda	Chirrramuda		
Physical Parameters								
1	Color	Hazen	<5	<5	<5	<5	5	15
2	Turbidity	NTU	<5	<5	<5	<5	1	5
3	pH	--	7.10	7.30	7.60	7.70	6.5-8.5	NR
4	Conductivity	µS/cm	439.0	747.7	406.8	691.1	$	$
5	TDS	mg/l	267.8	463.60	263.0	429.8	500	2000
Chemical Parameters								
6	Alkalinity	mg/l	91.0	196.0	89.0	192.0	200	600
7	Total Hardness	mg/l	117.4	243.3	112.8	243.8	300	600
8	Calcium	mg/l	15.20	48.20	18.8	47.9	75	200
9	Magnesium	mg/l	19.30	29.90	16.0	30.2	30	100
10	Sodium	mg/l	39.0	40.7	35.0	28.0	$	$
11	Potassium	mg/l	6.0	9.0	5.0	10.0	$	$
12	Bicarbonate	mg/l	91.0	196.0	89.0	192.0	$	$
13	Chloride	mg/l	77.0	89.4	69.0	79.2	250	1000
14	Sulphate	mg/l	18.70	27.1	17.3	36.8	200	400
15	Nitrate	mg/l	1.60	23.3	1.7	1.63	45	NR
16	Fluoride	mg/l	0.29	0.24	0.27	0.71	1.00	1.5
17	Phenolic compound	mg/l	BDL	BDL	BDL	BDL	0.001	0.002
18	Cyanide	mg/l	BDL	BDL	BDL	BDL	0.05	NR
19	Aluminum	mg/l	BDL	BDL	BDL	BDL	0.03	0.2
20	Arsenic	mg/l	BDL	BDL	BDL	BDL	0.01	0.05
21	Cadmium	mg/l	BDL	BDL	BDL	BDL	0.003	NR
22	Chromium	mg/l	BDL	BDL	BDL	BDL	0.05	NR
23	Iron	mg/l	0.13	0.41	0.08	0.27	0.30	NR

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

Sl. No	Parameters	Unit	Code of Sampling Sites				IS 10500:2012	
			GW 1	GW 2	GW 3	GW 4	Acceptable limits	Permissible limits
			Project Site	Naya Rampur	Bajarmuda	Chirrramuda		
24	Copper	mg/l	BDL	BDL	BDL	BDL	0.05	1.5
25	Lead	mg/l	BDL	BDL	BDL	BDL	0.01	NR
26	Manganese	mg/l	BDL	BDL	BDL	BDL	0.1	0.3
27	Mercury	mg/l	BDL	BDL	BDL	BDL	0.001	NR
28	Zinc	mg/l	0.14	0.07	0.16	0.23	5	15

Source: On-site monitoring/sampling and analysis by EEPL
$- Not Specified, NR= No Relaxation

Table 2.9: Detection Limit

Sl. No.	Parameter	Unit	Detection limit
1	Cyanide (as CN)	mg/l	0.008
2	Phenolic Compounds	mg/l	0.001
3	Total Chromium (as Cr)	mg/l	0.005
4	Zinc (as Zn)	mg/l	0.005
5	Aluminum (as Al)	mg/l	0.01
6	Copper (as Cu)	mg/l	0.005
7	Manganese (as Mn)	mg/l	0.005
8	Nickel (as Ni)	mg/l	0.005
9	Arsenic (as As)	mg/l	0.005
10	Lead (as Pb)	mg/l	0.005
11	Selenium (as Se)	mg/l	0.005
12	Cadmium (as Cd)	mg/l	0.005
13	Hg	µg/l	0.05
14	Iron	mg/l	0.1

pH: The data revealed that the pH value of ground water samples varied from 7.10 to 7.70. The water samples were slight alkaline in characteristic. The reasons for such conditions may be due to different types of buffers that may be present in the ground water and presence of weak basic salt in the soil.

Conductivity: Conductivity of ground water ranged between 406.80 µS/cm to 747.70 µS/cm. The maximum value of EC was observed in at GW2 (Naya Rampur) and the minimum value found in the sample at village at GW3 (Bajarmuda). No limit has been specified by BIS for conductivity.

Hardness: Hard water makes it difficult for domestic water users. Hardness is defined as the concentration of calcium and magnesium in water expressed as the equivalent of calcium carbonate ($CaCO_3$).

The maximum total hardness of ground water was found to be 243.79 mg/l in sample at GW4 (Chirramuda) and the minimum was observed as 112.75 mg/l in the sample at GW2 (Bajarmuda). 100 % of the samples were within the permissible limit recommended by BIS (600 mg/l) and WHO (450 mg/l) but 75% of the samples exceed the acceptable limit of BIS (300 mg/l).

Sulphate: Sulphate is a naturally occurring element found in ground water. Minimum Sulphate concentration was found at GW3 (Bajarmuda, 17.30 mg/l) and a maximum of 36.80 mg/l at GW4 (Chirramuda). The acceptabled BIS limit for sulphate in drinking water is 200 mg/l and maximum permissible limit is 400 mg/l. None of the samples exceeded the acceptable limit and maximum permissible limit prescribed by BIS.

Chloride: The maximum chloride concentration (89.40 mg/l) was found at GW2-Naya Rampur and the minimum (69.00 mg/l) was recorded at GW3-Bajarmuda.The samples were compared with the BIS standard and all the samples were within the acceptable limit of 250 mg/l.

Nitrate: The concentration of nitrate in ground water samples ranged from 1.60 mg/l at GW1-Project Site to 2.30 mg/l at GW2-Naya Rampur. All the samples were compared with the BIS standard and found within the acceptable limit of 45 mg/l.

Fluoride: Fluoride in groundwater has drawn worldwide attention due to its considerable impact on human physiology. Though fluoride is considered as an essential element at very lower concentration for human beings, higher concentration leads to health defects. The maximum level of fluoride (0.71 mg/l) was found in GW4 (Chirramuda) and the minimum value (0.24 mg/l) was found at GW2 (Naya Rampur).

Heavy Metals: Some of the metals are essential to sustain life - calcium, magnesium, potassium and sodium must be present for normal body functions. Also, cobalt, copper, iron, manganese, molybdenum and zinc are needed at low levels as catalyst for enzyme activities (Adepoju-Bello et al., 2009). However, excess exposure to heavy metals can result in toxicity.

In the ground water samples, iron concentration was found in the range of 0.08 mg/l at GW3 to 0.41 mg/l at GW2. The recommended BIS acceptable limit for iron in drinking water is 0.3 mg/l. 75% of the samples recorded concentration more than the acceptable limit.

Zinc concentration in the ground water samples were within the acceptable limit of 5 mg/l prescribed by BIS. Other heavy metals like arsenic, cadmium, chromium, copper, lead, manganese and mercury were recorded below detection limit.

2.7.2.2 Surface Water Quality

The samples for ascertaining surface water quality was collected from 3 locations. The details of the locations and the water quality is shown in **Table 2.10** & Ground water sampling Locations and Surface water sampling Locations area shown in **Figure 2.3**.

Table 2.10: Surface Water Quality

| Sl. No. | Parameters | Unit | Site Code | | | |
			SW1: Chini Nala	SW2: Kelo River	SW3: Bendra Nala	SW3: Pond at Bajarmuda
1	Color	Hazen	<5	<5	<5	<5
2	Turbidity	NTU	20	25	32	20
3	pH	--	7.6	7.5	7.8	7.5
4	Conductivity (at 25^{0}C)	µS/cm	328	318	351	301
5	Total Dissolve Solids	mg/l	196.0	194.0	216.0	191.0
6	Alkalinity as CaCO$_3$	mg/l	68.5	81.5	84	76.2
7	Total Hardness as CaCO$_3$	mg/l	109.3	95.0	130.0	98.5
8	Calcium as Ca	mg/l	28.8	24.7	32.8	27.1
9	Magnesium as Mg	mg/l	9.1	8.1	11.7	7.5
10	Sodium	mg/l	12	15	8	11
11	Potassium	mg/l	8.8	9.2	7.1	8.1
12	Bi-Carbonate	mg/l	68.5	81.5	84.0	76.2
13	Chloride as Cl	mg/l	39.9	41.8	39.2	39.7
14	Sulphate as SO$_4$	mg/l	19.5	8.4	18.7	9.1
15	Nitrate as NO$_3$	mg/l	11.2	1.9	9.8	1.8
16	Fluoride as F	mg/l	0.28	0.19	0.26	0.17
17	Phenolic compound	mg/l	BDL	BDL	BDL	BDL
18	Cyanide	mg/l	BDL	BDL	BDL	BDL
19	DO	mg/l	4.7	5.3	5.1	4.2
20	BOD	mg/l	2.3	2.1	2.4	3.8
21	COD	mg/l	6.9	8.9	7.3	7.8
22	Oil & Grease	mg/l	<5	<5	<5	<5
23	Arsenic	mg/l	BDL	BDL	BDL	BDL
24	Cadmium	mg/l	BDL	BDL	BDL	BDL
25	Total Chromium	mg/l	BDL	BDL	BDL	BDL
26	Iron	mg/l	0.29	1.18	2.18	1.19
27	Copper	mg/l	BDL	BDL	BDL	BDL

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

Sl. No.	Parameters	Unit	Site Code			
			SW1: Chini Nala	SW2: Kelo River	SW3: Bendra Nala	SW3: Pond at Bajarmuda
28	Lead	mg/l	BDL	BDL	BDL	BDL
29	Manganese	mg/l	BDL	BDL	BDL	BDL
30	Mercury	mg/l	BDL	BDL	BDL	BDL
31	Zinc	mg/l	BDL	BDL	BDL	BDL
32	Total Coliform	MPN/100ml	920	1400	1400	920

Source: On-site monitoring/sampling and analysis by EEPL

Table 2.11: Water Quality Criteria as per CPCB

Designated Best Use	Class of Water	Criteria
Drinking water source without conventional treatment but after disinfection	A	• Total Coliform Organism MPN/100ml shall be 50 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 6mg/l or more • Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organised)	B	• Total Coliform Organism MPN/100ml shall be 500 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 5mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	• Total Coliform Organism MPN/100ml shall be 5000 or less • pH between 6 to 9 • Dissolved Oxygen 4mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	D	• pH between 6.5 to 8.5 • Dissolved Oxygen 4mg/l or more • Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	• pH between 6.0 to 8.5 • Electrical Conductivity at 25°C micro mhos/cm Max.2250 • Sodium absorption Ratio Max. 26 • Boron Max. 2mg/l
	Below-E	• Not Meeting A, B, C, D & E Criteria

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY
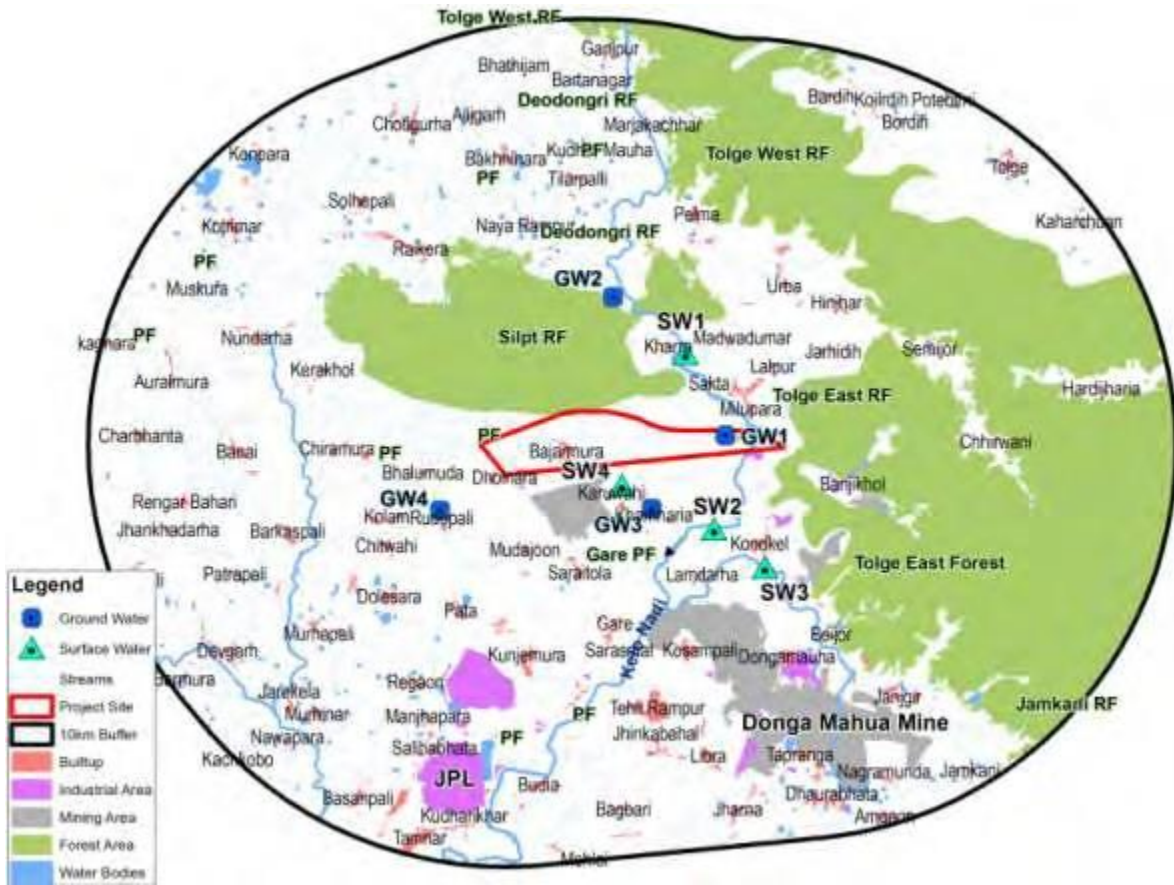
Figure 2.3: Water Sampling Locations

GROUND WATER

Sampling Code: GW1	**Name of Site:** Near Project Site

Sampling Code: GW2

Name of Site: Naya Rampur

Sampling Code: GW3

Name of Site: Bajarmuda

Sampling Code: GW4

Name of Site: Chirramuda

SURFACE WATER

Sampling Code: SW1 | **Name of Site:** Chini Nala

Sampling Code: SW2 | **Name of Site:** Kelo River

Sampling Code: SW3 | **Name of Site:** Bendra nala

Sampling Code: SW4   **Name of Site:** Pond at bajarmuda

2.8   AIR ENVIRONMENT

The prime objective of the baseline air quality study was to establish the existing ambient air quality of the study area, which will also help to assess the conformity to standards of the ambient air quality during the operation of project. This section describes the identification of sampling locations, methodology adopted during the monitoring period and sampling frequency.

2.8.1   Frequency & Parameter of Sampling

Ambient air quality monitoring has been carried out twice a week in each location during the study period (December 2016 to February 2017). The baseline data of ambient air has been generated for the following parameters as mentioned below.

- PM_{10}
- $PM_{2.5}$
- Sulphur-dioxide (SO_2)
- Nitrogen dioxide (NO_2)
- Carbon monoxide (CO)
- Heavy metals in PM_{10}

The duration of sampling of fine particulate matter ($PM_{2.5}$), Respirable particulate matter (PM_{10}), SO_2 and NO_2 was each twenty-four hourly continuous sampling per day and CO was sampled for 8 hours continuous thrice in 24-hour duration. The monitoring was conducted for two days in a week for one month. This is to allow a comparison with the present revised standards mentioned in the latest Gazette Notification of the Central Pollution Control Board (CPCB) (November 2009).

It was ensured that the equipment was placed at a height of at least 3 to 4 m above the ground level at each monitoring station, for negating the effects of wind-blown ground dust. The distance of the sampler from any air flow obstacle i.e. buildings, walls, was more than two times the height of the obstacle. The equipment was placed at open space free from trees and vegetation which otherwise act as a sink of pollutants

resulting in lower levels in monitoring results. Monitoring has been carried out as per the latest CPCB and MoEF&CC guidelines and notifications.

The monitoring locations have been selected keeping in mind the seasonal as well as the annual wind direction pattern of the study area, accessibility, topography, safety and presence of inhabited localities. The details of the monitoring locations are depicted in the **Table 2.12** and **Figure 2.4**.

Table 2.12: Air Quality Monitoring Stations

SL.NO.	Sampling Code	Name of site	Latitude	Longitude
1	AAQ 1	Near Project Site	22°11'0.50"N	83°30'50.91"E
2	AAQ2	Naya Rampur	22°12'9.74"N	83°30'15.22"E
3	AAQ3	Khamahariya	22° 9'15.20"N	83°31'36.36"E
4	AAQ4	Kolam	22° 8'47.24"N	83°27'3.11"E

Source: Selection of monitoring locations by EEPL
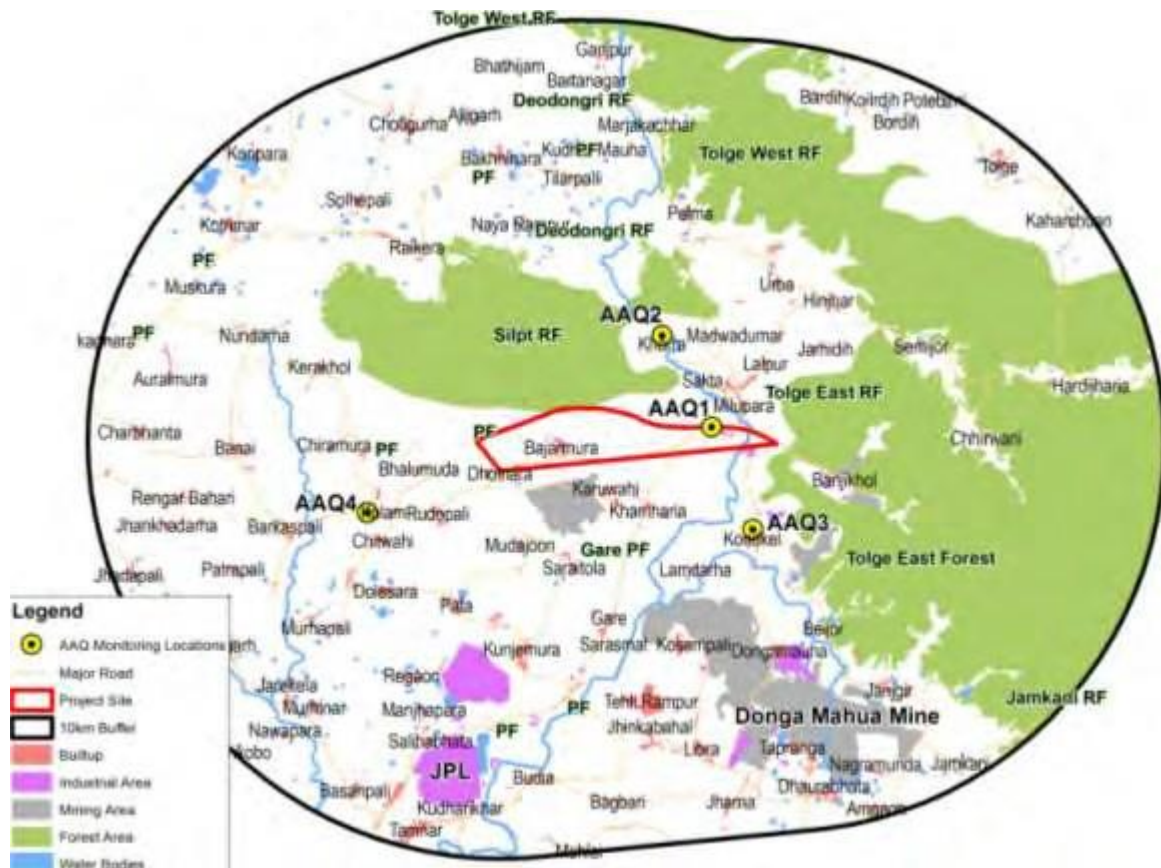
Figure 2.4: Air Quality Sampling Locations

2.8.2 Instruments used for Sampling and Analytical Techniques

With a view to collecting the samples, Envirotech Make Calibrated Respirable Dust Samplers (RDS-APM 460 BL) along with Gaseous attachment and Fine Particulate

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

Matter (FPS-APM 550) have been used. The RDS is capable of drawing air at a flow rate of 0.95 to 1.3 m³/min with very little pressure drop for RDS and FPS is designed to operate at an air flow rate of 1m³/hr. Filter papers (EPM 2000, Whatman & Whatman 46.2 mm dia) were used for the collection of samples to analyze them for particulate matters and heavy metals. Samples for analyzing SO_2 & NO_2 were collected by drawing air at a flow-rate of 0.5 liters per minute (lpm) through an absorbing solution for the duration of 24 hrs. Sampling and analysis methodology adopted is given in **Table 2.13**.

Table 2.13: Sampling & Analysis Methodology

Sl. No.	Parameter	Methodology
1	Particulate Matter 10 (PM_{10}) (µg/m³)	APM 550 Fine Particulate Sampler (Gravimetric method)
2	Particulate Matter 10 ($PM_{2.5}$) (µg/m³)	APM 550 Fine Particulate Sampler (Gravimetric method)
3	Sulphur Dioxide SO_2 (µg/m³)	West and Gaeke Method
4	Nitrogen dioxide NO_2(µg/m³)	IS 5182, Part 6, Jacob &Hochheiser modified
5	Carbon monoxide (mg/m³)	IS 5182, Part 10, Non-dispersive Infrared Absorption method

2.8.3   Analysis of Baseline Concentration

The analysis was carried out as per the method described in the applicable IS codes. Various statistical parameters like 98th percentile, average, standard deviation, maximum and minimum values have been computed from the observed raw data for all the AAQ monitoring locations. The results are shown in **Table 2.14** to **Table 2.18**.

Table 2.14: Particulate Matter (PM_{10}) in µg/m³

Stations	PM_{10}	NAAQS
Near Project Site (AAQ1)	56.5	100
Naya Rampur (AAQ2)	48.7	100
Khamahariya (AAQ3)	53.0	100
Kolam (AAQ4)	51.8	100
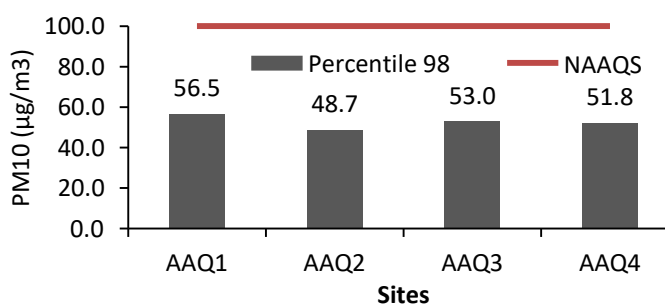
Source: Monitoring/sampling/testing by Envirotech East Private Limited, Kolkata

Table 2.15: Particulate Matter ($PM_{2.5}$) in µg/m³

Stations	$PM_{2.5}$	NAAQS
Near Project Site (AAQ1)	18.6	60
Naya Rampur (AAQ2)	15.0	60

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
Gare Pelma Sector III Coal Block ,Tamnar Tehsil, Raigarh District, Chhattisgarh

ENVIRONMENT BASELINE STUDY
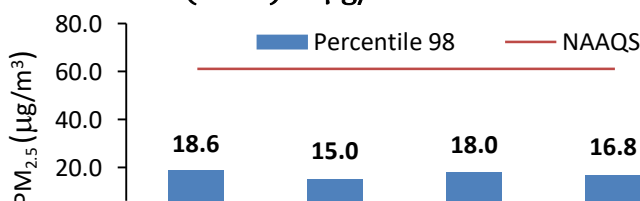
Table 2.15: Particulate Matter (PM$_{2.5}$) in µg/m³

Stations	PM$_{2.5}$	NAAQS
Khamahariya (AAQ3)	18.0	60
Kolam (AAQ4)	16.8	60

Source: Monitoring/sampling/testing by Envirotech East Private Limited, Kolkata

Table 2.16: Sulphur Dioxide (SO$_2$) in µg/m³

Stations	SO$_2$	NAAQS
Near Project Site (AAQ1)	9.7	80
Naya Rampur (AAQ2)	7.5	80
Khamahariya (AAQ3)	6.3	80
Kolam (AAQ4)	8.3	80
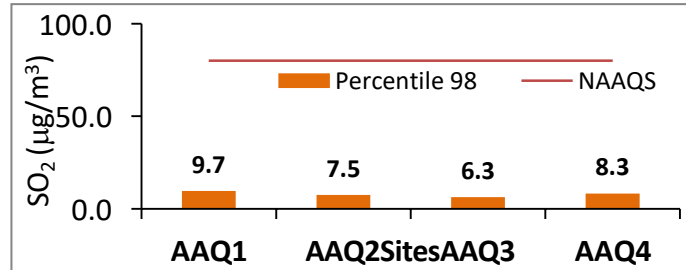
Source: Monitoring/sampling/testing by Envirotech East Private Limited, Kolkata

Table 2.17: Nitrogen Dioxide (NO$_2$) in µg/m³

Stations	NO$_2$	NAAQS
Near Project Site (AAQ1)	14.3	80
Naya Rampur (AAQ2)	10.9	80
Khamahariya (AAQ3)	13.1	80
Kolam (AAQ4)	12.7	80
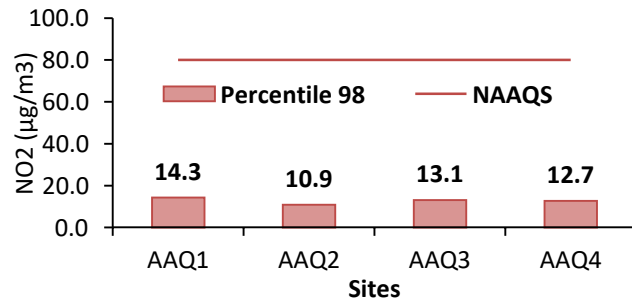
Source: Monitoring/sampling/testing by Envirotech East Private Limited, Kolkata

Table 2.18: Carbon Monoxide (CO) in mg/m³

Stations	CO	NAAQS (8 hr.)
Near Project Site (AAQ1)	0.56	2
Naya Rampur (AAQ2)	0.51	2
Khamahariya (AAQ3)	0.58	2
Kolam (AAQ4)	0.59	2
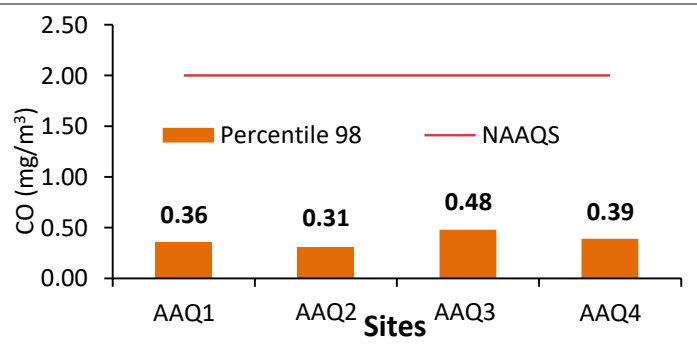
Source: Monitoring/sampling/testing by Envirotech East Private Limited, Kolkata

Heavy metals were recorded below detection limit except Pb, which was recorded only in BAAQ8 (Durgapur) and BAAQ10 (Surya Alloy Industries). The 98th percentile of the results for PM$_{10}$, PM$_{2.5}$, SO$_2$, NO$_2$, CO and Pb are presented in **Table 2.19**.

Table 2.19: Consolidated 24 hours Averaging Values of AAQ (98th Percentile)

Stations	PM$_{10}$ µg/m³	PM$_{2.5}$ µg/m³	SO$_2$ µg/m³	NO$_2$ µg/m³	CO mg/m³

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

Stations	PM_{10}	$PM_{2.5}$	SO_2	NO_2	CO
	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	mg/m^3
Near Project Site (AAQ1)	56.5	18.6	9.7	14.3	0.56
Naya Rampur (AAQ2)	48.7	15.0	7.5	10.9	0.51
Khamahariya (AAQ3)	53.0	18.0	6.3	13.1	0.58
Kolam (AAQ4)	51.8	16.8	8.3	12.7	0.59
National Ambient Air Quality Standard					
Industrial, Residential, Rural & Other Areas	100**	60**	80**	80**	04***
Ecologically Sensitive Area (notified by Central Government)	100**	60**	80**	80**	04**

Source: Gazette of India Notification, dated 18th Nov, 2009

* Annual Arithmetic Means of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals,

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable shall be complied with 98% of the time in a year. 2% of the time they may exceed the limits but not on two consecutive days of monitoring,

*** For CO, 1 hourly standard is being considered

2.8.4   Observation & Interpretation

Particulate Matter (PM_{10} & $PM_{2.5}$): The minimum concentration of PM_{10} and $PM_{2.5}$ was found to be 48.7$\mu g/m^3$ and 15.0 $\mu g/m^3$ respectively at AAQ2 (Naya Rampur). The maximum concentration of these two parameters were recorded as 56.5 $\mu g/m^3$ and 18.6 $\mu g/m^3$ at AAQ1 (Near Project Site). Anthropogenic sources including fuel combustion, incineration, domestic heating for households and fuel combustion for vehicles give rise to PM_{10} concentration in the study area.

Higher concentration of $PM_{2.5}$ were observed in near Project Site due to industrial nature of the area and traffic. In all locations, PM_{10} and $PM_{2.5}$ concentrations were below the prescribed standard.

Sulphur Dioxide (SO_2): The source of SO_2 in the study area is mainly from burning fuels containing sulfur or emissions from coal combustion depending on the Sulphur content in the coal. Sulfur dioxide reacts with other substances in the atmosphere to form sulfate aerosols (USEPA, 1982)[1]. Since most sulfate aerosols are part of $PM_{2.5}$, they may have an important role in the health impacts associated with fine particulates (WHO, 1979)[2]. However, the values of Sulphur pollutants in this case were found well below the NAAQ standard.The concentration of SO_2 in the study area ranges from 6.3 $\mu g/m^3$ in AAQ3 (Khamahariya) to 9.7 $\mu g/m^3$ in AAQ1 (Porject Site).

---

[1]USEPA (United States Environmental Protection Agency). 1982. *Air Quality Criteria for Particulate Matter and Sulfur Oxides.* EPA-600/8-82-029, December, Research Triangle Park, N.C.

[2]WHO (World Health Organization) 1979, "Sulfur Oxides and Suspended Particulate Matter," *Environmental Health Criteria* 8 Geneva

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

Oxides of Nitrogen (NO₂): In the study area, NO_2 concentration varied between 10.9 μg/m³ at AAQ2 (Naya Rampur) to 14.3 μg/m³ at AAQ1 (Near Project Site). The values of Oxides of Nitrogen were found well below the NAAQ standard. The primary sources of NO_2 are motor vehicles, electric utilities and residential sources that burn fuels. NO_2 is one of the main ingredients involved in the formation of ground level ozone, which can trigger serious respiratory problems. It reacts to form nitrate particles, acid aerosols, as well as NO_2, which also cause respiratory problems (NAPAP 1991)[3].

Carbon Monoxide (CO): 98 percentile values of CO in the study area varies from 0.51 mg/m³ in AAQ2 (Naya Rampur) to 0.59 mg/m³ in AAQ4 (Kolam). The values recorded were below the prescribed standard of NAAQ.

Sampling Code: AAQ1

Name of Site: Near Project Site

Sampling Code: AAQ2

Name of Site: Naya Rampur

---

[3]NAPAP (National Acid Precipitation Assessment Program). Various years, 1987–91, Washington, D.C.: Government Printing Office.

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

Sampling Code: AAQ3

Name of Site: Khamahariya

Sampling Code: AAQ4

Name of Site: Kolam

2.9 NOISE LEVEL

Noise levels were recorded at an interval of 60 minutes during the day and night times to compute the day equivalent and night equivalent level. The noise level was recorded continuous for 24 hours at an interval of 1 hour. The noise level was monitored once during the study period at each monitoring location. The noise level is recorded in dB(A). The monitoring locations are shown in **Figure 2.5**.
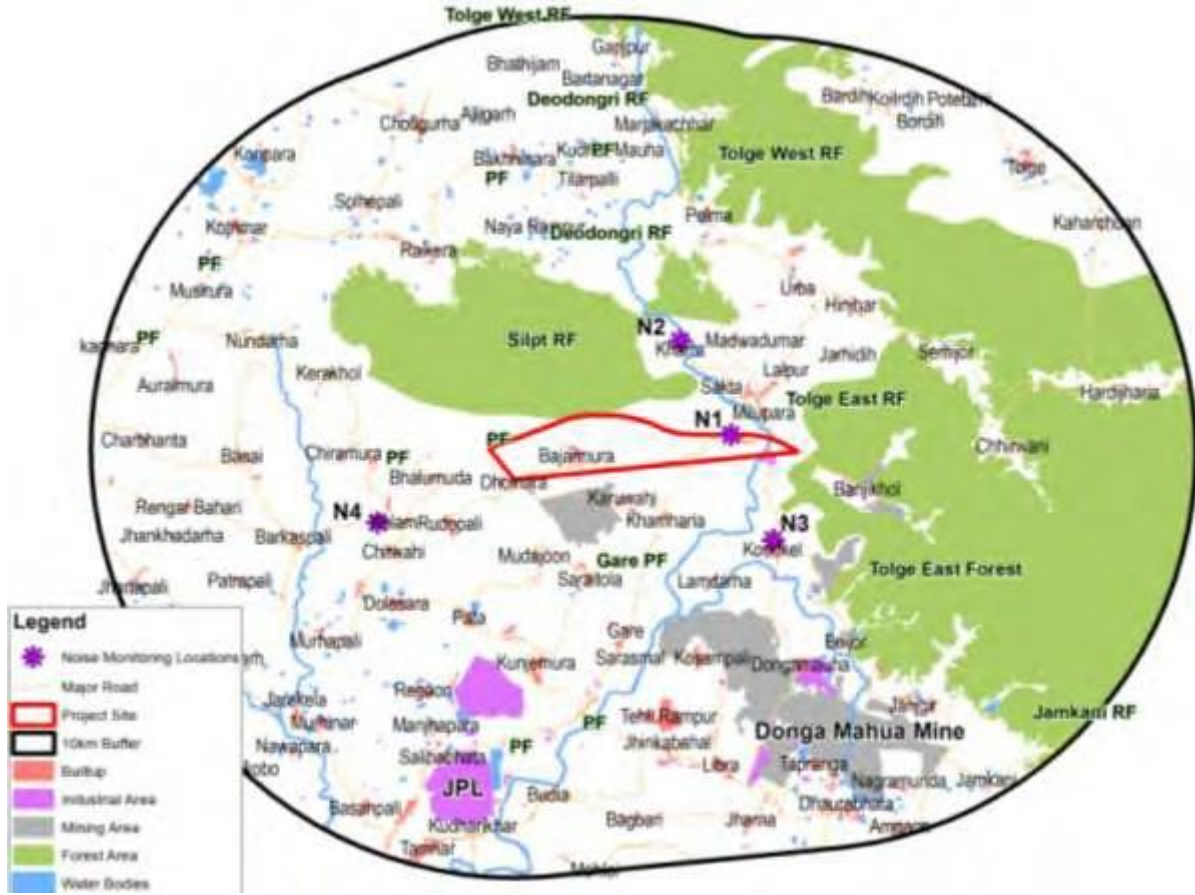
Figure 2.5: Noise Level Monitoring Locations

2.9.1 Sampling Techniques

The SLM100 is a "Type 2" Integrating Sound Level Meter designed to meet the requirements of IS 15575 (Part1) 2005. The instrument has a frequency weighting of "A" type and allows the user to select Slow or Fast mode of measurement. A built-in Data Logger can record all the important Sound Level parameters in Non-Volatile Flash memory for 24 hours making detailed field data collection very simple. Each record consists of the Leq, Lmin and Lmax Sound Pressure Level and Sound Exposure Level (SEL) observed during the recording interval. A built-in Real Time Clock maintains a date and time stamp in the recorded data. National Ambient Noise Quality Standards as per CPCB is given in **Table 2.20.**

Table 2.20: Ambient Noise Quality Standards as per CPCB

Type of Area	Limits in dB(A) Leq*	
	Day Time	Night Time
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

*-dB (A) Leq denotes the time weighted average of the level sound in decibels on scale A which is relatable to human hearing

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

Source: Pollution Control Acts, Rule and Notifications issued there under, by Pollution Control Law Series: PCLS/02/2006(Fifth Edition) of Central Pollution Control Board, January 2006, pp 926
Day and Night time shall mean from 6:00 a.m. to 10:00 p.m. and 10:00 p.m. to 6:00 a.m. respectively

2.9.2   Analysis of Result

According to the classification of CPCB noise monitoring sites in buffer zone remain in two type areas – residential zone (N2 to N3) and industrial zone (N1).

It could be concluded from **Table 2.21** and **Figure 2.6** that the monitored noise level in the study area varied from 69.0 dB (A) at N1 (Project Site) to 44.7 dB(A) N2 (Naya Rampur) during day time.

During night time, the noise level varied between 57.0 dB(A) to 40.1 dB(A) at N1.

Overall the ambient noise level in the monitored locations was found to be within the permissible limits stipulated for residential and industrial areas.

Table 2.21: Noise Level in the Study Area

Sl No	Station Code	Monitoring Station	Average Leq value in dB (A)					
			Day			Night		
			Lmax	Lmin	Leq	Lmax	Lmin	Leq
1	N1	Project Site	69.0	58.4	65.4	57.0	53.5	55.3
2	N2	Naya Rampur	54.1	44.7	50.5	44.5	40.1	42.4
3	N3	Khamahariya	56.9	47.5	53.3	49.0	40.7	43.2
4	N4	Kolam	56.6	46.9	53.0	46.5	41.0	44.7

Source: On-site monitoring/sampling and analysis by EEPL
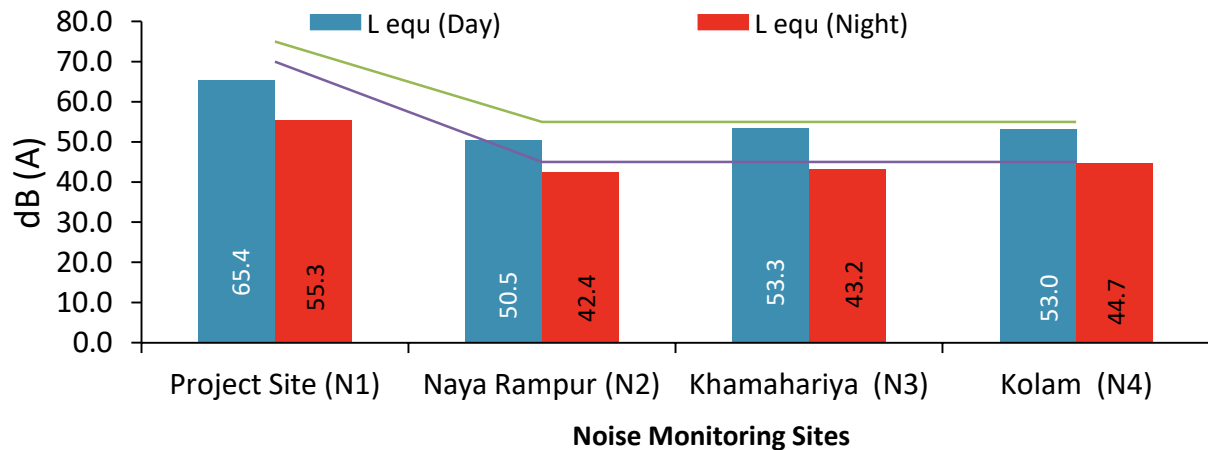
Figure 2.6: Leq during Day time versus prescribed Standard

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY

Sampling Code: N1

Name of Site: Near Project Site

Sampling Code: N2

Name of Site: Naya Rampur

Sampling Code: N3

Name of Site: Khamahariya

Sampling Code: N4

Name of Site: Kolam

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

ENVIRONMENT BASELINE STUDY
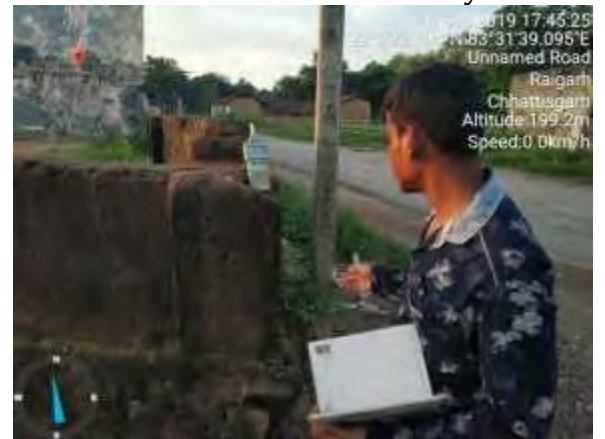
Flora & Fauna Study

3. FLORA & FAUNA STUDY

3.1 INTRODUCTION

Conservation of Biodiversity has become the most important requirement of the present-day world. This is because survival of the man depends upon the biodiversity. Biodiversity consists of two components: richness, or taxonomic diversity, and evenness, or the distribution of individuals among taxa. Anthropogenic factors are eroding both the richness as well as evenness components of the biodiversity, jeopardizing the survival of human race itself. This realization has initiated serious efforts towards conservation of both the components of biodiversity. One of the causes for the erosion of biodiversity has been recognized to be the mining activity. Some of the important minerals of our country are lying below the forests. Opencast mining of such areas are bound to result in the destruction or fragmentation of the habitat. If the area under mining is not having any endemic species then the mining will result only in the reduction in the gene pool, i.e. the evenness component of the biodiversity. However, mining an area with endemic species will have more drastic effect on biodiversity. Similarly, if the area falls under crucial migratory route of a species then also the mining may have some impact on such migratory species. Thus, it is required to evaluate the area, going to be mined, for any endemic and endangered species and any direct or indirect impact on biodiversity.

Mining is required for development. Then, is the mining antithesis of development? No, it cannot be, provided sufficient measures are taken to offset the impact on biodiversity. Present account is, thus, an evaluation of the status of the biodiversity of the proposed mining lease area, and proposed offset measures to any negative impact on biodiversity. Chhattisgarh state has almost sub-tropical humid climate, a climate good to support a rich than 40% of its land area is covered with forests. However, only a fragmentary knowledge of biodiversity of the state is there. In the animal kingdom, richness component of almost all the mammals is known. Some listing of amphibian and fishes are also available, but for other groups of animals, very little or almost no record is available. Similarly, among plants Botanical Survey of India has published Flora for some of the districts of the state. There are several publications on the medicinal plants and some publications on the edible mushrooms of the state, but, for other groups of plants, although, some research work has been done in the universities but there are no published records of their wealth.

This chapter deals with the description of existing Ecological setting of the project area. Project study area boundary forms a distance of 10 km from the periphery of the proposed site. Ecological data includes the all about flora and fauna data (vegetation,

wild animals, biodiversity of natural system, migratory routes of fauna and possibility of breeding grounds & trophic status of the water bodies present in the study area).

3.2 OBJECTIVES OF THE STUDY

The present study was undertaken with the following objectives:

- To assess the nature and distribution of vegetation, wild animals, biodiversity of natural system, migratory routes of fauna and possibility of breeding grounds & trophic status of the water bodies present in the study area in and around the project site within the study area;
- To assess the type of wild animals within the study area;
- To assess the biodiversity of natural system present in the study area;
- To ascertain migratory routes of fauna and possibility of breeding grounds within the study area;
- To assess the trophic status of the water bodies, present in the study area.

3.3 APPROACH

A participatory and consultative approach was followed for executing the assignment on Biodiversity and Ecological Assessment of the Gare Pelma Sector III coal Mines Projects. A team of experts have visited the project area and conducted the ecological survey. Meetings were also held during the ecological survey with forest officials and local community. Forest working plan, census handbook, gazetteer and other records related to ecology of the region were also collected.

3.4 ECOLOGY OF THE AREA

The area comes under broad category of sub-humid to dry deciduous, mixed and sal forests. Sal forest is considered to be the sub-climax leading to mixed forest as the climax formation. Natural vegetation of the area is a forest. Due to anthropogenic factors, including the cattle grazing, savannas like structures have developed. These factors are causing also rapid degradation of forest both in the plains and more importantly in the hills as well. First to disappear from the forests of the area are the timber trees like Bija (Pterocarpus marsupium) and Sal (Shorea robusta). This is then followed by the extraction of fuel wood, leading to the conversion of forests to scrub land and then to a grazing (grass) land. Soil in the area is mostly sandy loam locally called as "matasi". The area is under sub-tropical and dry to sub-humid climate. Winter is mild to cool with lowest temperature occasionally going down below 100C in winter while the peak summer temperature may reach up to 500C. Although occasional rains are received, but most testing to the life is the, post monsoon, long dry spell of about eight months. The dryness becomes more testing during the dry and hot summer

months, particularly the months of March to mid-June, with scorching sun. Relative humidity may go as low as 20% during this period. Typical climax vegetation of the area is sal forest. According to Champion and Seth two types of forests are visible in the area 1. 3C/C2e. The Moist Peninsular sal forest and 2. The 3C/C3 Moist mixed deciduous Forest.

Sal, under best protection and lesser disturbance grows to a height of 15 to 20 m. with 0.14 to 0.18 percent basal cover. Forests in the area range from heavily degraded condition to relatively in good condition. The ground is covered with herbaceous and shrub vegetation during the rainy months up to about middle of the winter months (January}, after which most of the herbaceous vegetation is dead and most of the shrubs start sheding leacves. Leaf fall of the trees start from late winter month (February) which continues to about early summer (March). Actually some plants start shedding their leaves as early as in the month of November (eg. *Terminalia tomentosa*) while some species may continue shedding leaves till the Month of April. However, new leaves start appearing from the middle of March and are almost complete till about the end of the month of May. April and up to about middle of the month of May are the months when the lower strata of the forest is almost totally leafless, increasing the visibility to long distances. These are the best months to observe the wildlife making them vulnerable to the poachers, also. To take a better view of the wild life, it is best to seat near a water hole, which remain very few during these months. Dominant tree, sal, is leafless for a shorter time ranging from a few days to about a month, depending upon the sites. At moist places leafless condition of the species is for a very short time. May is the month when the maximum thickness of leaf litter is observed which continues up to the rainfall, when the disappearance of the litter starts. However, fire may cause burning of the litter from a small to large areas. Fire in the forests is very common in the area. The fire, however, does not cause much damage. Herbaceous plants have already shed their seeds, most of which survive the light surface fire. Similarly, the tubers are already buried deep in the soil going unhurt due to surface fire. Trees are either leafless or have leaves very high from the ground, hence, there is no damage to the foliage.

Disappearance of the litter, with the onset of rains, is very fast, due to hot and humid condition. Almost all the litter has disappeared till about the month of October. Teak litter is first to disappear while the sal litter may persist up to the month of December

and even later. Tuberous, corm and rhizomatous forms like the members of Liliaceae and Araceae are first to appear immediately after the onset of rains, followed by the growth of other herbaceous species. Surface of the forest gets clothed well with herbaceous vegetation within only 15-20 days. Insects, mollusks and reptiles are at their peak, in the area, during this time Mushroom start growing after about fifteen days to a month after the onset of rains. However, Astreus species is special to be mentioned. This is believed to have mycorrhizal association with the sal. It starts coming up within about a week of the rainfall in the area. However, only trained persons are able to locate the mushroom because its fruiting body remains below the soil, coming up only after the fruiting body has developed to non-edible stage. Similarly, coming little later than the *Astreus sp*. is the *Termitomyces sp*. It grows on termite mounds. Both the species of mushrooms are considered to be a delicacy in the area fetching a good price in the market. Forest floor is replete with a large variety of other edible and non-edible, mycorrhizal, saprophytic, parasitic and *termitomycetes* fungi, more prominently the mushrooms.

The core and buffer zones include the village settlements with their cultivated fields, forest areas as well as vast areas reduced to grasslands due to heavy, anthropogenic disturbances. The disturbance includes cattle grazing and other illegal operations including collection of fire wood. The flora and fauna are similar both in core and buffer zones. The protected and reserve forest areas range from heavily disturbed to much disturb. Chhote Jhad ka Jungle support shrubby growth of mostly the species with good coppicing ability (*Lagerstroemia parviflora, Shorea robusta*) or less important species (*Chloroxylon swietenia*). In more disturbed and open forest land *Holarrhaena antidysenterica* dominates with its coppices. Some open places are dominated by the small, shrub stage plants of Diospyros melanoxylon and Butea *monosperma.* Teak (*Tectona grandis*) is not a natural species of the area but has been planted at a few patches. Eucalyptus plantation is not much common in the area. Village areas are heavily infested with weeds like *Hyptis suaveolens*, Xanthium strumarium, Calatropis gigantea, Pennisetum pedicillatum and *Ageratum conyzoides*, but the *notorius* weed *Parthenium hysterophorus* has not become much problematic and has, so far not invaded the forest areas. Cultivated field bunds support good growth of *Hyptis suaveolens, Themeda quadrivalvis, Iselema laxum, Heteropogon contortus, Bothriochloa pertusa* and *Pennisetum pedicillatum*. Forest openings have

grasses like *Andropogon aciculatus, Andropogon fulvus, Eragrostis tenella*, Aristida setacea and herbs like *Hemigraphis indica*, the shade support the growth of *psyophyte, Oplismanus burmannii*. The forests lack the Aonla (*Emblica officinalis*) trees mainly due to lopping and cutting of the tree for fruit collection. Village outskirts are identifiable from a distance due to presence of large Mahua (*Madhuca latifolia*) trees in abundance. Also common are the mango (*Mangifera indica*) groves near to the villages. Timber trees of larger girth, particularly Bija and Sal are almost absent. Sal being a good coppicer is able to maintain its density but the Bija is progressing rapidly towards disappearance from the forests.

The cultivated fields are generally plain areas under single crop cultivation, lying fallow for almost eight months in a year. Rice is the major crop raised in the area as kharif crop during the rainy season. The area has no irrigation facility hence Rabi crop during dry season is not possible. The waste lands are used mostly as grazing grounds. Some important features observed on these wastelands are that *Aristida adscecionis* is the most common species, growing abundantly on the wastelands. The species is not grazed by the cattle. At some other places coppicing of senha (*Lagerstroemia parviflora*) with multiple shoots is observed. At some other places' wastelands are covered by the scattered, bushy growth of tendu (Diospyros melanoxylon) and Palas (*Butea monosperma*). These two plant species have proved to be the only plant species able to survive in these highly disturbed areas. The remaining soil surfaces, not covered by these bushes, are covered by the annual and perennial grasses, sedges and forbs. The village settlements are small villages. Outside the village houses, Palas (*Butea monosperma*) and Mahua (*Madhuca latifolia*) are seen commonly growing outside the village areas. These are the trees which have been left un-cut during the clearing of the forest for settlement. These trees have very little fuel or timber values and are useful only when they are standing. Leaves of both the trees are used for the preparation of "Dona" and "Pattal". The Butea tree is used for Lac cultivation also. Mahua tree is the source of mahua flower used in the preparation of local alcoholic drink the "Daru or the Tharra" while its fruit yields an oil. Some mango trees are also observed outside the village areas, but are not so common in the presently applied mining lease area, as could be observed outside the village areas in other parts of Chhattisgarh.

Water bodies are

1. Natural streams

2. Manmade ponds, dug wells and tube wells

Most of the streams are of seasonal type and are restricted mainly to the forest area. The only perennial stream is the river Kelo. The river flows a long way down to the soutgh to join the river Mahanadi. The river forms also the eastern boundary of the applied mining lease area. Manmade or excavated ponds are quite common in the area. In earlier days ponds and dug wells were the major source of water to the villages. A peculiar feature of the excavated ponds is that their water remains silty for a long time may be 10 to 12 years. During this period water is yellow in colour due to suspended silt. Fishes and other aquatic life is rare including the hydrophytes. The water, even then, supports a good number of frogs. The water becomes clear only after thick growth of hydrophytes. Now-a-days the culture of excavated ponds is declining. Their places are being taken over by the tube wells. Fast increase in the number of tube wells is causing lowering down of the water table, rapidly. So far, no any serious pollution has been recorded in any type of water or water bodies.

Basically, the area comes under al forest region with interspersed mixed forests. There are patches of teak (*Tectona grandis*), and Sal plantations within the core zone

3.5   METHODOLOGY

3.5.1   Data Collection

The core and buffer zones, both the areas, include revenue forests including reserve and protected forests, orange areas, chhote jhad ka jungle, bade jhad ka jungle, grazing lands and cultivated lands. Hence, the flora and fauna are similar in core and buffer zones and have been shown also, together. However, data were collected more rigorously for the core zone as compared to the data collection in the buffer zone.

3.5.2   Period of survey

The area was visited in the month of August 2019 and September 2019. In data collection the support and help of local forest officials were also taken. Data on the density and frequency of the tree layer were collected mainly for the reserve and protected forests and the orange areas. Information on wildlife was obtained mainly through interviews of the local people.

3.5.3   Methodology for Primary Data Collection and Analysis

Extensive and intensive field visits for collection of primary data were carried out during the study period. Plants parts or samples (from forests) were collected and identified with the help of pertinent regional floras and herbaria. The survey on agriculture land and other areas except forest land was done by identifying and enumerating trees and other species by visual observations. The villagers were interviewed to know about the agricultural crops and their rotation throughout the year.

3.5.3.1   Sampling of vegetation

Vegetation survey was conducted through 'Quadrate Method'. The size of the quadrates was decided by number of species – area curve and mostly 10 m x 10 m for trees, 5 m x 5 m for shrubs and 1 m x 1 m for herbaceous species was adopted to conduct vegetation studies. The analytic characters viz. frequency, abundance, density, basal area and importance value index were calculated using following formulae.

3.5.3.2   Frequency

It is defined as the chance of finding a species in a particular area in a particular trial sample. Thus, a higher frequency values shows a greater uniformity of its spread or dispersion (Ambasht and Ambasht, 1990).

$$\text{Frequency} = \frac{\text{Number of quadrats in which species occur}}{\text{Total number of quadrats studied}} \times 100$$

3.5.3.3   Abundance

It is the number of species occurring in a particular site. It does not give total picture of the number strength of a species in an area because only the quadrats of occurrence are taken into consideration (Ambasht and Ambasht, 1990).

$$\text{Abundance} = \frac{\text{Total number of individuals of species}}{\text{Total number of quadrats in which species occur}} \times 100$$

3.5.3.4 Density

It is expressed as a numerical strength of a species. Though, density is an indicator of the abundance of the species; it does not indicate the distribution of species with regard to space. It helps to identify the dominant and rare species and is also an indicator of the standing biomass and productivity of the region (Ambasht and Ambasht, 1990).

$$\text{Density} = \frac{\text{Total number of individuals of the species in all quadrats}}{\text{Total number of quadrats studied}} \times 100$$

Basal area or cover will also be quantified by selecting some stems of different sizes for each species by the method described by Misra (1968).

3.5.3.5 Basal Area

It is an area occupied by the base of a tree. It is considered as a good indicator of the size, volume, or weight of tree. Basal area provides information on the production or dominance of larger and smaller trees in an ecosystem. It is one of the most important parameters in estimating the standing biomass in area that in turn is used a measure of productivity. The basal area was calculated by dividing 4 with the square of cbh.

$$\text{Basal Area or Cover} = \frac{C^2}{4}$$

Where, C is cbh (circumference at breast height) for trees and cgh (circumference at ground level) for shrubs.

3.5.3.6 Importance Value Index (IVI)

The importance value index (IVI) was determined as the sum of the relative dominance (basal cover), relative frequency and relative density (Curtis, 1959). IVI is a statistical quantity which gives an overall picture of the importance of the species in the plant community. Since the above relative parameters give clues individually all the parameters are summed up in order to provide the total picture of sociological structure of a species in a community, and called as Importance Value Index (IVI). It thus incorporates three important parameters that are measure of diversity and productivity of every species. Relative values and IVI are calculated as follows:

$$\text{Relative frequency} = \frac{\text{Number of occurrence (frequency) of the species}}{\text{Number of occurrence (sum of frequency) of all the species}} \times 100$$

$$\text{Relative density} = \frac{\text{Number of individuals (density) of the species}}{\text{Number of individuals (sum of density) of all the species}} \times 100$$

Relative frequency =	Total number of the species --- X 100 Number basal area of all the species

Relative abundance may be used in places of relative dominance for shrubs and herbs. Sum of basal cover of individual plants of a species will yield total stand basal cover of that species.

IVI= Relative frequency + Relative dominance + Relative density

3.5.3.7 Index of diversity

The diversity index (H') will be computed by using Shannon-Wiener information Index (Shannon and Wiener, 1963). Information functions as follows:

$$H' = - \sum (n_i/N) \log (n_i/N)$$

Where, n_i is the total number of individuals of species i and N is the total number of individuals of all species in that community.

3.5.3.8 Data Analysis

The vegetation data have been quantitatively analyzed for density, frequency and basal area as per Curtis & McIntosh (1950) and Ambasht and Ambasht (1990). The relative values of frequency, density and dominance are determined following Phillips (1959) and Misra (1968). These relative values were summed up for getting the value of Importance Value Index (IVI) of individual species (Curtis 1959). On the basis of Importance Value Index, dominant, co-dominant and associated species were recognized in different sites.

3.6 METHODS FOR AQUATIC FLORA AND FAUNA AND TOTAL COLIFORMS AND E.COLI

Following groups of Aquatic flora and fauna (from surface water bodies) and microbiological groups (from surface water bodies and groundwater samples) are generally analyzed for studying aquatic biodiversity and biological water quality.

- Phytoplankton
- Aquatic weeds
- Zooplankton
- Fish species

Aquatic bodies are surveyed for the presence of aquatic weeds and the extent of their coverage in the water bodies. The list of aquatic infesting the lakes and rivers is made.

Water samples are collected and preserved for phytoplankton and zooplankton analysis as per Standard Methods. Phytoplankton are identified and enumerated by **Lackey Drop Count Method** and zooplankton is identified and enumerated by **Sedgewick Rafter Method. Palmer's Pollution Index** was calculated for Phytoplankton

showing the presence of organic pollution in the water samples. **Shannon Wiener Index** is applied to both phytoplankton and zooplankton to analyze their biodiversity in the water bodies which is correlated with the tropic levels in the water bodies.

The list of fish species is prepared by inquiry with the local fishermen and data on commercial fishery is obtained from local Fishery Department.

Total Coliforms and faecal coliforms (*E. coli)* are analyzed by **Multiple Fermentation Tube Method** or **Membrane Filter Technique Method** as per Standard Methods

3.7   METHODS FOR SURVEY OF FAUNA

Collect the information on wild life present or occasional present or rarely present in the core zone and buffer Zone (sampling station wise) by inquiry with forest persons and local people and visual observation. The fauna is listed.

Random survey for the fauna was also carried out and recorded both in the core zone and buffer zone. These covers scats, dung, sign etc., interview with the forest officials and knowledgeable persons of the areas. Secondary data (from Forest Department and published literature) are also collected.

Effort is made to identify the migratory paths of wild animals considering the water sources, forest patches and fodder plants and grasslands in the study area and the direct and indirect signs of their presence.

Effort is made to visualize the fragmentation of forest and obstruction of migratory paths due to human activity like construction roads, canals, projects, conversion of forest into agriculture and residential purpose etc. - present status

Effort is made to identify the impact of project activity and mitigation measures for:

- Modification of drainage pattern in /core zone and mitigation measures
- Impact on Wild life habitat in core zone or buffer zone and mitigation measures
- Impact of forest de-reservation on fragmentation of forest
- Impact of project activity (road construction, overhead rope way for ore or any other activity) on migratory paths or habitat of the wild animals and mitigation measures
- Impact of predicted air pollution on wild life and mitigation measures like water spraying, green belt and other methods of dust control.
- Prediction of Impact of mining on the water pollution and aquatic life of surrounding surface water bodies by studying drainage pattern and suggestion of mitigation measures
- Impact of noise pollution on wild life and mitigation measures

- Impact of project activity on the biodiversity of National Park/Sanctuary/biosphere reserve and mitigation measures

3.8 COLLECTION OF SECONDARY DATA

3.8.1 Interaction with Forest Department

The Secondary list of Flora and Fauna will collect from Working Plan of the Forest Division (Raigarh) for reference. The list of flora and fauna will be found in the region, prepare with conduct field survey and discussion with concerned Forest Department personnel using the list available in the Working Plan as a base.

3.8.2 Interaction with Local people

Instant interaction with old local people and villagers and group discussions with educated people of villages will be conduct during the study period for elicit information about local plant, animals and their uses and Gathering data for ethno biology.

3.9 FLORA & FAUNA STUDY OF CORE ZONE

3.9.1 Land use of Core Zone

The core zone or the area applied for mining lease is characterized by undulating topography with elevation varying from 302 m to 330 m above MSL. The block has distinct topographic highs roughly aligned in E-W direction in the southern part. In general, the slope of the ground is towards north and south. The core zone or the area applied for mining lease in mainly Forest Land, Government Waste Land and private land. The breakup is a under:

Table 3.1: Land use of Core Zone

Sl. No	Type of Land	Total Area Ha.	%
1	Built-up	16.25	2.57
2	Crop Land	219.59	34.79
3	Fallow Land	161.84	25.64
4	Forest/ Natural Vegetation Cover	156.57	24.80
5	Industrial Area	0.36	0.06
6	Scrub Land	73.53	11.65
7	Waste Land	2.37	0.38
8	Waterbodies	0.71	0.11
	Total	631.22	100.00

Source: This Land-use land cover (of the 10km study area) area calculated by satellite Image (FCC) classification

3.9.2 The Revenue lands

The revenue land consists of mostly the cultivated land. The cultivated lands are of two types:

  i. Upland
  ii. Low land

I. Upland Cultivated Land

Up lands are cultivated only during the rainy months thus have only one crop. These areas are generally near the village settlements. After rainy months these area generally, lie fallow, exposed to some level of wind erosion. At some of the places with irrigation facility some Rabi crops, mostly as vegetables, are raised on these uplands. Crops cultivated on uplands as kharif crop include:

Table 3.2: Cultivated Crops in Core Zone

Sl	Local Name	English name	Botanical Name
A. Cerels			
1	Dhan	Paddy	*Oryza sativa*
2	Makka	Maize	*Zea mays*
B. Pulses and oil			
1	Arhar	Pigeon pea	*Cajanus cajan*
2	Til	Sesamum	*Sesamum inicum*
3	Kulthi	Horse-gram	*Dolochos biflorus*
4	Kusum	Safflower	*Carthemus tinctorius*
5	Urd	Black gram	*Phaeolus mungo*
6	Mungphali	Ground nut	*Arachis hypogea*
D. Vegetables			
1	Tamatar	Tomato	*Lycopersicum esculantum*
2	Baigan	Brinjal	*Solanum melongena*
3	Bhindi	Lady's finger	*Abelmoschus esculentus*
4	Barbatti	Cowpea	*Vignainensis/unguiculatoo*
5	Karela	Bitter gourd	*Momordica charantia*
6	Torai	Ridge gourd	*Luffa acutangula*
7	Kaddu	Pumpkin	*Cucurbita moschata*
8	Gilki	Sponge gourd	*Luffa cylindrica*
9	Palak	Beet	*Beta vulgaris*
10	Lalbhaji	Amaranth	*Amaranthus spp.*
11	Rakhia Kaddu	White Gourd	*Benincasa hispida*
12	Kundru	-	*Coccinia grandis*
13	Khira	Cucumber	*Cucumis sativus*
14	Lauki	Bottle gourd	*Lagenaria siceraria*
15	Chichinda	Snake gourd	*Trichosanthes anguina*
16	Ghuiyan	Pichigi	*Colocasia esculenta*
17	Dhaniya	Coriander	*Coriandrum sativum*

Source: Field Study by Greencindia Consulting Private Limited

II.   Low Land Cultivated Land

Low lands in the core zone are all un-irrigated land. Only a single crop of rice is raised on these lands as a raifed crop. For almost eight months in a year these areas lie fallow. Movement of cattle is a common feature in this area, scrapping any growing edible plants on these areas. In addition to the cultivated crop many species of herbaceous weeds make their appearance from late monsoon months to the end of winter months. However, all the plants die with the approach of summer months and these areas are totally devoid of any plant life during the summer months.

3.9.2.1   Chhote Jhad ka Jungle (Forest with smaller plants)

This is area categorized as forest only because it is in the possession of Forest department. It includes an area of 24.442 ha constituting 3.88 percent of Core Zone. The area is open grazing land. Some scattered bushes of tenu (*Diuospyros melanoxylon*) are present here and there. Some isolated trees of Mahua may also be observed in the area as the sole representative of forest trees. Barring the perennial tendu bushes, vegetation in the form of herbs, is present in the area only during rainy months.

3.9.2.2   Bade Jhad ka Jungle (Forest with larger trees):

An area of 8.183 ha is included under Bade Jhad ka Jungle constituting 1.30 percent of the Core Zone.

3.9.2.3   Forest Land

An area of 165.102 ha, Reserve Forest 114.028 18.11 %, Protected Forest 25.585 (4.06) & Orange Area 25.489 Ha (4.05 %) are included under Forest Land constituting 26.23 percent of the Core Zone. The Forest area is under following compartments

Table 3.3: Details of Forest Compartment

S.N.	Division	Range	Compartment No.	Forest Name	Category Of Forest	Area (In Ha.)
1			721	Silot	RF	41.00
2			722	Silot	RF	73.28
3			730	Milupara	PF	5.40
4			743	Khamariya	PF	4.20
5	Raigarh	Tamnar	738	Karwahi	PF	15.98
6			733	Bhalwahidongri(A)	OA	18.78
7			734	Bhalwahidongri(B)	OA	3.12
8			735	Bhalwahidongri(C)	OA	0.27
9			736	Bhalwahidongri(D)	OA	1.35
10			737	Bhalwahidngri(E)	OA	1.95
Total						165.10

Source: GP III Land schedule

3.10 STUDY AREA

The study area included of core zone. Three study sites were selected on the basis of forests, species richness and direction of the area: The details of phytosociological sampling locations are shown in **Table 3.4**.

Table 3.4.: Phytosociological sampling locations

Code	Name of Study Site	Latitude (N)	Longitude (E)	Direction of Block
Site-1	Karwahi reserve Forest (738)	22⁰ 11 '34.0 .	83⁰ 9' 34.05	South
Site-2	Silot Reserve forest (721)	22⁰ 11 '10.4	83⁰ 8' 53.19	Northe West
Site-3	Silot Reserve Forest (722)	22⁰ 10 '46. 9	83⁰ 30' 1.11	East

3.11 FLORA STUDY IN THE CORE ZONE

Shorea Robasta, Mahuca indica, Termanilia tomentosa etc. are as common species in the study and command area of the region. Phytosociological characters of the study area have been calculated for selected forest communities of the area.

3.11.1 Trees

Site wise phytosociological attributes of trees are given in **Table 3.5** to **Table 3.7**. Tree species in the Site-1 showed a total density of 1970.00 plants/ha with total basal cover

(TBC) value of 309.06 m2/ha. The highest density was recorded for *Shorea robusta, Madhuca indica, and Terminallia tomentosa*. Importance Value Index (IVI) was also calculated for all species. *Shorea robusta*, revealed highest IVI (60.36) and emerged as a dominant tree species. The co-dominant species of the site is *Madhuca indica, Terminallia tomentosa, Bridelia retusa, and Pongamia pinnata*. The least dominant species of the site is *Anogeissus latifolia*.

Table 3.5: Site I (Tree)– Compartment No 738 (Karwahi Protected Forest)

Botanical Name	Quadrates (10X10 m)										Total Plants	Frequency (%)	Abundance	Density (Plants/ha)	TBC (m²/ha)	Importance Value Index
	1	2	3	4	5	6	7	8	9	10						
Madhuca indica	5	3	4	0	2	0	4	4	0	4	26	70	3.71	260	88.41	53.87
Shorea robusta	3	7	6	9	5	6	3	5	0	2	46	90	5.11	460	66.42	60.36
Terminallia tomentosa	4	3	1	3	3	2	2	1	0	0	19	80	2.38	190	27.43	32.31
Bridelia retusa	2	3	0	3	2	3	1	2	0	0	16	70	2.29	160	29.30	29.67
Pongamia pinnata	0	3	4	2	0	4	0	0	8	0	21	60	3.50	210	23.15	28.49
Gmelina arborea	0	0	2	0	0	2	1	2	3	5	15	50	3.00	150	16.63	21.61
Careya arborea	0	0	0	0	3	5	2	0	5	4	19	50	3.80	190	14.04	22.81
Diospyros melanoxylon	0	0	0	0	0	4	2	3	3	0	12	40	3.00	120	29.26	22.45
Boswellia serrata	0	0	0	0	0	0	0	2	4	3	9	30	3.00	90	6.82	11.95
Semecarpus anacurdium	0	0	0	0	0	0	0	0	3	4	7	20	3.50	70	4.41	8.43
Anogeissus latifolia	0	0	0	0	0	0	0	0	4	3	7	20	3.50	70	3.22	8.04
											197	580		1970		
Dominance of the site (Simpson Index) = 0.12																
Diversity of the site (Shannon Weiner Index) = 0.99																

Similarly, Site-2 and Site-3, are dominated by *Shorea robusta, Madhuca indica, Buchanania lanzan and Terminallia tomentosa* with IVI values 47.46, 40.41, 27.27, 35.60, 36.69 and 21.59 respectively. Least dominant species in these sites are *Albizzia procera, Salmalia malabarica, Anogeissus latifolia, Dalbergia latifolia, Boswellia serrata and Lagerstroemia parviflora*.

Table 3.6: Site II (Tree) - Compartment No 721 (Silot Reserve forest)

Botanical Name	Quadrates (10X10 m)										Total Plants	Frequency (%)	Abundance	Density (Plants/ha)	TBC (m²/ha)	Importance Value Index
	1	2	3	4	5	6	7	8	9	10						
Shorea robusta	8	5	6	4	6	2	0	1	3	0	35	80	4.38	350	29.75	47.46
Buchanania lanzan	4	4	3	0	4	0	0	1	0	1	17	60	2.83	170	16.38	27.27
Terminallia tomentosa	2	3	4	0	0	0	2	0	2	0	13	50	2.60	130	12.75	21.59
Acacia catechu	1	0	5	3	0	0	2	1	0	0	12	50	2.40	120	11.84	20.53
Garuga pinnata	0	2	2	2	0	0	1	0	2	1	10	60	1.67	100	5.53	17.32
Gmelina arborea	0	0	5	2	3	3	1	0	0	2	16	60	2.67	160	11.10	23.70
Madhuca indica	0	0	3	3	5	4	3	0	2	0	20	60	3.33	200	34.25	39.12
Diospyros melanoxylon	0	0	0	5	3	5	0	2	0	0	15	40	3.75	150	23.41	27.30
Bridelia retusa	0	0	0	0	0	5	0	3	1	1	10	40	2.50	100	9.63	16.73
Anogeissus latifolia	0	0	0	0	0	5	0	2	0	0	7	20	3.50	70	4.41	9.20
Azadirachta indica	0	0	0	0	0	5	2	3	0	0	10	30	3.33	100	4.60	12.37
Butea monosperma	0	0	0	0	0	0	2	0	2	2	6	30	2.00	60	2.76	9.19
Pterocarpus marsupium	0	0	0	0	0	0	3	1	0	1	5	30	1.67	50	2.30	8.39
Semecarpus anacurdium	0	0	0	0	0	0	0	2	0	1	3	20	1.50	30	1.38	5.33
Adina cordifilia	0	0	0	0	0	0	0	0	2	2	4	20	2.00	40	1.84	6.12
Albizzia procera	0	0	0	0	0	0	0	0	2	0	2	10	2.00	20	0.92	3.06
Salmalia malabarica	0	0	0	0	0	0	0	0	1	2	3	20	1.50	30	1.38	5.33
Total											188	680		188		

													0		

Dominance of the site (Simpson Index) = 0.089
Diversity of the site (Shannon Weiner Index) = 1.12

Table 3.7: Site III (Tree) - Compartment No 722 (Silot Reserve forest)

Botanical Name	Quadrates (10X10 m)										Total Plants	Frequency (%)	Abundance	Density (Plants/ha)	TBC (m2/ha)	Importance Value Index
	1	2	3	4	5	6	7	8	9	10						
Terminallia tomentosa	4	1	0	2	3	0	0	0	1	0	11	50	2.20	110	10.60	19.18
Shorea robusta	3	7	0	0	4	5	3	0	2	3	27	70	3.86	270	22.95	38.49
Madhuca indica	4	5	5	1	0	3	2	0	0	2	22	70	3.14	220	32.72	41.82
Gmelina arborea	2	5	4	0	0	1	2	0	0	1	15	60	2.50	150	12.34	23.80
Diospyros melanoxylon	1	3	2	0	1	1	3	1	1	0	13	80	1.63	130	5.77	21.06
Terminalia chebula	0	2	3	3	2	2	0	1	1	0	14	70	2.00	140	13.49	25.22
Adina cordifilia	0	0	3	2	2	3	0	0	0	0	10	40	2.50	100	12.64	18.64
Azadirachta indica	0	0	1	0	0	0	1	0	0	2	4	30	1.33	40	13.65	14.64
Terminaliya arjuna	0	0	2	2	1	2	0	0	0	0	7	40	1.75	70	8.48	14.34
Butea monosperma	0	0	0	2	2	0	0	1	0	0	5	30	1.67	50	3.15	8.59
Cleistanthus collinus	0	0	0	3	1	0	2	0	0	1	7	40	1.75	70	3.22	11.02
Ailanthus excels	0	0	0	1	2	0	2	0	0	0	5	30	1.67	50	2.30	8.05
Semecarpus anacurdium	0	0	0	0	0	2	2	2	0	0	6	30	2.00	60	2.76	8.91

Aegle marmelos	0	0	0	0	0	0	2	0	1	1	4	30	1.33	40	1.84	7.20

Botanical Name											Total Plants	Frequency (%)	Abundance	Density (Plants/ha)	TBC (m²/ha)	Importance Value Index
Pometia pinnata	0	0	0	0	0	0	1	5	2	0	8	30	2.67	80	3.68	10.61
Buchanania lanzan	0	0	0	0	0	0	0	2	0	1	3	20	1.50	30	1.38	5.09
Pterocarpus marsupium	0	0	0	0	0	0	0	3	1	0	4	20	2.00	40	1.84	5.94
Lagerstroemia parviflora	0	0	0	0	0	0	0	4	0	0	4	10	4.00	40	1.84	4.67
Anogeissus latifolia	0	0	0	0	0	0	0	0	3	0	3	10	3.00	30	1.38	3.82
Dalbergia latifolia	0	0	0	0	0	0	0	0	2	1	3	20	1.50	30	1.38	5.09
Boswellia serrata	0	0	0	0	0	0	0	0	0	3	3	10	3.00	30	1.38	3.82
Total											178	790		1780	790	
Dominance of the site (Simpson Index) = 0.074																
Diversity of the site (Shannon Weiner Index) = 1.16																

3.11.2 Shrubs

The shrub species at the forest floor are observed as Andrographis *paniculata, Mucuna prurita Asparagus racemosus Carissa carandus Ziziphus spp, Carissa spp* and *Calotropis gigantea*. The result of phytosociological characters was determined by calculating frequency, density, importance value index, dominance and diversity of the selected stands. The details of the phytosociological attributes are given in following **Table 3.8 to 3.10**.

Table 3.8: Site I (Shrubs) – Compartment No 738 (Karwahi Protected Forest)

Botanical Name	Quadrates (5X5 m)										Total Plants	Frequency (%)	Abundance	Density (Plants/ha)	TBC (m²/ha)	Importance Value Index
	1	2	3	4	5	6	7	8	9	10						
Andrographis paniculata	8	5	0	7	7	5	0	7	0	3	42	70	6.00	877.80	9.40	54.05
Asparagus racemosus	7	9	7	0	5	6	0	0	6	0	40	70	5.71	836.00	13.48	60.93

Carissa carandus	3	6	5	5	6	0	4	3	5	6	43	90	4.78	898.70	10.51	61.22

	1	2	3	4	5	6	7	8	9	10						
Croton oblongifolius	0	3	3	3	0	0	8	4	0	0	21	60	3.50	438.90	5.32	33.89
Zizyphus oenophile	0	0	5	6	0	3	5	5	6	0	30	60	5.00	627.00	6.12	39.74
Vitex negundo	0	0	0	4	0	0	3	2	3	2	14	50	2.80	292.60	3.73	25.22
Solanum nigram	0	0	0	0	0	0	0	5	3	5	13	30	4.33	271.70	2.22	17.29
Rauwolfia	0	0	0	0	0	0	0	0	0	6	6	10	6.00	125.40	1.32	7.67
											209	440		4368.10	52.08	
Dominance of the site (Simpson Index) = 0.159																
Diversity of the site (Shannon Weiner Index) = 0.83																

Table 3.9: Site II (Shrubs)- Compartment No 721 (Silot Reserve forest)

Botanical Name	Quadrates (5X5 m)										Total Plants	Frequency (%)	Abundance	Density (Plants/ha)	TBC (m²/ha)	Importance Value Index
	1	2	3	4	5	6	7	8	9	10						
Zizyphus oenophile	4	3	2	0	4	3	3	0	2	1	22	80	2.75	343.2	1.8948	36.835
Abrus precatorius	3	0	1	0	4	4	1	0	0	1	14	60	2.33	218.4	2.1301	28.771
Mucuna prurita	4	3	5	5	1	2	0	0	2	0	22	70	3.14	343.2	4.372	44.513
Carissa carandus	3	4	3	0	1	3	0	2	1	0	17	80	2.12	265.2	2.7365	36.891
Croton oblongifolius	0	3	0	4	0	0	0	5	0	0	12	30	4	187.2	1.0075	17.369
Solanum nigram	0	0	4	3	0	4	2	3	2	3	21	50	4.2	327.6	5.2038	43.25
Smilax macrophylla	0	0	0	4	2	0	3	0	3	1	13	30	4.33	202.8	2.6267	24.286
Cynodon dactylon	0	0	0	0	0	5	2	3	1	0	11	40	2.75	171.6	2.8078	25.628
Imperata cylindrica	0	0	0	0	0	3	5	4	0	0	12	30	4	187.2	1.8258	20.54
Cuscuta reflexa	0	0	0	0	0	0	0	2	3	1	6	30	2	93.6	0.6267	12.046
Butea superba	0	0	0	0	0	0	0	3	0	3	6	20	3	93.6	0.5704	9.9042
											156	520	34.63	2433.6	25.802	300.03

Dominance of the site (Simpson Index) = 0.104

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE **P**ELMA **S**ECTOR **III C**OAL **B**LOCK **,T**AMNAR **T**EHSIL, **R**AIGARH **D**ISTRICT, **C**HHATTISGARH

FLORA & FAUNA STUDY

Diversity of the site (Shannon Weiner Index) =

Table 3.10: Site III (Shrubs) - Compartment No 722 (Silot Reserve forest)

Botanical Name	Quadrates (5X5 m)										Total Plants	Frequency (%)	Abundance	Density (Plants/ha)	TBC (m²/ha)	Importance Value Index
	1	2	3	4	5	6	7	8	9	10						
Albizia lebbeck	2	2	0	4	0	0	3	4	3	0	18	60	3.00	270.00	1.49	29.25
Eugenia sp	4	3	3	0	5	1	2	0	5	0	23	70	3.29	345.00	3.36	42.59
Bombax ceiba	2	2	3	0	2	0	1	4	0	0	14	60	2.33	210.00	2.68	31.78
Sterculia urens	3	1	2	3	0	1	0	5	2	3	20	80	2.50	300.00	3.10	41.20
Madhuca latifolia	0	2	0	4	3	6	2	3	0	0	20	60	3.33	300.00	1.61	31.13
Buchanania lanzan	0	0	1	3	0	3	2	1	0	4	14	60	2.33	210.00	3.34	34.68
Melia azadirach	0	0	0	0	3	5	0	1	0	3	12	40	3.00	180.00	2.33	25.37
Cordia myxa	0	0	0	0	0	2	2	0	3	4	11	40	2.75	165.00	2.70	26.32
Rubbia cordifolia	0	0	0	0	0	3	1	1	1	0	6	40	1.50	90.00	0.88	14.99
Lannea grandis	0	0	0	0	0	0	0	0	3	3	6	20	3.00	90.00	0.60	10.21
Zizyphus xylopyrus	0	0	0	0	0	0	0	0	1	2	3	20	1.50	45.00	0.27	6.77
Murraya exotica	0	0	0	0	0	0	0	0	3	0	3	10	3.00	45.00	0.44	5.71
											150	560	31.54	2250.00	22.80	300.01
Dominance of the site (Simpson Index) = 0.010																
Diversity of the site (Shannon Weiner Index) = 1.01																

3.12 FAUNA IN THE CORE ZONE

The terrestrial fauna includes common invertebrates and vertebrates. Wild fauna species like Bear, Fox and Jackal were reported to be more common than other animal species in the area. The major aquatic fauna are fishes, amphibians and water snakes. The list of faunal species is given below:

3.12.1 Mammals

Table 3.11: List of Mammals in Core Zone

S.N	Local Name	English Name	Zoological Name	Status WL(Protection) Act 1972	
				Schedule	Part
1	Siyar	Jackal	*Canis aureus*	II	II
2	Bhalu	Sloth bear	*Melursus ursinus*	I	I
3	Kharaha	Indian hare	*Lepus ruficaudatus*	IV	-
4	Gilhari	squirrel	*Funambulus pennanti*	IV	-
5	Chamgadad	fruit bat	*Cynopterus sphinx*	V	-
6	Chooha	Field rat	*Bandicota benghalensis*	V	-
7	Lomadi	Indian fox	*Vulpus benghalensis*	II	II
8	Bandar	Monkey	*Macaca mulatta*	III	-
9	Neola	Mangoose	*Herpetes edwardsi*	IV	-
10	Hurra	Hyaena	*Hyaena hyaena*	III	-
11	Langoor	Common langur	*Semnopithecus entellus*	II	I
12	Chital	Spotted dear	*Axis axis*	III	-
13	Jangali billi	Jungle cat	*Felis chaus*	II	II
14	Jangalisuar	Wid boar	*Sus scrofa*	III	-
15	Sahi	Porcupine	*Hystrix indica*	IV	-

Source: Field Study by Greencindia Consulting Private Limited& Discussion with local people,Forest officials

3.12.2 Avifauna

Table 3.12: List of Birds in Core Zone

S. N	English Name	Zoological Name	Status WL (Protection) Act, 1972
1	House crow	*Corvrus splendens*	V
2	Comman myna	*Acridotheris tristis*	IV
3	Brahminy myna	*Sturnus pagodrum*	IV
4	Pied myna	*Sturnus contra*	IV
5	Black drongo	*Dicrurus adsimilis*	IV
6	Spotted dove	*Streptopelia chinensis*	IV
7	Blue jay	*Coracias benghalensis*	IV
8	Parakeet	*Psittacutla krameri*	IV
9	Little Green Bee-Eater	*Merops orientalis*	IV
10	Koel, Cuckoo	*Eudynamys scolopaicea*	IV
11	Phakhta	*Streptopelia chinensis*	IV
12	Jangali Kaua	*Corvus macrorhynchos*	V
13	Jangali Tota	*Taccocua leschenaultia*	IV
14	Tania Tota	*Psittacula cyanocephala*	IV
15	Tota	*Psittacula krameri*	IV
16	Neelkanth	*Coracias benghalensis*	IV

17	Bater (Grey Quail)	*Coturnix coturnix*	IV

S. N	English Name	Zoological Name	Status WL (Protection) Act, 1972
18	Basanti (Indian cuckoo)	*Cuculus micropterus*	IV
19	Kite	*Milvus migrans*	IV
20	Peafowl	*Pavo cristatus*	I
21	Redwhiskered bulbul	*Pycnonotus jocosus*	IV
22	Besra Sparrow-Hawk	*Accipiter vigratus*	IV
23	Paddy Bird/Pond Bird	*Ardeola grayii*	IV
24	Small Blue Kingfisher	*Alcido atthis*	IV
25	Scaup Duck	*Aythya marila*	IV
26	Common Hoopoe	*Epupa epops*	IV

Source: Field Study by Greencindia Consulting Private Limited& Discussion with local people, Forest officials

3.12.3 Reptiles

Table 3.13: List of Reptiles in Core Zone

S. N	Local Name	Zoological Name	Status WL(Protection) Act 1972	
			Schedule	Part
1	Dhaman/Indian Rat snake	*Ptyas mucosus*	II	II
2	Dhondwa/Water sanke	*Enhydris enhydris*	IV	-
3	Nag/Cobra	*Naja naja*	II	II
4	Common Karait	*Bungarus caeruleus*	IV	-
5	Russel viper	*Vipera ruselli*	II	II
6	Sita Ki Lath	*Amphiesma stolata*	-	-
7	Girgit (Garden lizard)	*Calotes versicolor*	-	-

Source: Field Study by Greencindia Consulting Private Limited& Discussion with local people, Forest officials

3.12.4 Amphibia

Table 3.14: List of Amphibia in Core Zone

S.N	Local Name	English Name	Zoological Name	Status WL(Protection) Act 1972	
				Schedule	Part
1	Mendhak	Bull frog	*Hoplobatrachus tigerinus*	IV	-
2	Mendhak	Common toads	*Duttaphrynus melanostictus*	IV	-
3	Mendhak	Skipper frog	*Euphlyctis cyanophlyctis*	IV	-
4	Mendkak	Small frog	*Microhyla ornata*	IV	-

5	Mendhak	Tree frog	*Polypedates maculatus*	IV	-

Source: Field Study by Greencindia Consulting Private Limited& Discussion with local people

3.12.5 Spiders and insects

Table 3.15: List of Spider & Insects in Core Zone

Sl	Name	Zoological Name
1	Hunting spider	*Pisarua mirabills*
2	House spider	*Tegenaria domestica*
3	Hair Dragonfly	*Brachytron pratense*
4	Emperor Dragonfly	*Anax imperator*
5	Grasshoppers	-
6	Common Green	*Tettigonia viridissima*
7	Rice grasshopper	*Hieroglyphus. Banian*
8	Common painted Grasshopper	*Pecilocerus pictus*
9	Paddy Jassids	*Nephotettix apicalis*
10	Skeletonizers	*Hyblea purea mechaerales*
11	Defoliators	*Hepalia mauritia*
12	Swarming caterpillar	*Spodoptera mauritia*
13	Ant lion	*Myrmeleo sp.*
14	Scolopender	*Scolopendra morsitans*
15	Praying mantid	*Sphoromantis lineola*
16	Common stick insect	*Carausius morosus*
17	Cockroach	*Blatta orientalis*
18	American cockroach	*Periplanata americana*
19	Firefly	*Aracnocampa sp.*

Source: Field Study by Greenc India Consulting Private Limited& Discussion with local people, Forest officials

3.12.6 Butterfly

More than 20 species of butterfly have been recorded from the applied mining lease area.

Thirteen of them have been identified clearly as given below:

Table 316: List of Butterfly in Core Zone

Sl. No.	Zoological Name
1	*Acraea viola*
2	*Eurema andersoni*
3	*Eurema brigitta*
4	*Eurema laeta*
5	*Euthalia nais*
6	*Gandeca harina*
7	*Hypolimnas bolina*

8	*Hypolimnos misippus*
9	*Junonia lemonias*
10	*Junonia orithiya*
11	*Neptis hylas*
12	*Phalanta phalantha*
13	*Tanaecia lepidea*

Source: Field Study by Greenc India Consulting Private Limited& Discussion with local people, Forest officials

3.13 FLORA & FAUNA STUDY OF BUFFER ZONE

3.13.1 Land use of the Buffer Zone

The land cover in the buffer zone is also similar to the core zone. Tree density is much reduced in the forest. Significant decrease in the density of larger trees particularly of timber value like Bija is unfortunate. Similarly, the Aonla trees have almost disappeared from the forest. Mahua trees in the orange area as well as in the forest near the villages are prominent because they are the only trees left uncut with their large crown. Sal trees of higher girth have become very rare. This is all due to illegal cutting of the trees. Herb layer in the forest have mostly the species tolerant to grazing and trampling. Most of the medicinal herbs have become rare and some of them like Kaliyari have disappeared from the area. The list of medicinal plants includes the herbaceous species like: *Adiantum lunulatum, Asparagus racemosus, Celastrus paniculata, Curculigo orchioides, Dioscorea bulbifera, Diplocyclos palmatus, Elephan topus scaber, Evolvulus alsinoides, Hemidesmus indicus, Spilanthus calva* and *Tephrosia purpurea* and small tree species like *Holarrhaena antidysenterica*. Much reduced abundance of *Andrographis paniculata*, the forest exhibit clear cut impact of anth ropogenic factors like illegal cutting of trees, unsustainable removal of medicinal plants and unchecked cattle grazing.

Buffer zone within 10 km radius from the applied lease area, on the basis of satellite imagery interpretation consists of more than 41% of Forest Land while agriculture land about 25.62% of the area.

Table 3.17: Land Use Details of Buffer Zone (Based on Satellite Imagery Interpretation)

Sl	LU/LC Class	Area in Ha.	%
1	Built-up	778.79	1.61
2	Crop Land	12,369.39	25.62

3	Fallow Land	8,053.51	16.68
4	Forest/ Natural Vegetation Cover	20,213.09	41.87
5	Industrial Area	566.18	1.17
6	Mining Area	1,468.80	3.04
7	Scrub Land	4,148.93	8.59
8	Waste Land	458.86	0.95
9	Waterbodies	218.73	0.45
	Total Area in Ha.	**48,276.28**	**100.00**

Source: This Land-use land cover (of the 10km study area) area calculated by satellite Image (FCC) classification

Generally, a single crop, mostly the rice, is grown in the cultivated land in the rainy season. Then the cultivated lands generally lie fallow for almost 8 months in a year. Dense forest area is dominated by sal. The forests are at different stages of growth depending upon the period after the area has been extracted. Selective removal of trees of timber value like sal (*Shorea robusta*), bija (Pterocarpus marsupium), gamhar (*Gmelina arborea*) etc. has converted the areas in to open forest. Further removal of other trees like dhawra (*Anogeissus latifolia*) saja (*Terminalia tomentosa*) tendu (Diospyros melanoxylon) etc. converts the area in to scrub land. These areas are dominated by species with good coppicing ability or species multiplying with root suckers like Senha (*Lagerstroemia parviflora*), tendu (*Diospyros melanoxylon*) and dudhi (*Wrightia tinctoria*). Out of these destructions mahua (*Madhuca latifolia*) is the only tree saved from scathing. Trees of mahua, left uncut, grow in to large trees with bulbos crown. Scattered presence of the tree gives savanna like appearance to the totally denuded, revenue forest areas, particularly surrounding the village settlements. Due to this and also due to the ponds, generally surrounded by large trees of bargad (*Ficus benghalensis*) and peepal (*Ficus religiosa*), occasionally with mango trees, village settlements can be recognized from great distances. Elephant is emerging as one of the causes for the destruction of crops. However, the hanuman langur, neola and parrot have also been reported to be even more important in eating away and destroying the crops, than the elephants. Hanuman langur has emerged in recent year to be a great nucence and has become vermin not only due to destruction of the crop, but because it causes damages to the houses by moving on the earthen tiled roofs. There are some refugee settlements of migrants from Bangladesh (East Pakistan).

These people cultivate tadi palm (*Borassus flabellifer*) and Chhind (*Phoenix sylvestris*) for extracting tadi (the stem sap flow), for which these Bengali migrants have special liking.

3.13.2 Forest Area in Buffer Zone

There are many Protected Forests within the 15 km radius area around the project site. However, there are no National Parks, Wildlife Sanctuaries etc. within the 15-km area. The environmental sensitive locations including forests and water bodies are given in Table 3.18 & 3.19.

Table 3.18: Protected (PF), Reserve forests (RF) and Orange area (OA) in Buffer zone

Sl.	Compartment No.	Division	Forest Range	Name of Forest	Category of forest	Area (ha)	Direction
Forest in 0 - 2.5 km Radius
1	713	Raigarh	Tamnar	Silot	RF	184.292	N
2	714	Raigarh	Tamnar	Silot	RF	212.511	N
3	715	Raigarh	Tamnar	Silot	RF	154.501	N
4	718	Raigarh	Tamnar	Silot	RF	181.419	N
5	719	Raigarh	Tamnar	Silot	RF	168.522	N
6	720	Raigarh	Tamnar	Silot	RF	199.748	N
7	724	Raigarh	Tamnar	Silot	RF	233.266	N
8	725	Raigarh	Tamnar	Silot	RF	450.52	N
9	726 P	Raigarh	Tamnar	Kharra	PF	7.207	N
10	727 P	Raigarh	Tamnar	-	PF	9.813	N
11	728 P	Raigarh	Tamnar	-	PF	10.254	N
12	729 P	Raigarh	Tamnar	Chhapedongri	PF	4.797	N
13	731 P	Raigarh	Tamnar	Kolam	PF	16.897	W
14	735 OA	Raigarh	Tamnar	Bhalwahidongri(C)	OA	2.817	N
15	740	Raigarh	Tamnar	Mudgaon	RF	13.154	S
16	741 P	Raigarh	Tamnar	Saraitola	PF	16.488	S
17	742 P	Raigarh	Tamnar	Gare	PF	53.888	S
18	746 P	Raigarh	Tamnar	Lalpur	PF	23.898	N
19	747 P	Raigarh	Tamnar	Koylar	PF	20.590	N
20	778	Raigarh	Tamnar	Tolge Purva	RF	446.038	E
21	779	Raigarh	Tamnar	Tolge Purva	RF	327.926	E
22	782	Raigarh	Tamnar	Tolge Purva	RF	300.768	E
23	783	Raigarh	Tamnar	Tolge Purva	RF	241.772	E
24	784	Raigarh	Tamnar	Tolge Purva	RF	881.267	E
25	785 P	Raigarh	Tamnar	-	PF	74.887	E
26	787 P	Raigarh	Tamnar	Konrkel	PF	28.592	E
Forest in 2.5-5 km Radius
1	709	Raigarh	Tamnar	Silot	RF	163.209	NW

Sl.	Compartment No.	Division	Forest Range	Name of Forest	Category of forest	Area (ha)	Direction
2	710	Raigarh	Tamnar	Silot	RF	137.462	NW
3	711	Raigarh	Tamnar	Silot	RF	189.521	N
4	712	Raigarh	Tamnar	Silot	RF	196.287	NW
5	716	Raigarh	Tamnar	Silot	RF	116.394	N
6	717	Raigarh	Tamnar	Silot	RF	90.375	N
7	744 P	Raigarh	Tamnar	Pata	PF	30.698	S
8	748 P	Raigarh	Tamnar	Jaridih	PF	18.994	N
9	749 P	Raigarh	Tamnar	Hinjhor	PF	51.970	N
10	750 P	Raigarh	Tamnar	Sabjula	PF	23.643	N
11	751 P	Raigarh	Tamnar	Pelma	PF	14.815	N
12	752 P	Raigarh	Tamnar	Pandrikhol	PF	16.763	N
13	755 P	Raigarh	Tamnar	Semijar	PF	19.036	E
14	756 P	Raigarh	Tamnar	Murgapahar	PF	15.728	E
15	757 P	Raigarh	Tamnar	Tendu	PF	11.086	E
16	765	Raigarh	Tamnar	Tolge Paschim	RF	229.78	N
17	767	Raigarh	Tamnar	Tolge Purva	RF	195.729	N
18	768	Raigarh	Tamnar	Tolge Purva	RF	224.277	E
19	774	Raigarh	Tamnar	Tolge Purva	RF	-	ES
20	775	Raigarh	Tamnar	Tolge Purva	RF	346.267	ES
21	776	Raigarh	Tamnar	Tolge Purva	RF	179.668	ES
22	777	Raigarh	Tamnar	Tolge Purva	RF	243.678	ES
23	780	Raigarh	Tamnar	Tolge Purva	RF	164.502	E
24	781	Raigarh	Tamnar	Tolge Purva	RF	249.221	E
25	786 P	Raigarh	Tamnar	Khamhariya	RF	21.206	E
26	788 P	Raigarh	Tamnar	Lamdarha	RF	60.728	SE
27	789 P	Raigarh	Tamnar	Dongamauha	RF	118.837	SE
28	860 OA	Raigarh	Tamnar	Kathauatikra	OA	37.593	W
29	1352	Raigarh	Gharghoda	Deodogri	RF	273.489	N
30	1361 P	Raigarh	Gharghoda	Sukta Dongri	PF	38.852	N
31	1362 P	Raigarh	Gharghoda	Naya Rampur	PF	42.116	N
32	1363 OA	Raigarh	Gharghoda	Nayadih	OA	11.936	N
33	1364 P	Raigarh	Gharghoda	Lapda	PF	42.069	N
Forest in 5 - 10 Km Radius							
1	745 P	Raigarh	Tamnar	Kelo	PF	123.920	S
2	753 P	Raigarh	Tamnar	Urba	PF	7.342	N
3	754 P	Raigarh	Tamnar	Deodogari	PF	23.817	N
4	758	Raigarh	Tamnar	Tolge Paschim	RF	288.392	N
5	759	Raigarh	Tamnar	Tolge Paschim	RF	175.686	N
6	760	Raigarh	Tamnar	Tolge Paschim	RF	213.012	N
7	761	Raigarh	Tamnar	Tolge Paschim	RF	298.179	N
8	762	Raigarh	Tamnar	Tolge Paschim	RF	204.743	N
9	763	Raigarh	Tamnar	Tolge Paschim	RF	255.218	N

Sl.	Compartment No.	Division	Forest Range	Name of Forest	Category of forest	Area (ha)	Direction
10	764	Raigarh	Tamnar	Tolge Paschim	RF	323.315	N
11	766	Raigarh	Tamnar	Tolge Purva	RF	212.81	N
12	769	Raigarh	Tamnar	Tolge Purva	RF	347.056	E
13	770	Raigarh	Tamnar	Tolge Purva	RF	265.716	E
14	771	Raigarh	Tamnar	Tolge Purva	RF	444.683	ES
15	772	Raigarh	Tamnar	Tolge Purva	RF	270.552	ES
16	773	Raigarh	Tamnar	Tolge Purva	RF	-	ES
17	790 P	Raigarh	Tamnar	Beljar	PF	7.146	SE
18	791 P	Raigarh	Tamnar	Tapranga	PF	36.434	SE
19	792 P	Raigarh	Tamnar	Janjgir	PF	31.945	SE
20	793 P	Raigarh	Tamnar	Bendra	PF	59.346	SE
21	794 P	Raigarh	Tamnar	Bajarmuda	PF	33.470	SE
22	795 P	Raigarh	Tamnar	Dakshin, Dongamauha	PF	26.794	S
23	796 P	Raigarh	Tamnar	Dhaurabhantha	PF	25.034	S
24	858 P	Raigarh	Tamnar	Jhariyapali	PF	56.942	W
25	859 OA	Raigarh	Tamnar	Banai OA	OA	6.905	W
26	861 P	Raigarh	Tamnar	Banai	PF	29.598	W
27	862 P	Raigarh	Tamnar	Kerakhol	PF	31.686	W
28	863 P	Raigarh	Tamnar	Dongri	PF	18.908	W
29	864 P	Raigarh	Tamnar	Auraimuda	PF	116.567	W
30	1335 OA	Raigarh	Gharghoda	-	OA	-	WN
31	1345 OA	Raigarh	Gharghoda	Chanadongri	OA	88.562	N
32	1346 OA	Raigarh	Gharghoda	Mukhurmuda	OA	57.772	N
33	1347 P	Raigarh	Gharghoda	Bartangar	PF	58.383	N
34	1348 P	Raigarh	Gharghoda	Bichhinara	PF	14.793	N
35	1349 P	Raigarh	Gharghoda	Kharra Dongri	PF	35.76	N
36	1350 OA	Raigarh	Gharghoda	Kudhurmahua	OA	23.826	N
37	1351 P	Raigarh	Gharghoda	Kudhurmahua	PF	24.211	N
38	1353 OA	Raigarh	Gharghoda	Tilaipali	OA	30.164	N
39	1354 P	Raigarh	Gharghoda	Tal	PF	17.45	N
40	1355 P	Raigarh	Gharghoda	Ranmuda	PF	29.246	N
41	1356 P	Raigarh	Gharghoda	Bichhinar	PF	12.933	N
42	1357 P	Raigarh	Gharghoda	Jamjhor	PF	52.597	N
43	1358 OA	Raigarh	Gharghoda	Salhepatra	OA	34.398	N
44	1359 P	Raigarh	Gharghoda	Bagdhari	PF	9.774	NW
45	1360 OA	Raigarh	Gharghoda	Raikera	OA	41.911	NW
46	321	Dharamjaigarh	Lailunga	-	RF	-	N
47	322	Dharamjaigarh	Lailunga	-	RF	-	N
48	323	Dharamjaigarh	Lailunga	-	RF	-	N
49	324	Dharamjaigarh	Lailunga	-	RF	-	N
50	325	Dharamjaigarh	Lailunga	-	RF	-	N

Sl.	Compartment No.	Division	Forest Range	Name of Forest	Category of forest	Area (ha)	Direction
51	331 P	Dharamjaigarh	Lailunga	-	PF	-	NE
52	332 P	Dharamjaigarh	Lailunga	-	PF	-	NE
53	333 P	Dharamjaigarh	Lailunga	-	PF	-	NE
54	334 P	Dharamjaigarh	Lailunga	-	PF	-	NE
55	335 P	Dharamjaigarh	Lailunga	-	PF	-	NE
56	336 P	Dharamjaigarh	Lailunga	-	PF	-	NE
57	337 P	Dharamjaigarh	Lailunga	-	PF	-	NE
58	338 P	Dharamjaigarh	Lailunga	-	PF	-	NE
59	339 P	Dharamjaigarh	Lailunga	-	PF	-	NE
60	341	Dharamjaigarh	Lailunga	-	RF	-	NE
61	342	Dharamjaigarh	Lailunga	-	RF	-	NE
62	343	Dharamjaigarh	Lailunga	-	RF	-	NE
63	344	Dharamjaigarh	Lailunga	-	RF	-	NE
64	345	Dharamjaigarh	Lailunga	-	RF	-	NE
65	347	Dharamjaigarh	Lailunga	-	RF	-	NE
66	348	Dharamjaigarh	Lailunga	-	RF	-	NE

Source: Forest Copartment Record & Map of Raigarh & Dharmayjaygarh Division
Note: OA=Orange Area, PF = Protected Forest, RF = Reserve Forest

Table No 3.19: Strems/Rivers in Buffer Zone

Sl	Name of water Stream	Distance From Project Site	Direction from Project Site
1	Kelo River	Within Core Zone	Extreme East
2	Pajhar Nala	5.5	West
3	Digi Nala	6	West

3.14 PLANT SPECIES RECORDED FROM THE BUFFER AREA

It is difficult to prepare an exhaustive list of all the species of plants, particularly the herbs, from any sizable area. It may run in to at least 200 to 300 species. However, with the following mentioned species of trees, shrubs and herbs, some other trees shrubs and herbs were recorded from the core zone as well as from the buffer zone. A list of the same is being given below:

3.14.1 Tree Species

Table 3.20: Tree Species in Buffer Zone

S. No.	Vernacular/Local Name	English Name	Scientific Name
1	Akol	*Alangium salvifolium*	*Cornaceae*
2	Achar, Char	*Buchanania lanzan*	*Anacardiaceae*
3	Arjun, Kahu, Kauha	*Terminaliya arjuna*	*Combretaceae*

S. No.	Vernacular/Local Name	English Name	Scientific Name
4	Anjan	*Hardwickia binate*	*Leguminosae*
5	Amta	*Bauhiniya malabarica*	*Leguminosae*
6	Amaltaas	*Cassia fistula*	*Leguminosae*
7	Asta, Astara, Bosa	*Bauhiniya racemosa*	*Leguminosae*
8	Aam	*Mangifera indica*	*Anacardiaceae*
9	Aanola	*Emblica officinalis*	*Euphorbiaceae*
10	Imli	*Tamarindus indica*	*Leguminosae*
11	Kakai, Gorghati	*Flacourtia indica*	*Bixaceae*
12	Kachnar	*Bauhinia variegate*	*Leguminosae*
13	Karchi, Dudhi	*Holarrhena antidysenterica*	*Apocynaceae*
14	Kathjamun	*Eugenia heyneana*	*myrtaceae*
15	Kasai, Saja	*Bridelia retusa*	*Euphorbiaceae*
16	Karanj, Karanji	*pongamia pinnata*	*Leguminosae*
17	Kari, Homba	*Miliusa tomentosa*	*Anonaceae*
18	Kalasiras	*Albizzia lebbek*	*Leguminosae*
19	Kali Dudhi	*Wrightia tomentosa*	*Apocynaceae*
20	Kumbhi	*Careya arborea*	*Myrtaceae*
21	Kullu	*Sterculia urens*	*Streculiaceae*
22	Kusum	*Scleichera oleosa*	*Sapindaceae*
23	Keolar	*Bauhinia purpurea*	*Leguminosae*
24	Kekad, Kekar	*Garuga pinnata*	*Burseraceae*
25	Kem, Mundi	*Mitragyna parviflora*	*Rubiaceae*
26	Khatua, Katma	*Antidesma diandrum*	*Euphorbiaceae*
27	Khirni	*Mimusops hexandra*	*Sapotaceae*
28	Khair	*Acacia catechu*	*Leguminosae*
29	Khamer	*Gmelina arborea*	*Verbenaceae*
30	Galgala	*Cochlosperium religiosu*	*Bixaceae*
31	Gilchi, Girchi	*Casearia graveolens*	*Samydaceae*
32	Gursukri	*Grewia hirsuta*	*Tiliaceae*
33	Gular	*Ficus glomerata*	*Moraceae*
34	Ghot,Ghatol	*Zizyphus xylopyra*	*Rhamnaceae*
35	Chichwa, Muyar	*Albizzia odortissima*	*Leguminosae*
36	Chirol	*Holoptelea integriflolia*	*Ulmaceae*
37	Chuna	*Zizyphus rugosa*	*Rhamnaceae*
38	Lamraci, Arn	*Elaeodendron glaucum*	*Celastraceae*
39	Jamun	*Syzygium cumini*	*Myrtaceae*
40	Jhingar, Moyan, Gunja	*Lannea coromandelica*	*Anacardiaceae*
41	Tinsa	*Ougeinia oojeinensis*	*Leguminosae*
42	Tendu	*Diospyros melanoxylon*	*Ebenacea*

S. No.	Vernacular/Local Name	English Name	Scientific Name
43	Dhur, Vrihar	*Euphorbia neriifolia*	*Euphorbiaceae*
44	Dudhi	*Wrightia tinctoria*	*Apocynaceae*
45	Dahiwas	*Cordia macleodii*	*Boraginaceae*
46	Dhobin	*Dalbergia paniculata*	*Leguminosae*
47	Dhaman	*Grewia tiliaefolia*	*Tiliaceae*
48	Dhaura	*Anogeissus latifolia*	*Combretaceae*
49	Neem	*Azadirachta indica*	*Meliaceae*
50	Tondri	*Casearia tomentosa*	*Samydaceae*
51	Palas	*Butea monosperma*	*Leguminosae*
52	Panjra, Gadhapalash	*Erythrina suberosa*	*Leguminosae*
53	Pakar	*Ficus infectoria*	*Moraceae*
54	Papda, Papra	*Gardenia latifolia*	*Rubiaceae*
55	Peepal	*Ficus religiosa*	*Moraceae*
56	Pula, Baranga	*kydia calycina*	*Malvaceae*
57	Feda, Kharhar	*Gardenia turgida*	*Rubiaceae*
58	Bad	*Ficus bengalensis*	*Moraceae*
59	Baheda	*Terminalia bellerica*	*Combretaceae*
60	Beeja	*Pterocarpus marsupium*	*Leguminosae*
61	Chhind, Kuchhachhind	*Phoenix acaulis*	*Palmae*
62	Bel	*Aegle marmelos*	*Rutaceae*
63	Ber, Bor	*Zizyphus mauritiana*	*Rhamnaceae*
64	Bhanwarsal, Bhormal	*Hymenodictyon excelsun*	*rubiaceae*
65	Bhirra	*chloroxylon swietenia*	*Meliaceae*
66	Bhilwa, Beewa	*Semecarpus anacurdium*	*Anacardiaceae*
67	Madhukamini	*Murraya paniculata*	*Rutaceae*
68	Mahanim	*Ailanthus excels*	*Simarubaceae*
69	Mahua	*Madhuca indica*	*Sapotaceae*
70	Medsing	*Dolichandrone falcate*	*Bignoniaceae*
71	Mokha	*Schrebera swietceioides*	*Oleaceae*
72	Rekwa, Hiwar	*Acacia leucophloea*	*Leguminosae*
73	Roli, Sinduri	*Mallotus philippinensis*	*Euphorbiaceae*
74	Rohan, Rohni	*Soymida febrifuga*	*Meliaceae*
75	Harra	*Terminalia chebula*	*Combretaceae*
76	Haldu	*Adina cordifilia*	*Rubiaceae*
77	Hingot, Hingan	*Balanites aegyptiaca*	*Simarubaceae*
78	Shisham	*Dalbergia latifolia*	*Leguminosae*
79	Safed Siris	*Albizzia procera*	*Leguminosae*
80	Sagaun, Saag	*Tectona grandis*	*Verbenaceae*
81	Saaja	*Terminallia tomentosa*	*Combretaceae*
82	Saal	*Shorea robusta*	*Depterocarpaceae*

S. No.	Vernacular/Local Name	English Name	Scientific Name
83	Salai	*Boswellia serrata*	*Burseraceae*
84	Sitafal, Sharifa	*Anona squamosa*	*Anonaceae*
85	Senha, Lendiya	*Lagerstroemia parviflora*	*Lythraceae*
86	Semal	*Salmalia malabarica*	*Malvaceae*

Source: (i) Forest Working Plan, Raigarh Division (ii) Field visit by GCPL (iii) Discussion with local people & officials

3.14.2 Climbers Species

Table 3.21: Climbers in Buffer Zone

S. No.	Vernacular/Local Name	English Name	Scientific Name
1	Amarbel	*Cuscuta reflexa*	*Convolvulaceae*
2	Anantmul	*Hemidesmus indicus*	*Asclepiadaceae*
3	Irni, Churni	*Zizyphus Mugosa*	*Rhamanaceae*
4	Kaddu, Kand	*Dioscorea Bulbifera*	*Dioscoreaceae*
5	Karbel, Nagbel	*Cryptolepis buchanani*	*Asclepiadaceae*
6	Kakad Bel, Keksi	*Momordica diodica*	*Cucurbitaceae*
7	Kiwach, Kanchkuri	*Mucuna prurita*	*Leguminosae*
8	Kewati	*Ventilago calyculata*	*Rhamanaceae*
9	Khairbel, Kalibel	*Ventilago madraspatana*	*Rhamanaceae*
10	Gumchi, Gunj, Ratti	*Abrus precatorius*	*Leguminosae*
11	Gurar, Gaaj	*Milletia auriculata*	*Leguminosae*
12	Chameli	*jasminum arborescens*	*Oleaceae*
13	Chilati(Chhoti)	*Acacia pennata*	*Mimoseae*
14	Chilati(Badi)	*Acacia caesia*	*Mimoseae*
15	Dhimarbel, Chhorising	*Ichnocarpus frutescens*	*Apocynaceae*
16	Dokar Bel	*Spatholibus parrsflorus*	*Leguminosae*
17	Dudhi, Dudhbel	*Vallaris solanacea*	*Apocynaceae*
18	Nashbel, Mola	*Butea parviflora*	*Leguminosae*
19	Bechandi	*Dioscorea hispida*	*Dioscoreaceae*
20	Palas Bel, Bodal	*Butea superb*	*Leguminosae*
21	Pipar Bel, Faig	*Conbretum decandrum*	*Combretaceae*
22	Mahul, Maljhan	*Bauhinia vahlii*	*Leguminosae*
23	Malkangni, Faig	*Celastrus paniculata*	*Celastraceae*
24	Morbel	*Clematis triloba*	*Ranunculaceae*
25	Ramdataun	*Smilax macrophylla*	*Liliaceae*
26	Shikakai	*Acacia rugata*	*Leguminosae*
27	Satawar, Dashmoor	*Asparagas racemusos*	*Liliaceae*
28	Hadjodi	*Cissus quadrangularis*	*Ampelidaceae*

Source: (i) Forest Working Plan, Raigarh Division (ii) Field visit by GCPL (iii) Discussion with local people & officials

3.14.3 Herbs and Shrubs

Table 3.22: Herbs and Shrubs in Buffer Zone

S. No.	Vernacular/Local Name	English Name	Scientific Name
1	Aak, Madwar	*Calotropis gigantea*	*Asclepiadaceae*

S. No.	Vernacular/Local Name	English Name	Scientific Name
2	Aak	*Calotropis procera*	*Asclepiadaceae*
3	Archid	*Vanda parviflora*	*Orchidaceae*
4	Uat Katara	*Echinops echinatus*	*Compositeae*
5	Aethi, Marodfalli	*Helicteres isora*	*Streculiaceae*
6	Kalabansa, Bandar	*Colebrookea oppositiflolia*	*Labiateae*
7	Karauda	*Carissa Spinarum*	*Apocynaceae*
8	Kathmular	*Ficus hispida*	*Moraceae*
9	Kharata, Gursukadi	*Grewia hirsute*	*Tiliaceae*
10	Kharata, Jungli mehandi	*Dodonaea viscose*	*Sapondaceae*
11	Gajar	*Parthenium hysterophorus*	*Compositeae*
12	Gokhru, Sarata	*Tribulus terrestris*	*Zygophyllaceae*
13	Gokhru	*Acanthospermum hispidum*	*Zygophyllaceae*
14	Gokhru	*Xanthium strumarium*	*Compositeae*
15	Chirayta	*Andropogon paniculata*	*Palmae*
16	Chirota, Tarvar	*Cassia tora*	*Laguminosae*
17	Chitavar, Chitrak	*Plumbago zeylanica*	*Plumbaginaceae*
18	Chind, Chui	*Phoenix acaulis*	*Palmae*
19	Jungli Baingan	*Solanum nigrum*	*Solaneceae*
20	JUngli Kela	*Ensete superbum*	*Musaceae*
21	Jungli Tilli	*Sesamum orientale*	*Pedaliaceae*
22	Jungli Tulsi	*ERanthemum purpurascents*	*Acanthaceae*
23	Jungli San	*Crotalaria psectabilis*	*Leguminosae*
24	Bhau	*Tamarix diocia*	*Tamaricaceae*
25	Tulsi	*Ocimum sanctum*	*Labiateae*
26	Dikamali, Kurru	*Gardenia Lucida*	*Rubiaceae*
27	Dhatura (white)	*Datura stramonium*	*Solanaceae*
28	Dhatura (black)	*Datura metel*	*Solanaceae*
29	Dhavai	*Woodfordia fruiticosa*	*Lythraceaee*
30	Nagfani	*Opuntia elator*	*Cactaceae*
31	Nirgud	*Vitex negundo*	*Verbenaceae*
32	Neel, Girgoli	*Indigofera tinctoria*	*Leguminosae*
33	Tigerclow, Bichhuacha	*Martynia annua*	*Peda liaceae*
34	Dodhra, Adhoda	*Achymthes aspera*	*Amarantaceae*
35	Bansuli	*Grewia rolhii*	*Tiliaceae*
36	Bodhi	*Eriolanea hookariana*	*Steoulinaceae*
37	Ban kapas	*Thespesia lampas*	*Malvaceae*
38	Ber	*Zizyphus jijuba*	*Rhamnaceae*
39	Bhandar, Bhaat	*Clerodendron viscosum*	*Verbenaceae*
40	Bhuvar, Vor, Vruhar	*Euphorbia neriifolia*	*Euphorbiaceae*
41	Makoy	*Zizyphus oenoplia*	*Rhamnaceae*
42	Martona	*Carvia callosa*	*Acanthaceae*
43	Madhukamini	*Murrata paniculata*	*Rutaceae*
44	Mehandi	*Lawsonia inermis*	*Lythraceae*
45	Mainar	*Catunaregam spinosa*	*Rubiaceae*

S. No.	Vernacular/Local Name	English Name	Scientific Name
46	Munga	*Moringa oleifora*	*Moringaceae*
47	Raimunia, Laitana	*Lantana camara*	*Verbenaceae*
48	Ratanjyot, Ranijhar	*Jatropha curcas*	*Euphorbiaceae*
49	Lipti, Lapti, Chikati	*Desmodium latifolium*	*Leguminosae*
50	Vaybanding	*Embelia prericottam*	*Myrsinaceae*
51	Vaikal	*Maytenus senegulensis*	*Celastraceae*
52	Van Tulsi	*Hyptis suaveolens*	*Labiateae*
53	Beshram, Sadabahar	*Ipomoea carnea*	*Convolvulaceae*
54	Siparkata, Pila, dhatura	*Argemone Mexicana*	*Papaverceae*
55	Sisal	*Agave sislana*	*Agave veaece*
56	Hathiakand	*Leea macrophylla*	-
57	Harisingar, Kharsali	*Nyctanthes arbortrisis*	*Oleaceae*

Source: (i) Forest Working Plan, Raigarh Division (ii) Field visit by GCPL (iii) Discussion with local people & officials

3.14.4 Grasses and Bamboos

Table 3.23: Grasses and Bamboos in Buffer Zone

S. No.	Vernacular/Local Name	English Name	Scientific Name
1	Anjan, Kus	*Cenchrus cliaris*	*Gramineae*
2	Kail, Marbel	*Dichanthium annulatum*	*Gramineae*
3	Katabahari, Bhod	*Aristida setaceae*	*Gramineae*
4	Karabahari, Gagru	*Coix gigantean*	*Gramineae*
5	Kolia	*Sitaria glauca*	*Gramineae*
6	Kaans	*Saccharum apontanuem*	*Gramineae*
7	Kushal, Sukal	*Heterpogon contortus*	*Gramineae*
8	Khas	*Vetiveria Ziznioides*	*Gramineae*
9	Gunher (bhusar sirra)	*Themeda quadrivalvis*	*Gramineae*
10	Chir (Chirbahari)	*Imeperata cylindrical*	*Gramineae*
11	Ponai, Poki falli	*Apluda mutica*	*Gramineae*
12	Ponia	*Schima sulcatum*	*Gramineae*
13	Phoolbahari	*Arundinella setose*	*Gramineae*
14	Bans	*Dendrocalamus strictus*	*Gramineae*
15	Baru	*Sorghum halepense*	*Gramineae*
16	Bhurbhusi	*Erodonagrostis tenella*	*Gramineae*
17	Merkel	*Bothriochloa pertusa*	*Gramineae*
18	Moya	*Pennisetum alopecures*	*Gramineae*
19	Mushan, Muchel	*Iseilema laxum*	*Gramineae*
20	Munj	*Saccharum munja*	*Gramineae*
21	Dinanath	*Pennisetum pedicellatum*	*Gramineae*
22	Dub	*Cynodon dactylon*	*Gramineae*
23	Rusa	*Cymbopogon martini*	*Gramineae*
24	Sabai, Bagai	*Eulaliopsis binata*	*Gramineae*
25	Senar	*Sehima nervosum*	*Gramineae*
26	Selria, Kill	*Digitaria sanguinalis*	*Gramineae*

Source: (i) Forest Working Plan, Raigarh Division (ii) Field visit by GCPL (iii) Discussion with local people & officials

3.14.5 Epiphytes, Parasites and Other

Table 3.24: Epiphytes, Parasites and Other in Buffer Zone

S. No.	Vernacular/Local Name	English Name	Scientific Name
1	Amar bel	*Cuscuta reflexa*	*Convolvulaceae*
2	Ankid	*Vanda parviflora*	*Orchidaceae*
3	Bada, Badra	*Dendrophthoe*	*Loranthaceae*
4	Badra	*Viscum articulatum*	*Loranthaceae*
5	Katang Baas	*Bambusa arundincea*	*Graminaceae*
6	Tand	*Borassus flabelliefer*	*Convovlaceae*

Source: (i) Forest Working Plan, Raigarh Division (ii) Field visit by GCPL (iii) Discussion with local people & officials

3.14.6 Cultivated Plants

Table 3.25: Cultivated Plants in Buffer Zone

S. No.	Local Name	English Name	Scientific Name
A. Cereals & Millets			
1	Dhan	Paddy	*Oryza sativa*
2	Makka	Maize	*Zea mays*
3	Gehu	Wheat	*Triticum sp.*
4	Sawa	Millet	*Panicum miliare*
5	Minjri, Madia	Millet	*Eleucine coracana*
6	Kutki	Minor millet	*Panicum miliare*
7	Kodo	Minor millet	*Paspalun scrobiculatum*
8	Jwar	Millet	*Sorghun vulgare*
9	Jau	Barley	*Hordeum vulgare*
B. Pulses and oil			
1	Arandi	Castor seed	*Ricinus cummunis*
2	Alsi	Linseed	*Linum usitatissimun*
3	Arhar	Pigeon pea	*Cajanus cajan*
4	Til	Sesamum	*Sesamum inicum*
5	Kulthi	Horse-gram	*Dolochos biflorus*
6	Kusum	Safflower	*Carthemus tinctorius*
7	Urd	Black gram	*Phaeolus mungo*
8	Mung	Mung gram	*Phaseolus radiates*
9	Surajmukhi	Sunflower	*Helianthus annus*
10	Sarson	Mustard	*Brassica campestris var. sarso*
11	Matar	Pea	*Pisum sativum*
12	Mungphali	Ground nut	*Arachis hypogea*
C. Fruit			

1	Kela	Banana	*Musa paradisiaca*
2	Aam	Mango	*Mangifera indica*
3	Nibbu	Lime	*Citrus aurantifolia*
4	Amrud	Guava	*Psidium guajava*
5	Papita	Papaya	*Carica papaya*
6	Kathal	Jack-fruit	*Artocarpus heterophyllus*
7	Seetaphal	Custard-apple	*Annona squamosa*
8	Ber	Jujube	*Ziziphus mauritiana*
D. Vegetables			
1	Tamatar	Tomato	*Lycopersicum esculantum*
2	Baigan	Brinjal	*Solanum melongena*
3	Pattagovi	Cabbage	*Brassica oleracea*
4	Phulgovi	Cauliflower	*Brassica oleracea*
5	Ganthgovi	Knolkhol	*Brassica oleracea*
6	Bhindi	Lady's finger	*Abelmoschus esculentus*
7	Barbatti	Cowpea	*Vignainensis/unguiculatoo*
8	Aloo	Potato	*Solanum tuberosum*
9	Muli	Radish	*Raphanus sativas,*
10	Karela	Bitter gourd	*Momordica charantia*
11	Torai	Ridge gourd	*Luffa acutangula*
12	Kaddu	Pumpkin	*Cucurbita moschata*
13	Gilki	Sponge gourd	*Luffa cylindrica*
14	Palak	Beet	*Beta vulgaris*
15	Lalbhaji	Amaranth	*Amaranthus spp.*
16	Rakhia Kaddu	White Gourd	*Benincasa hispida*
17	Kundru	-	*Coccinia grandis*
18	Khira	Cucumber	*Cucumis sativus*
19	Lauki	Bottle gourd	*Lagenaria siceraria*
20	Chichinda	Snake gourd	*Trichosanthes anguina*
21	Ghuiyan	Pichigi	*Colocasia esculenta*
22	Lahson	Garlic	*Allium sativum*
23	Dhaniya	Coriander	*Coriandrum sativum*

Source: (i) Forest Working Plan, Raigarh Division (ii) Field visit by GCPL (iii) Discussion with local people & officials

3.14.7 Ethnobiology (Medicinal Plants):

Almost every plant species has got some or the other medicinal value. Recognition of medicinal value of a plant varies also from region to region. Due to unchecked cutting and

removal, many of the useful plant species have either disappeared or have become exceedingly scarce in the area. This is true also for the medicinal plants. Only a few plant species, to be named as medicinal plants, are visible in the area, but with much reduced density. These include the herbaceous species like: *asparagus racemosus, celastrus paniculata, curculigo orchioides, dioscorea bulbifera, diplocyclos palmatus, elephantopus scaber, evolvulus alsinoides, hemidesmus indicus and tephrosia purpurea*, and small tree species like *holarrhaena antidysenterica*.

Table 3.26: Medicinal Plants in Buffer Zone

S. No.	Common Name	Scientific name	Parts used	Ethnobotanical / medicinal uses
1.	Ratti	*Abrus precatorius*	Seed	Snake bite, fiver
2.	Katha	*Acacia catechu*	Bark, Hard Wood, Juice, Leaf, Flower	Toothache, cough and cold, stomach pain, coloring, betel nut
3.	Babool	*Acacia nilotica*	Whole Plants, Flower	Jaundice, itching, worms, tooth ache, eye elements, cough, facial paralysis, easy delivery, asthma, fever, carpentry work
4.	Khoruch	*Achyranthes aspera*	Root, Seed, Whole Plant	Snake bite, stomach pain, fever, hydrophobia, skin problem, cough
5.	Bach	*Acorus calamus*	Rhizome, Leaves	Delayed delivery, Abdominal disorder, eye and skin problem, cough, piles
6.	Adusa	*Adhatoda vasica*	Leaves, Root, Whole Plant	Asthma, urinary problem, piles, cough,
7.	Bel	*Aegle marmelos*	Leaf, Root, Fruit, Stem, Juice,	Mouth ulcer, Piles, Headache, headache, fever, weakness, dysentery, cataract, chest seed pain, as gum
8.	Siris	*Albizia lebbek*	Root, Flower Seed, Bark, Stem, Root, Flower	Scorpion bite, migraine, piles, hydrocele, toothache, wound and cut, carpentry
9.	Gritkumari	*Aleo vera*	Leaves	Cosmetics, burns, cut and wound, fracture, gastric, eye problem, Headache
10.	Chaulai bhaji	*Amaranthus virdis*	Leaves	Eye elements, blood purification, fodder
11.	Akarkara/ akarkha	*Anacyclus pyrethrum*	Whole Plant	Heart disease, paralysis, stomach problem, fever, tooth ache
12.	Chota	*Andrographis*	Whole Plant	Malarial fever, for feeding cattles

S. No.	Common Name	Scientific name	Parts used	Ethnobotanical / medicinal uses
	chirayata	*paniculata*		
13.	Bhuineem	*Andrograthis panculata*	Whole Plants	Joint pain, jaundice, head ache, malaria, anti helm-antic
14.	Ramphal	*Annona reticulata*	Fruit, Leaf, Seeds, Stem	Digestion, tumor, cancer, diabetes
15.	Sitaphal, chitaphal	*Annona squamosa*	Leaves, Fruits, Bark	Intoxicating, edible, seeds in diabetic problems
16.	Pilikatere	*Argemone maxicana*	Yellow Milk, Oil, Root, Bark, Leaf	Ring worm, abdominal pain, ulcer, jaundice, cough, asthma, male impotency
17.	Satawar	*Asparagus racemosus*	Whole Plant	Piles, fever, wound, anti-toxic, weakness, cough, diarrhoea , head ache, asthma, urinary disorder
18.	Neem	*Azadirachta indica*	Seed Oil, Bark, Leaf, Wood, Fruit	Heart problems, eczema, arthritis, white discharge, ear and tooth ache, malaria, anti-toxic and anti-microbial, tooth washing, furniture making, chicken pox, blood purification, cosmetics
19.	Baans, Bans	*Bambusa arundinacea*	Whole Plant	Wound healing, tuberculosis, bronchitis, Leprosy, food and fodder, feeding of cow after delivery, musical instruments
20.	Kachnar	*Bauhinia variegata*	Buds, Bark, Flower	Constipation, antiseptic, stomatitis, piles
21.	Punarnava	*Boerhaavia diffusa*	Whole Plant	Kidney stone, arthritis
22.	Semar	*Bombax ceiba*	Bark, Fruit, Leaves	Piles, leprosy, anti-dote, medicinal cotton, anemia, liver and spleen disease
23.	Chironji	*Buchanania lanzan*	Seed, Leaf	Applied on cut, wound and eczema
24.	Palas	*Butea monosperma*	Gum, Root, Seed, Flower	Night blindness, eye disorder, epilepsy, diarrhea, eczema, arthritis, abdominal worm, cataract, worship, dyes
25.	Patharchtta	*Byophyllum pillatum*	Leaf, Stem	Antiseptic, cures kidney stone, skin disease, head ache
26.	Aak/ Akwan	*Caltropis procera*	Fruit, Whole Plant	Cut and wound, leprosy, dropsy, rheumatic pain, asthma, bronchitis
27.	Papita	*Carica papaya*	Leaf, Fruit, Seed, Latex	Liver enlargement, heart problem, piles, skin problem,

S. No.	Common Name	Scientific name	Parts used	Ethnobotanical / medicinal uses
				cosmetics
28.	Karonda	*Carissa carandus*	Root, Fruit	Anemia, constipation
29.	Amaltas	*Cassia fistula*	Leaf, Root, Seed, Wood	Ring worm, wound, fever, leprosy, cough
30.	Brahmi, Brahmni	*Centella asitica*	Leaf, Whole Plant	Insomnia, enhance memory, hair anxiety, b.p. problem, chicken pox
31.	Safedmusli	*Chlorophytum tuberosum*	Root	Tuberculosis, male impotency, tonic
32.	Sevanti	*Chrysanthemum corinarium*	Flower, Bark, Root	Purgative, anti helmantic, Cultural use
33.	Hadjor	*Cissus quadrangularis*	Stem	Fracture
34.	Nimbu/limbu	*Citrus medica*	Fruit, Leaf, Root, Whole Plant	Throat disorder, constipation, antiseptic digestion, dandruff, fever, cough, juices
35.	Kochai	*Colocasia esulenta*	Leaves Corm	Vegetable, constipation, weakness, alopecia
36.	Keu	*Costus speciosus*	Rhizome	Liver related disease
37.	Kalimusali	*Curculigo orchioides*	Root Juice	Dysentery
38.	Amarbel	*Cuscuta reflexa*	Whole Plant	Conjunctivitis, respiratory disorder, piles, ulcer, stomach problem, swelling of eye
39.	Doobghas	*Cynodon dactylon*	Leaves, Whole Plants	Leucorrhoea, excessive pus formation, piles, epilepsy, nasal bleeding, cancer, eczema, eye and mouth problem, headache, urinary problem, paper making, fodder
40.	Shisham	*Dalbergia sissoo*	Oil, Leave, Whole Plant	Skin disorder, toothache, eye aliments, burning sensation, carpentry work
41.	Gulmohar	*Delonix regia*	Leaf, Flower, Wood	Skin trouble, coloring
42.	Dhatura	*Dhatura strumoniun*	Leaves Whole Plant	Eye problem, asthma, arthritis, headache, male impotency, cultural use
43.	Tendu	*Diospyros melanoxylon*	Pulp, Fruit, Leaf	Healing of crack feet, edible, bad breath, dysentery
44.	Fern	*Dryopteris filixmas*	Rhizome	Anthelmintic

S. No.	Common Name	Scientific name	Parts used	Ethnobotanical / medicinal uses
45.	Amla, aawla	*Emblica officinalis*	Seed, Fruit, Leaf, Bark	Constipation, arthritis, fever, itching, digestive, hair fall, diabetes, eye and skin problem
46.	Kari	*Erycibe panculata*	Leaf	Night blindness
47.	Dudhi	*Euphorbia hirta*	Root, Leaf	Cough, dysentery, Anti - asthmatic, milk secretion, fodder
48.	Shankhpushhpi	*Evovulus alsinoides*	Whole Plant	Headache, brain tonic, vomiting, diabetes, weakness
49.	Bargad	*Ficus benghalensis*	Latex, Leaf, Bark, Root	Prevent loss of hair, pain killer in joint pain, diabetes
50.	Gular	*Ficus glomerata*	Fruit Milkey Latex	Diabetes, asthma, piles, urinary problem
51.	Dumar	*Ficus racemosa*	Leaf, Fruit, Milk, Root	Leucorrhoea, piles, Stomach pain, dysentery, fiver, ulcer
52.	Peepal	*Ficus religiosa*	Whole Plants, Letex	Eczema, toothache, leucorrhoea, cutand wound, earache, cough and cold, jaundice, stomach pain, fodder, worship
53.	Gamhar	*Gmelina arborea*	Root, Flower, Fruit, Bark Leaf, Wood	Weakness, snake bite, anti-dote, cut and wound, carpentry construction work
54.	Haldu	*Haldinia cordifolia*	Root, Bark	Pain killer, intestinal worms
55.	Gudhal	*Hibiscus rosa sinensis*	Flower, Seed, Leaves, Root	Hair fall, cough and cold, male impotency, stomach pain, worship.
56.	Chameli	*Jasmminum grandiflorum*	Leaf, Root, Flower, Oil	Ulcer, headache, mouth disease, impotency, skin disease, ear problem, worm, fever, perfume
57.	Ratanjot	*Jatropha curcas*	Seed Oil	Rheumatic pain, night blindness
58.	Mehandi	*Lawsonia inermis*	Seeds, Leaves, Root	Eye disorder, hair fall and coloring, burn, jaundice, headache, stomach problem
59.	Mahua	*Madhuca latifolia*	Flower, Whole Plant	Anti-bacterial, carpentry work, pain killer, wine/liquor, worship
60.	Aam	*Mangifera indica*	Fruit, Whole Plant, Seeds	Cough and cold, anti-dysenteric worm, furniture work, religious use, heat stroke, for pickles, carpentry
61.	Mahaneem	*Melia azadirachta*	Fruit, Seed, Whole Plant	Stomatitis, internal worm, stone in urinary bladder, swelling, etching, fever, eye problem

S. No.	Common Name	Scientific name	Parts used	Ethnobotanical / medicinal uses
62.	Pudina	*Mentha spicata*	Leaf	Gastro intestinal disorder, fever, cholera, skin problem, cough and cold, sauces
63.	Lajwanti	*Mimosa pudica*	Leaves, Root	Piles, diarrhea, swelling, jaundice, excessive urination, indigestion
64.	Munga	*Moringa oleifera*	Fruit, Bark, Leaves, Root	Piles, cough, intestinal worm, Bp., gum problem, headache
65.	Mitha neem patti	*Murraya koenigii*	Root, Leaf	Treatment of anemia, vomiting, wound, hair loss
66.	Harsringar	*Nyctanthes arbortristis*	Stem, Flower	Fracture, worship,
67.	Vantulsa/ bantulsi	*Osmium basilicum*	Leaves, Seed, Root,	Cough and cold, green tea, giddiness
68.	Karanj	*Pangamia pinnata*	Seed, Leaf	Leucoderma, parasiticide, malaria
69.	Tejraj	*Peucedanum nagpurense*	Bark, Leaf	Joint pain, sexual disorders
70.	Masbandhi	*Porana paniculata*	Root	Joining the fractured bone, wound
71.	Amrood,bihi	*Psidium guajava*	Fruit, Whole Plant	Joint pain, cough, heart ailment, toothache, dysentery, ulcer
72.	Bija	*Pterocarpus marsupium*	Wood, Bark, Leaf	Diabetes, diarrhea, constipation, coloring
73.	Aanar	*Punica grantum*	Fruit Leaf, Whole Plant	heart problem, eye and ear disorder, tonic, migraine, jaundice, vomiting, piles, worm
74.	Aarandi	*Ricinus communis*	Leaf, Seed	Seed oil in purgative, piles, joint pain, hair fall, skin disease, head ache
75.	Rose	*Rosa damascene*	Root Leaf, Flower,	Cultural use, wounds, diarrhea, diabetes, skin infection, cosmetics
76.	Sarpagandha	*Roulfia serpentine*	Root, Bark	Snake bite, bp. Control, joint pain, fever, malaria, ulcer
77.	Agastiya	*Sesbania grandiflora*	Flower, Leaf, Stem, Bark	Constipation, migraine, epilepsy, leucorrhoea, pain killer
78.	Saal/ sarai	*Shorea robusta*	Fruit, Seed, Whole Plant	Dysentery, anti-dote, Furniture
79.	Jamun	*Syzygium cumini*	Fruit, Bark, Seed, Leaf	Piles, diabetes, loose motion, eye and ear problem, Syphilis, vomiting, lever swelling, furniture
80.	Imli	*Tamarindus indica*	Leaves, Bark, Seeds, Wood	Scorpion bite, scabies, stomach pain, furniture

S. No.	Common Name	Scientific name	Parts used	Ethnobotanical / medicinal uses
81.	Sagon	*Tectona grandis*	Whole Plant	Burning sensation, arthritis, kidney and skin disease, furniture, diabetes, ulcer
82.	Kahua/Arjun	*Terminalia arjuna*	Bark Leaf	Heart and liver disease
83.	Harra	*Terminalia chebula*	Fruit and Bark	Digestion, skin problem
84.	Bankapas	*Thespesia populnea*	Stem, Bark, Flower	Dog bite, making in fiber and paper
85.	Kaner	*Thevetia peruviana*	Leaf, Flower	Worship, toothache, healing, cut and wound
86.	Giloy	*Tinospora cardifalia*	Whole Plant	Piles, eye problem, fiver, jaundice, arthritis
87.	Ashwagandha	*Withnania somnifera*	Leaves, Root, Whole Plant	Cough, stimulant, arthritis, ulcer
88.	Ber	*Zizyphus jujube*	Fruit, Leaf, Bark, Stem	Ulcer, fever, wound, abdominal pain, asthma, vegetable
89.	Bhirra	*Chloroxylon swietenia*	-	Tuberculosis
90.	Tulsi	*Ocimum sanctum*	Leaf	Fainting
91.	Karrewa	-	Fruit, Root	Tuberculosis
92.	Rohan	*Soymida febrifuga*	Bark	Tuberculosis
93.	Vishakhpara	-	Root	wound
94.	Ashok	*Saraca asoka*	Bark	attack
95.	Banrakas	-	Root	Joint pain
96.	Kokai	*Flacourtia ramontchii*	Bark	Diarrhea
97.	Dhawai	*Woodfordia fruticosa*	Flower	Menstruation
98.	Astibhang	-	Bark	fracture
99.	Sambarbhang	-	Seeds	Chest pain
100	Alsi	-	Seeds	Chest pain
101	Kala Jeera	-	Seeds	stomach pain
102	Tejrai	*Peucedanum nagpurense*	Bark, Leaf	Joint pain, Sexual disorders
103	Shivling	-	Seeds	Pregnancy
104	Gritkumari	*Aleo vera*	Leaf	Headache

S. No.	Common Name	Scientific name	Parts used	Ethnobotanical / medicinal uses
105	Vat	-	Root	Diarrhea
106	Chat (bad)	-	Milk	Piles
107	Jungli Bhindi	*Thespesia lampas*	Root	-
108	Teen Pattiyan	-	Root	Migraine
109	Fafan	-	Root	Cough
110	Chitawar	-	Root	Itching
111	Kelkand	-	Tubers	Headache
112	Path Koriya	-	Root	fecal bile
113	Tauraha	-	Bark	Cancer (Early stage)
114	Besharam	-	Leaf	Skin problem
115	Bagnakha	-	Seeds	Skin problem
116	Bade Dashmul	-	Stem	Tuberculosis

Source: (i) Forest Working Plan, Raigarh Division (ii) Field visit by GCPL (iii) Discussion with local people & officials

3.15 FAUNA IN THE BUFFER ZONE

Vegetation cover in the area is patchy with patches of cultivated fields, grasslands, shrubby forest with low to medium density. Water channels are scanty and of seasonal nature. However, the scarcity of water from late winter to the summer season is a major problem to the wildlife for their survival. Therefore, the wildlife is attracted to the village ponds for water resulting in man-animal conflicts. Wolf (*Canislupus*) Scaly ant eater (*Mannis crassicauda*), peacock (*Pavo cristatus*) and sloth bear (*Melursus ursinus*) are the schedule I animals. The sloth bear is a common visitor to the area. The animal is nocturnal but sometimes dares to enter the village outskirts even during the day time. It enters the village area for many types of food including the Gular (*Ficus glomarata*), Sugarcane (*Saccharum officinarum*), and tuberous crop like the potato (Solanum tuberosum). However more attractive to the village area to the bear is the mahua (*Madhuca latifolia*) flower. Flowering period of this tree is generally the months of March and April and so the frequency of visit of bear is more during these two months. Some mammals like Jackal (*Canis aureus*) and Fox (*Vulpusbenghalensis*) are more common, night visitors of the area. Frugivorous, five stripped squirrels (*Funambulus pennanti*) is seen only during the fruiting seasons of the trees, while trees, producing fruits to the liking of frugivorous bats (*Cynopterussphinx*) are rare, making the area, less probable place for their visit. Among the lizards, garden lizard

(*Calotes versicolor*), forest calotes (*Calotes rouxi*) are the lizards while Buffstripped keel back or Sita ki Lath (*Amphiesma stolata*), Cobra (*Naja naja*) and Dhaman or Indian rat snake (*Ptyas mucosus*) are some of the common snakes of the area. Among the amphibians the common toad (*Bufo melanostictus*) and the pond frog Rana *cyanophlictis* are the common frogs observed in the area. Some of the birds, are House crow (*Corvrus splendens*), Comman myna (*Acridotheris tristis*) Brahminy myna (*Sturnus pagodrum*), Spotted dove (*Streptopeliachinensis*), Parakeet (*Psittacutla krameri*) Koel, Cuckoo (*Eudynamys scolopaicea*), Phakhta (*Streptopelia chinensis*), Jangali Kaua (*Corvus macrorhynchos*), Neelkanth (*Coracias benghalensis*), Bater or Grey Quail (*Coturnix coturnix*), Basanti or Indian cuckoo (*Cuculus micropterus*), Kite (*Milvus migrans*), and Cattle egret (*Bubulcusibis*). Included with these are some other smaller animals belonging to group insect including the spiders, grasshoppers, insects and butterflies.

3.15.1 Fishes

Table 3.27: List of Fishes in Buffer Zone

S. No.	Vernacular/Local Name	English Name	Scientific Name
1	Alli	The Reba	*Cirrhina reba*
2	Catla	The Catla	*Catla catla*
3	Kalod, Kaloti	The Kalbasu	*Laben calbasu*
4	Kursa, Goli	-	*Labeo gonius*
5	Common Carp	The Common Carp	*Cyprinus carpio*
6	Kut Rohu	The Fringe-lipped carp	*Labeo fimbriatus*
7	Kohira	Ambassia	*Mastur aor*
8	Kagi	-	*Ambasus ranga*
9	Kangi	-	*Ambassu nama*
10	Kharpata	-	*Barbus sarana*
11	Gagra	The Large Murrel	*Ophicephalus marulius*
12	Chal, Chalwa	-	*Chela bacela*
13	Telpya, Marki Rohu	The Carp	*Tilipya mossibea*
14	Naren	The Mrigal	*Cirrhina mrigala*
15	Paren	The freshwater Shark	*Wallago attu*
16	Patola	-	*Notopeterus notopeterus*
17	Pabda	-	*Chena pabda*
18	Bam	-	*Mastacembelus armatus*
19	Bata, Mohini	The Bata	*Labeo bata*
20	Mahasheer, Badas	-	*Tortor*
21	Magur	-	*Clarius magur*
22	Rohu	The Rohu	*Labeo rohita*
23	Samal Sor	The Common Murrel	*Ophicephalus striatus*
24	Sigi	-	*Heteronopterus singhi*
25	Singhal, Singda	Catfish	*Mystus seenghla*

Source: (i) Forest Working Plan, Raigarh Division (ii) Field visit by GCPL (iii) Discussion with local people & officials

3.15.2 Reptiles

Majority of the reptile species are fossorial in habit therefore the assessment of reptiles and their diversity etc. holds special significance for any development projects. It is difficult to conduct quantitative study on reptiles within a short period of time. Therefore, the study relied on qualitative observations only. Study based on interview survey, secondary literature (Forest Working Plan, Raigarh) as well as direct observation were carried out. Therefore, only a check list of reptiles observed during the study period was prepared. The checklist of reptiles reported from the study area is given in **Table 3.28**.

Presence of python has been reported from villagers, although their occurrence could not be sighted during the field visit. The presence of monitor lizard was also not reported from the core or buffer zone. The star tortoise reported from the buffer area is listed as 'vulnerable' by the IUCN.

Table 3.28: Reptiles in Buffer Zone

S. No	Local Name	English Name	Scientific Name	Protection Status Schedule (WPA, 1972)	Conservation Status (IUCN)
1.	Azgar	Python	*Python molurus*	Sch I (Part II)	VU
2.	Asdriya, Daboiya	Russel's viper	*Vipera russelli*	Sch II	LC
3.	Kachua	Indian starred Tortoise	*Testudo elegaus*	Sch IV	-
4.	Kachua	The common Three kelled land tortoise	*Geoemyda trijuga*	Sch IV	NT
5.	Krait	Common krait	*Bungarus caerulens*	Sch IV	LC
6.	Krait (Dharidaar)	Banded krait	*Bungarus fasciatus*	Sch IV	LC
7.	Girgit	Chameleon	*Calotes versicolor*	-	-
8.	Goh, Gobra	Monitor Lizard	*Varanus monitor*	Sch I (part II)	-
9.	Chipkali	House Lizard	*Hermidactylus domesticus*	-	-
10.	Chipkali	Lizard	*Hermidactylus flaviviridis*	-	-
11.	Dhaman	Non-Poisonous snake	*Dendrophis pictus*	Sch IV	-
12.	Dhaman	Non-Poisonous snake	*Gongylophis comicus*	Sch IV	-
13.	Dhaman	Non-	*Lycoden aulicus*	Sch IV	-

S. No	Local Name	English Name	Scientific Name	Protection Status Schedule (WPA, 1972)	Conservation Status (IUCN)
		Poisonous snake			
14.	Dhaman	Non-Poisonous snake	*Zameniss mucosus*	Sch IV	-
15.	Nag	Cobra	*Naja naja*	Sch II	-

Source: (i) Forest Working Plan, Raigarh Division (ii) Field visit by GCPL (iii) Discussion with local people & officials

3.15.3 Avifauna

For creating baseline data on birds, we randomly walked in the study area during early morning i.e. 6:00 am to 9:00 am and in the evening from 5:00 pm to 7:00 pm. These are the time periods of the day when maximum bird movements are expected. We walked randomly in the study area and carried out sightings of birds ad libitum and recorded species based on their identification. Apart from walking randomly, we also relied on specific habitat search for different species i.e. dense bushes, wetland, ponds, big trees, agriculture areas etc. All the bird species are classified based on their conservation status, their schedule under Wildlife Protection Act 1972 and IUCN Status. This was used for finding out important bird species in the study area i.e. rare, endangered or species of high conservation significance. The bird species reported from the study area are tabulated in **Table 3.29**. No rare, endangered, endemic bird species were found to breed in the core or buffer zone during site visit except the pea fowl which is listed under Schedule I of Wildlife Protection Act, 1972.

Table 3.29: Birds in Buffer Zone

S. No.	Local Name	English Name	Scientific Name	Protection Status Schedule (WPA, 1972)	Conservation Status (IUCN)
1	Agayia murari	Rufostailed finch lark	*Ammomanes phoenicurus*	Sch IV	LC
2	Ablak Maina, Kavdi Maina	Pied Myna	*Sturnus contra*	Sch IV	
3	Ababil, Bhandik	Swallow	*Hirundo rustica*	-	LC
4	Aaruni	Redwinged Bush lark	*Miratra erythropte*	-	-
5	Ullu	Brown fish owl	*Bubo zeylonensis*	Sch IV	LC
6	Andha Bagla, Bhura Bagla	Pond Heron, paddy bird	*Ardeola grayii*	Sch IV	LC
7	Kathphora, Sona	Golden backed	*Dinopium*	Sch IV	-

S. No.	Local Name	English Name	Scientific Name	Protection Status Schedule (WPA, 1972)	Conserva tion Status (IUCN)
	Pathi, Sutaar	wood pecker	*bengalense*		
8	Kathphoria, Laal Potacha, Khod Pakshi	Chestnut bellied nuthatch	*Sitta castanea*	-	LC
9	Kathphora, Makhmali, Kapal Phor Pakshi	Velvetfronted Nuthatch	*Sitta frontalis*	-	LC
10	Kathphoria, Maratha Sutaar	Yellow fronted pied or Maratha wood pecker	*Picoides mahrattenses*	-	-
11	Kabutar	Blue Rock Pigeon	*Colunba livia*	Sch IV	-
12	Kavarya Nartak	White spotted fantail flycatcher	*Rhipidura albicollis*	-	LC
13	Kasva, Mo Dohuwa	Large cuckooshrike	*Coracina javensis*	-	LC
14	Kagla, Latora	Rufousbacked shrike	*Lanius schach*	-	LC
15	Kapshii	Black winged Kite	*Elanus caeruleus*	Sch IV	LC
16	Kaalpathi, Sutaar	Black backed woodpecker	*Picoides articus*	-	LC
17	Kaala Titar, Raak Titar	Grey partridge	*Francolinus pondicerianus*	-	LC
18	Kaala Pidda	Pied Bushchat	*Saxicola caprata*	-	LC
19	Kaala Bagla	Black Ibis	*Pseudibis papillosa*	-	LC
20	Kilkilla	White breasted Kingfisher	*Halcyon smyrnensis*	-	LC
21	Kilkilla, Kabri Dhibar	Pied Kingfisher	*Ceryle rudis*	Sch IV	LC
22	Katurga	Large Green Barbet	*Megalaima zeylainca*	-	-
23	Kukal	Indian Sandgrouse	*Pterocles exustus*	-	LC
24	Koyal	Koel, Cuckoo	*Eudynamys scolopaica*	Sch IV	LC
25	Korutiya	European Kestrei	*Falco finnusculus*	-	-
26	Kouwa	House Crow	*Coryus splendens*	Sch IV	

S. No.	Local Name	English Name	Scientific Name	Protection Status Schedule (WPA, 1972)	Conserva tion Status (IUCN)
27	Kowri Chiklaa	Little Ringed Plover	*Charadrius dubius*	-	LC
28	Khadpidda, Gappidas	Collared Bushchat	*Saxicola torquata*	Sch IV	LC
29	Gay Bagula	Cattel Egret	*Bubulcus ibis*	Sch IV	LC
30	Gid	Bengal vulture, Indian White backed vulture	*Gyps bengalensis*	-	CR
31	Gorraiya Chimni	House Sparrow	*Passer domesticus*	Sch IV	LC
32	Gadhari	Baybacked Shrike	*Lanius vittiatus*	-	LC
33	Duddhu, Ullu	Great Horned Owl or Eagle Owl	*Bubo bubo*	IV	LC
34	Chakravaak, Surkhab	Brahming Duck or Ruddy Sheldrake	*Tadorna ferruginea*	-	LC
35	Chalotra	Common Grey Hornbill	*Tockus Biroatris*	-	LC
36	Chaha	Common Snipe, Fantail Snipe	*Gallinago gallinago*	-	LC
37	Chatak	Pied Crested cuckoo	*Clamator jacobinus*	-	LC
38	Cheetah, Faakt Kavda	Spotted Dove	*Sterptopelia chinensis*	-	LC
39	Chirak	Indian Robin	*Saxicoloides fulicatus*	-	LC
40	Chil	Common pariah Kite	*Milvus Migrans*	Sch IV	LC
41	Chugad	Spotted Owlet	*Athene brama*	-	LC
42	Chipak	Common Indian Nightjar	*Caprimulgus asiaticus*	-	LC
43	Chota Kilkila	Common Kingfisher	*Alcedo atthis*	Sch IV	LC
44	Chota Nikhar, Bulalchashm	Small minivet	*Pericrocotus cinnamomeus*	-	LC
45	Chota Bagula, Chota Pisari Bagula	Little Egret	*Egretta garzetta*	Sch IV	LC

S. No.	Local Name	English Name	Scientific Name	Protection Status Schedule (WPA, 1972)	Conserva tion Status (IUCN)
46	Chota Basat, Tabat	Crimson breasted Barbet, Coppersmith	*Megalaima haemacephala*	-	LC
47	Chota Sutaar	Brown Crown Pigmy wood pecker	*Picoides nanus*	-	LC
48	Choti Jungli Murgi	Red Supurfowl	*Galloperdix spadice*	-	LC
49	Jardi	Yellow wattled lapwing	*Vanellus malabaricus*	-	LC
50	Jalmurgi	Indian Moorhen	*Gallinula chloropus*	-	LC
51	Jungli Kowa	Jungle Crow	*Corvus macrorhynchos*	-	LC
52	Jungli Chugad	Barred-jungle owlet	*Glaucidium radiatum*	-	LC
53	Jungli Totaa	Sirkeer Cuckoo	*Taccocua leschenaultii*	-	LC
54	Jungli Murgi	Grey Junglefowl	*Gallus sonneratii*	-	LC
55	Titiihi, Titvi	Red Wattled Lapwing	*Vanellus indicus*	Sch IV	LC
56	Tainya Tota, Tuyiia	Blossomheade d Parakeet	*Psittacula cyanocephala*	-	LC
57	Tipkedaar Munia	Spotted Munia	*Lonchura punctulata*	Sch IV	LC
58	Dho Fakhta, Gora Hola	Indian Ring Dove	*Streptopelia decaocto*	-	LC
59	Tari Ababil	Ashy Swallow Shrike	*Artamas fuscus*	-	-
60	Tota, Kir	Roseringed Parakeet	*Psittacula Krameri*	Sch IV	LC
61	Tanbula, Turra	Red Breasted Flycatcher	*Muscicapa parva*	-	LC
62	Chirchira Kalabhirbhira	Black redstart	*Phoenicurus ochruros*	-	LC
63	Dakshini Talwar Chonch Satbhai	Slatyheaded scimitar Babbler	*Pomarhinus sciticeps*	-	-
64	Darjin, Shindi	Tailore Bird	*Orthobombus sutorius*	-	-
65	Diyora	Ashycrowned	*Eremopterix*	-	LC

S. No.	Local Name	English Name	Scientific Name	Protection Status Schedule (WPA, 1972)	Conserva tion Status (IUCN)
		finch lark	*grisea*		
66	Deshi Maina	Common Myna	*Acridotheres tristis*	Sch IV	LC
67	Dhosan	White wagtail	*Motachilla alba*	Sch IV	
68	Nahar Ababil	Indian Cliff Swallow	*Hirundo fluvicola*	-	LC
69	Nikhar, Pahadi Bulalchashm	Scarlet Minivet	*Pericrocotus flammeus*	-	LC
70	Nilkanth	Indian Roller or Blue Jay	*Coracias Benghalensis*	Sch IV	-
71	Nilima	Tickell's Blus Flycatcher	*Muscicapa tickelliae*	-	LC
72	Nilmani	Black naped Blue Flycatcher	*Hypothpnis azurea*	-	LC
73	Pathhar Chitta	Crested Bunting	*Melophus lathami*	-	LC
74	Patinga, Benda radhu	Green Bee-eater	*Merops orientalis*	Sch IV	
75	Pandubbi	Little grebe or Debchick	*Podiceps ruficollis*	-	LC
76	Papiha	Common hawk cuckoo or Brain fever Bird	*Cuculus varius*	-	LC
77	Pahadi Bulbul	Redwhiskered Bulbul	*Pycnonotus Jocosus*	-	LC
78	Pahadi Bhujang	Whitebellied Drongo	*Dicrurus caerulescens*	-	LC
79	Pandu	Blueheaded Rock thrush	*Monticola cinclorhyncha*	-	LC
80	Pilak	Blackheaded oriole	*Oriolus xanthornus*	-	LC
81	pilak	Golden oriole	*Oriolus oriolus*	-	LC
82	Pilakya	Grey wagtail	*Motacilla cinerea*	-	LC
83	Pila Gaal Bagla	Yellow cheeked tit	*Parus xanthogenys*	-	LC
84	Futki	Ashy wren-warbler	*Prinia socialis*		LC
85	Bater	Grey Quail	*Coturnix coturnix*	Sch IV	
86	Baya, Sugran	Common weaver Bird	*Ploceus philippinus*	-	LC
87	Barsiri	Stone Curlew	*Burhinus*	-	LC

S. No.	Local Name	English Name	Scientific Name	Protection Status Schedule (WPA, 1972)	Conserva tion Status (IUCN)
			oedicnemus		
88	Bada Patringa	Large Green Bee-eater	*Merops superciliosus*	-	LC
89	Bada Batasi, Bada Ababbis	Alpine swift	*Apus melba*	-	LC
90	Bramhani maina	Grey headed myna	*Sturnus malabaricus*	-	LC
91	Bulbul	Redvented bulbul	*Pynonotus cafer*	Sch IV	
92	Bhujang, Kotwal	King Crow, Black drongo	*Dicrurus adsimilis*	-	LC
93	Bhimraj, Bhrig	Racquettailed Drongo	*Dicrurus panadiseus*	-	-
94	Bhori	Little Brown dove	*Streptopelia senegalensis*	Sch IV	
95	Mamula	Large pied wagtail	*Motacilla maderaspatensis*	-	LC
96	Mahalat, takkachor	Indian Tree Pie	*Dendrocitta vagabunda*	-	LC
97	Mahoka,Mokha Bhardwaj	Crow-pheasant or coucal	*Centropus sinensis*	Sch IV	
98	Mor, Mayur	Common Pea fowl	*Pavo cristatus*	-	LC
99	Rajgidhha	King Vulture	*Torgos calvus*	-	LC
100	Ramgangra	Grey tit	*Parus major*	Sch IV	
101	Raytota,Kantha, Hiraman,Tota	Large Indian Parakeet	*Psittacula eupatria*	-	NT
102	Rangin Kukal Pahadi Titar	Painted Sandgrouse	*Pterocles indicus*	-	LC
103	Rangin Titar	Painted partridge	*Francolinus pictus*	Sch IV	
104	Laiaa, Tarshepri Bhingri	Wiretailed Swallow	*Hirundo smithii*	-	LC
105	Lalmuniya	Red muniya or Avadavat	*Estrilda amandava*	-	LC
106	Lawa	Jungle Bush Quail	*Perdicula asiatica*	Sch IV	
107	Lawa, Loh	Black Breasted or Rain Quail	*Coturnix coromandelica*		LC
108	Shankar Khora	Purple Sunbird	*Nectatinia asiatica*	Sch IV	
109	Shama, Dayal	Magpie Robin	*Copsychus*	-	LC

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

FLORA & FAUNA STUDY

S. No.	Local Name	English Name	Scientific Name	Protection Status Schedule (WPA, 1972)	Conserva tion Status (IUCN)
			saularis		
110	Shahbaj, Tarewala Garur	Crested Hawk Eagle	*Spizhaetus cirrhatus*	-	LC
111	Shikra	Shikra	*Accipiter badius*	Sch IV	
112	Shubkanthi Jamin Kasturi	White throated ground Thrush	*Zoothera citrine*		-
113	Shubhrapathi Muniya	White backed munia	*Lonchuru strite*	Sch IV	-
114	Swargiya Nartak Dudhraj	Paradize fly catcher	*Terpsiphone paradise*	-	-
115	Safed Gidhh	White scavenger vulture	*Neophron percnopterus*	-	EN
116	Saatbhai	Jungle Babbler	*Turdoides striatus*	Sch IV	
117	Samanya Saatbhai	Common Babbler	*Turdoides candatus*		LC
118	Subhag	Lora	*Aegithina tiphia*	Sch IV	-
119	hariyal	Common Green Pigeon	*Treron phoenicoptera*	Sch IV	-
120	Hareba, harit, Kanchan	Gold Mantled chloropsis	*Chloropsis cochinchinensis*	-	NT
121	Hudhud, Hupu	Hoopoe	*Upupa epops*	-	LC

Source: (i) Forest Working Plan, Raigarh Division (ii) Field visit by GCPL (iii) Discussion with local people & officials

3.15.4 Mammals

Like birds, mammals are also occupying higher trophic levels in many ecosystems and respond quickly to the changes in their habitats therefore, serves as best indicators of the ecosystem health. Owing to low presence of mammalian species in the study area, it was difficult to estimate their population. More importantly, it was difficult to accommodate the sightings of nocturnal and diurnal animals in the study. Therefore, we prepared a qualitative check list of mammals based on their presences and absence using indirect evidences. The mammalian species reported form the study area is listed in **Table 3.30**. Among Schedule I species, elephant, Indian gazelle and wolf were reported from the study area.

Table 3.30: Mammals in Buffer Zone

S.	Local Name	English Name	Scientific Name	Protection Status Schedule (WPA, 1972)	Conservation Status (IUCN)
1	Udan Gilhari	Greyheaded Flying squirrel	*Petaurista elegans*	Sch II Part I	LC
2	Kala Hiran, Mrig, Harna	Black Buck, Indian antelope	*Antilpoe cervicapra*	-	-
3	Khargosh	Common Indian Hare	*Lepus ruficaudatus*	Sch IV	-
4	Gilhari	The Three striped palm squirrel	*Funambulus palmarum*	Sch IV	LC
5	Gilhari	The five striped palm squirrels	*Funambulus pennant*	Sch IV	-
6	Geedar, Siyar	Jackal	*Canis aurus*	Sch II	-
7	Gulbagh, Tendua	Panther	*Panthera pardus*	Sch I Part I	VU
8	Chamgadar	Shortnosed Fruit Bat	*Cynopterus sphinx*	IV	LC
9	Chamgadar	Bcarded Sheath tailed Bat	*Taphozous melanopogon*	-	LC
10	Chinkara	Indian Gazelle	*Gazella gazella*	Sch I	-
11	Chital	Spotted Deer	*Axis axis*	Sch III	-
12	Chuha	Field Rat	*Bandicota bengalensis*	IV	LC
13	Chuha	Indian Bash Rat	*Golunnda ellioti*	-	-
14	Chuhar, Moos	Indian Field Mouse	*Mus booduga*	IV	LC
15	Chuhar, Moosa	Spiny Field Mouse	*Mus platythrix*	IV	LC
16	Chuha	Common House Rat	*Rattus rattus*	IV	LC
17	Sausinga	Fourhorned Antelope	*Tectraceros quadricornis*	-	-
18	Chhachhundar	Grey Musk Shrew	*Suncus murinus*	-	LC
19	Junglee Kutta, Son Kutta	Indian Wild Dog	*Cuon alpinus*	Sch II Part I	-

S.	Local Name	English Name	Scientific Name	Protection Status Schedule (WPA, 1972)	Conservation Status (IUCN)
20	Junglee Billi	Jungle Cat	*Felis Chaus*	Sch II	-
21	Junglee Suwar, Warah	Indian Wildboar	*Sus scrofa*	Sch III	-
22	Nil, Nilgai	Blue Bull	*Boselaphus tragocamelus*	Sch III	-
23	Newla	Common Mangoose	*Herpestes edwardi*	Sch II	-
24	Bagar Billa	Hedgehog	*Paraechinus*	-	LC
25	Bagh, Sher	Tiger	*Panthera tigris*	I part I	EN
26	Bijju	Indian ratel, Honey Badger	*Mellivora capensis*	I part I	LC
27	Bandar	Rhesus Macaque	*Macaca mulata*	Sch II	-
28	Bhedki, Kakad, Kotri	Barking deer	*Muntiacus muntjak*	III	LC
29	Bhediya	Wolf	*Canis lupus*	Sch I	-
30	Richh, Bhalu	Sloth beer	*Melursus ursinus*	I part I	VU
31	Lakarbaghha, Jarakh	Striped hyaena	*Hyaena hyaena*	III	NT
32	Lomri	Indian Fox	*Vulpes bengalensis*	Sch II	-
33	Langoor	Common Langur	*Prebytis antellus*	Sch II	-
34	Shahi	Indian Porcupine	*Hystrix indica*	Sch II	-
35	Silu, Baj Kit	Indian Pangolin Scaly ant eater	*Manis crassicaudata*	Sch I (Part I)	EN
36	Saambhar	The Sambher	*Cervus unicolor*	III	-

Source: (i) Forest Working Plan, Raigarh Division (ii) Field visit by GCPL (iii) Discussion with local people & officials

3.16 ECOLOGICAL SENSITIVE ZONES

No National Parks, Wildlife sanctuaries, Wildlife corridors, Tiger reserves, Elephant reserves and Biosphere Reserves exist within 10-km radius from the ML boundary

3.17 ENDANGERED PLANTS

There is no presence of any threatened species in the study area.

Land use & Land cover Study

4. LANDUSE/LANDCOVER STUDY

4.1 INTRODUCTION

Land is the most important natural resource which embodies soil, water and associated flora and fauna involving total ecosystem. The knowledge of land use and land cover is important for many planning and management activities as it is considered as an essential element for modelling and understanding the earth feature system. The term land use relates to the human activity or economic function associated with a specific piece of land, while the term land cover relates to the type of feature present on the surface of the earth (Lillesand and Kiefer, 2000). Land use or land cover inventories are assessed in increasing importance in various sectors like agricultural planning, settlement and cadastral surveys, environmental studies and operational planning based on agro-climatic zones. Information on land use or land cover allows a better understanding of the land utilization aspects like cropping patterns, fallow lands, forests, will betelands and surface water-bodies which are vital for development planning. Land cover maps are presently being developed from local to national to global scales.

The importance of Land use and Land cover (LULC) dynamics in general and forest cover dynamics in particular is duly recognized by the International Geosphere Biosphere Programme (IGBP), the International Human Dimension Programme (IHDP) on Global Environmental Change (GEC), the United Nations Framework Convention on Climate Change (UNFCC) and many other.

Satellite remote sensing technology has found its acceptance worldwide for rapid resource assessment and monitoring, particularly in the developing world. Satellite images have been utilized for land use and land cover mapping. National Aeronautical and Space Administration (NASA) of USA has made most significant contributions with satellite based remote sensing techniques. Since 1972, after the Landsat-1 was launched, remote sensing technology and its application has undergone a tremendous change in terms of sensing development, aerial flights with improved sensors, satellite design development and operations including data reception, processing, interpretation, and utilization of satellite images. All these advancements have widened the applicability of remotely sensed data in various areas like forest cover, vegetation type mapping, and their changes on a regional scale. If satellite data is judiciously used along with the sufficient ground data, it is possible to carry out detailed forest inventories, monitoring of land use, and vegetation cover at various scales. To date, the most successful attempt in developing a general purpose classification scheme compatible with remote sensing data has been by Anderson et al. 1976, which is also

referred to as USGS classification scheme. Other classification schemes available for use with remotely sensed data are basically modification of the above classification scheme

4.2   SCOPE & OBJECTIVE

4.2.1 Scope of Study

The scope of Land Use and Satellite Mapping Study includes analysis of input spatial & non spatial data, digital image processing, image enhancement and image processing. The study will emphasize on the following broad aspects:

- **Spatial Data Sourcing**: To study the land use pattern of the area using LISS IV multi-spectral imagery will be used as input data. The spatial resolution of data will be 5.8m spread in various bands.

- **Image Rectification:** Image rectification procedures are often termed 'pre-processing' operations because they normally precede further manipulation and analysis of the image data to extract specific information;

- **Image Enhancement:** High pass filter used to visualize more correctly the linear features such as roads, rail, canal, river etc. Histogram Equalization is used to distinguish area of the same tone;

- **Image Interpretation, Mapping & Report Preparation:** Several parameters like terrain and various land use categories which are established on the map through mapping procedures. And produce Land-use/ Land cover report based on satellite image interpretation.

4.2.2. Objective of Study

A detailed land use mapping has been undertaken using satellite imagery to study the land use pattern of the area, so that assessment of the predominant land use and change in its pattern over a period of time can be assessed. This will help project implementing agency to make decision on manmade activities experienced by them.

This will also help in determining the suitability of land for different uses, planning future land uses for different objectives, analyzing land and land cover properties for both resource inventories and scientific studies and siting of uses.

4.3   STUDY METHODOLOGY

The sensitivity of the receiving environment i.e. existing land use is studied through Geographical Information System (GIS) techniques. Geographic Information Systems (GIS) is a scientific technique, which has revolutionized the way that land is inventoried, managed, planned, and studied. GIS provides the theories and methods for organization and analysis of original measurements of location and secondary spatial data, as well as topography. As an information system GIS provides for the organization, storage, analysis, modeling, mapping, and display of physical and biological data, as well as the

distribution of cultural or socio-economic data. GIS applications are diverse. They include determining the suitability of land for different uses, planning future land uses for different objectives, analyzing land and land cover properties for both resource inventories and scientific studies, and sitting of developmental activities.

4.4   DATABASE USED IN THE STUDY

To study and map the land use pattern of the area, IRS-P6 LISS IV MX Multispectral imagery (Resourcesat-1) with extension from 83°21'4.749" to 83°38'39.424" East and 22°17'32.998" to 22°3'51.923" North and from has been used as input data of 22nd January, 2019. The spatial Resolution of the satellite data is 5.8 m. FCC Imagery of study area shown in **Figure 4.1.** The bands used as input data for the current study have these following features:

- **Band 2: 0.52 - 0.59 μm (green):** This band corresponds to the green reflectance of healthy vegetation and is spanning the region between the blue and red chlorophyll absorption bands.

- **Band 3: 0.62 - 0.68 μm (red):** This red chlorophyll absorption band of healthy green vegetation is one of the most important bands for vegetation discrimination. In addition, it is useful for soil boundary and geological boundary mapping. Band 3 may exhibit more contrast than bands 1 and 2 because the effect of the atmosphere is reduced. The 0.69 m cut-off represents the beginning of a spectral region from 0.68 to 0.75 m where vegetation reflectance crossovers occur that can reduce the accuracy of vegetation studies.

- **Band 4: 0.77 - 0.86 μm (near infrared):** For reasons discussed above, the lower cut-off for this band was placed above 0.75 m. This band is especially responsive to the amount of vegetation biomass present in a scene. It is useful for identification of vegetation types, and emphasizes soil-crop and land-water contrasts
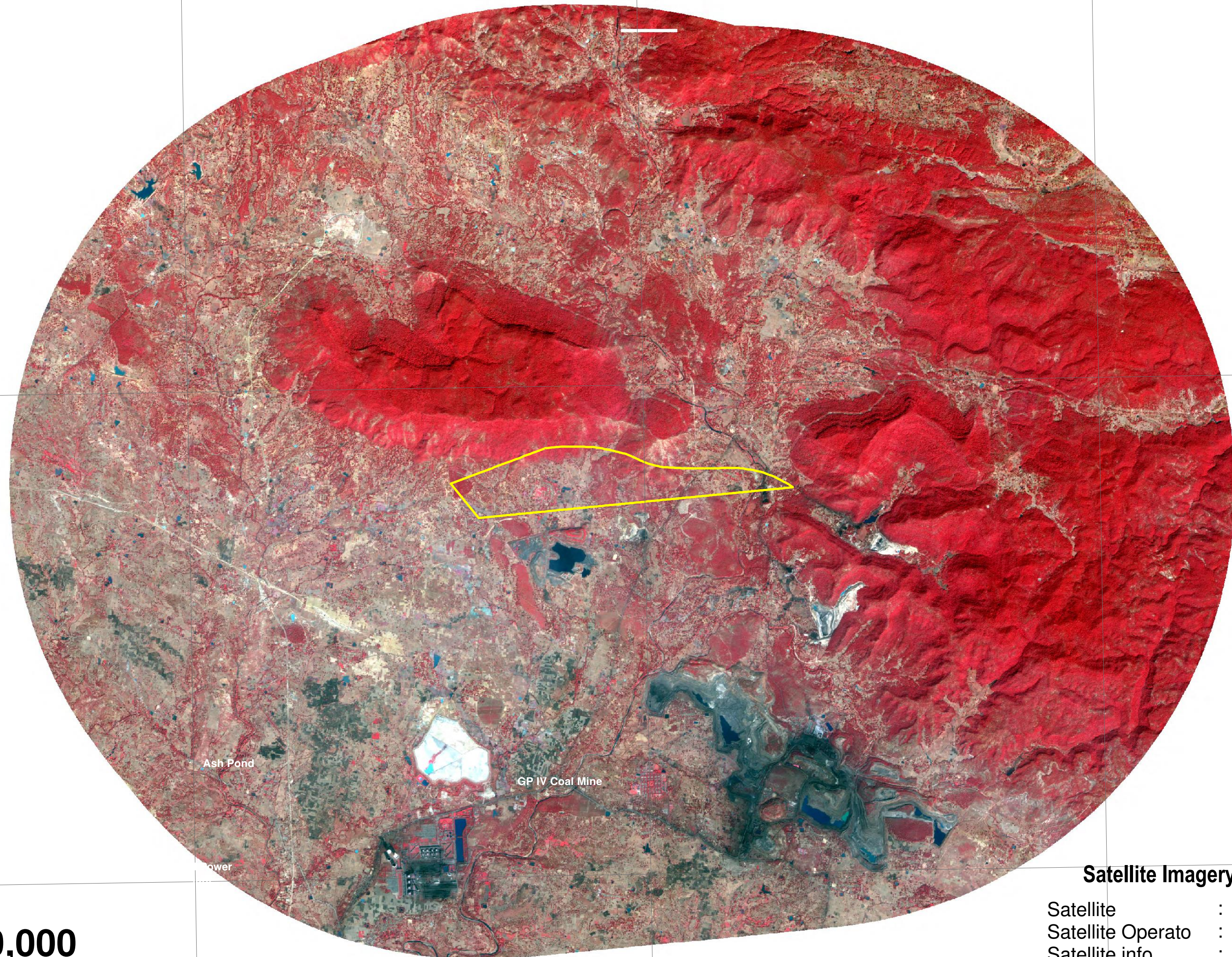
Table 4.1: Details of Sensor Specifications

SPECIFICATIONS	LISS-IV
No. of Bands	3 (MX)
Spectral Bands (μ)	B2 0.52 – 0.59, B3 0.62 – 0.68 & B4 0.77 – 0.86
Resolution (m)	5.8m
Swath (Km)	70/23
Revisit (days)	5
Data Rate (Mbs per stream)	105

Source: National Remote Sensing Centre (NRSC), Govt. of India

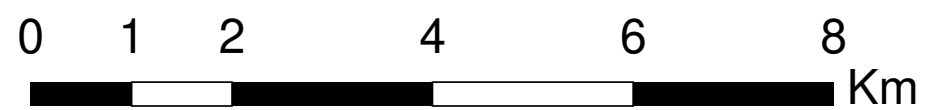# FCC Imagery of Study Area (GPIII- STUDY AREA)

83°24'0"E 83°30'0"E 83°36'0"E

22°12'0"N

22°6'0"N

Ash Pond

GP IV Coal Mine

Scale: 1:50,000

0 1 2 4 6 8
Km

Satellite Imagery Information

Satellite	:	Resourcesat 2
Satellite Operato	:	ISRO
Satellite info	:	IRS-P6 (RESOURCESAT 1)
Sensor	:	LISS-IV
Spatial Resolution	:	5.8m
Date of Capture	:	22/01/2019

4.5   SECONDARY DATA

The secondary database considered for validation and geo-referencing of the image is a follow:

- Topographical map in 1:50,000 scale of Survey of India: 64N/7, 64N/8, 64N/11 & 64N/12
- Village Level Maps and Cartographic Atlas on Regional Resource Mapping, 2011, Census of India
- District Planning Series Map, NATMO, 1998;

4.6   DIGITAL IMAGE PROCESSING

The digital image processing includes image rectification; image enhancement; visual interpretation and land use mapping. The processes are explained below.

4.6.1   Image Rectification

The satellite images are given in BSQ (Band Sequential) format. These are imported to ERDAS environment. Then geometric correction applied to the images to correct the distorted image data to create a more faithful representation of original scene. Image rectification procedures are often termed 'pre-processing' operations because they normally precede further manipulation and analysis of the image data to extract specific information.

4.6.2   Image Enhancement

This procedure is applied to the images in order to more effectively display or record the data for subsequent visual interpretation. High pass filter used to visualize more correctly the linear features such as, roads, rail, canal, river etc. Histogram Equalization was used to distinguished area of the same tone.

4.6.3   Training & Signature Generation & Classification

In order to add training samples, click the draw polygon icon. Now, we have to draw polygons where you know the land cover class.

For example, draw a polygon for an urban area and continue drawing urban areas representative of the entire image, not just a single area. After you have done a few, select all of your urban polygons and merge them into a single class. After this we can rename this training set as "urban". Once finished, begin creating training sets for your other classes.

At Generate signature file, by collecting training samples for each class. In addition, we have merged each class and renamed them accordingly.

It's time to create a signature file by clicking the "create a signature file" icon. We can revise or add additional samples, you can open it again at a later time.

Image classification toolbar gives several options for classification including: maximum likelihood, ISO cluster, class probability and principal components.

Each option has its own advantages but it's best to test each one for requirement. As input, will need your signature file which has the training samples. In other words, this generates a classified image with the classes we developed in our training set.

It may need a bit of trial and error with the signature files. Again, you can edit your signature file and rerun the classification until you are happy with the results.

4.6.4   Visual Interpretation and Land Use mapping

Satellite imagery contains detail records of features on the ground at the time of satellite overpass. An image interpreter systematically examines the images for generating the information required by him. Other supporting materials such as published maps and reports from various sources will increase the accuracy of the interpretation. The chain of process in visual interpretation of the shape and pattern in an image begins with detection. There are certain fundamental characteristics seen on images which aid in the visual interpretation of satellite imagery. These are tone/color, size, shape, texture, pattern, location, association, resolution and season. Visual interpretation is subjective and differs from person to person and also upon the season, scale, spectral bands, spatial resolution, overall image contrast &quality of the data.

The procedure for mapping for land use from satellite imagery of different season & on different scale is well established. Several parameters like terrain, climatic conditions, socio-economic trends, and environmental influences etc. play a vital role in the existence of various land use categories.

4.7   GENERATION OF LAND USE/LAND COVER MAP

- Step-I Layer stacking of three distinct file into a single file and create FCC
- Step-II Select an appropriate band used throughout the analysis. An examination of the three bands shows that the one visible band (2) provides less evidence of the various water surfaces across the image. Band 4, the near infrared band, clearly separates water bodies from other surfaces. Band 3 help to distinguish vegetation cover.

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

LAND USE / LAND COVER STUDY

- Step-III Digital classification: Un-supervised ISO data classification carried out considering green, red, NIR bands with 15 iterations and expected number of classes 31.
- Step-IV Aggregation of classes obtain through this classification session into classes having significance on the physical world was then carried out based on DN value.
- Step-V Visual interpretation is also done since digital classification only consider pixel values not the geographic location, association, shape, etc.
- Step-VI Comparison with some reference data and sample ground validation
- Step-VII Area Calculation of each Land Use/Land Cover Classes
- Line features layers overlay.
- Step-VIII Final Map and Report
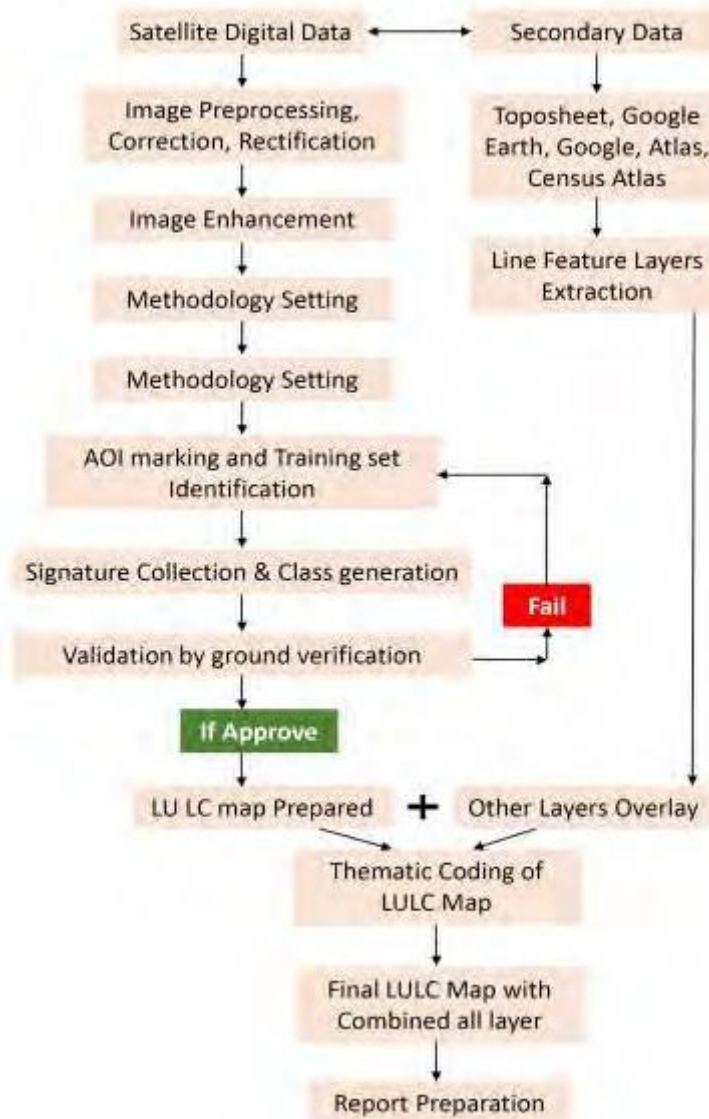
Figure 4.2: Flowchart of LU/LC Preparation Process in the Study

4.8   STUDY LIMITATION

There are some limitations for the interpretation of the satellite data. These are mentioned below:

- One-time data sometimes give same spectral response of different objects creates confusion in image analysis and sub classification
- One-time data is unable to show sub-classification in the study area
- Area of the line features like road, rail etc. is not been included since GIS does not give any calculation.

4.9   LAND-USE & LAND COVER IN STUDY AREA

4.9.1   Study Area Description

The study area is the land area within 10km radius taken from the outer periphery of the project site. The pattern of land use and land cover in the study area i.e. within 10 km radius is variable as the land is mainly Agricultural/ Crop Land and Forest Area. The study area on Google Image is shown in **Figure 4.3.**

4.9.2   Land Use/Land Cover Pattern

The land use/land cover pattern of the Study Area have been framed from the Satellite Imagery and Topo-sheet and authenticated by field visit. The land use/land cover pattern can be divided into following 9 categories:

(i)   Built-up

(ii)   Crop Land

(iii)   Fallow Land

(iv)   Forest/ Natural Vegetation Cover

(v)   Industrial Area

(vi)   Mining Area

(vii)   Scrub Land

(viii) Waste Land

(ix)   Waterbodies

The Built-up, Crop Land, Fallow Land, Forest/ Natural Vegetation Cover, Industrial Area, Mining Area, Scrub Land, Waste Land and Waterbodies are the lands cover in the study area whereas the agricultural land, Industries, plantation, mining and built-up are the land use in the study area. The given categories of land use and land cover pattern covers an area of about **48,276.28 Ha**. The percentage of land area covered in figures is mentioned in the **Table 4.2** and has been illustrated in the pie diagram in **Figure 4.4** and Land use/ land cover map of study area shown in **Figure 4.5**.

Google Imagery of Study Area (GPIII- STUDY AREA)

Scale: 1:50,000

0 1 2 4 6 8 Km

Ash Pond

GP IV Coal Mine

Jindal Power Plant

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE **P**ELMA **S**ECTOR **III** **C**OAL **B**LOCK ,**T**AMNAR **T**EHSIL, **R**AIGARH **D**ISTRICT, **C**HHATTISGARH

LAND USE / LAND COVER STUDY
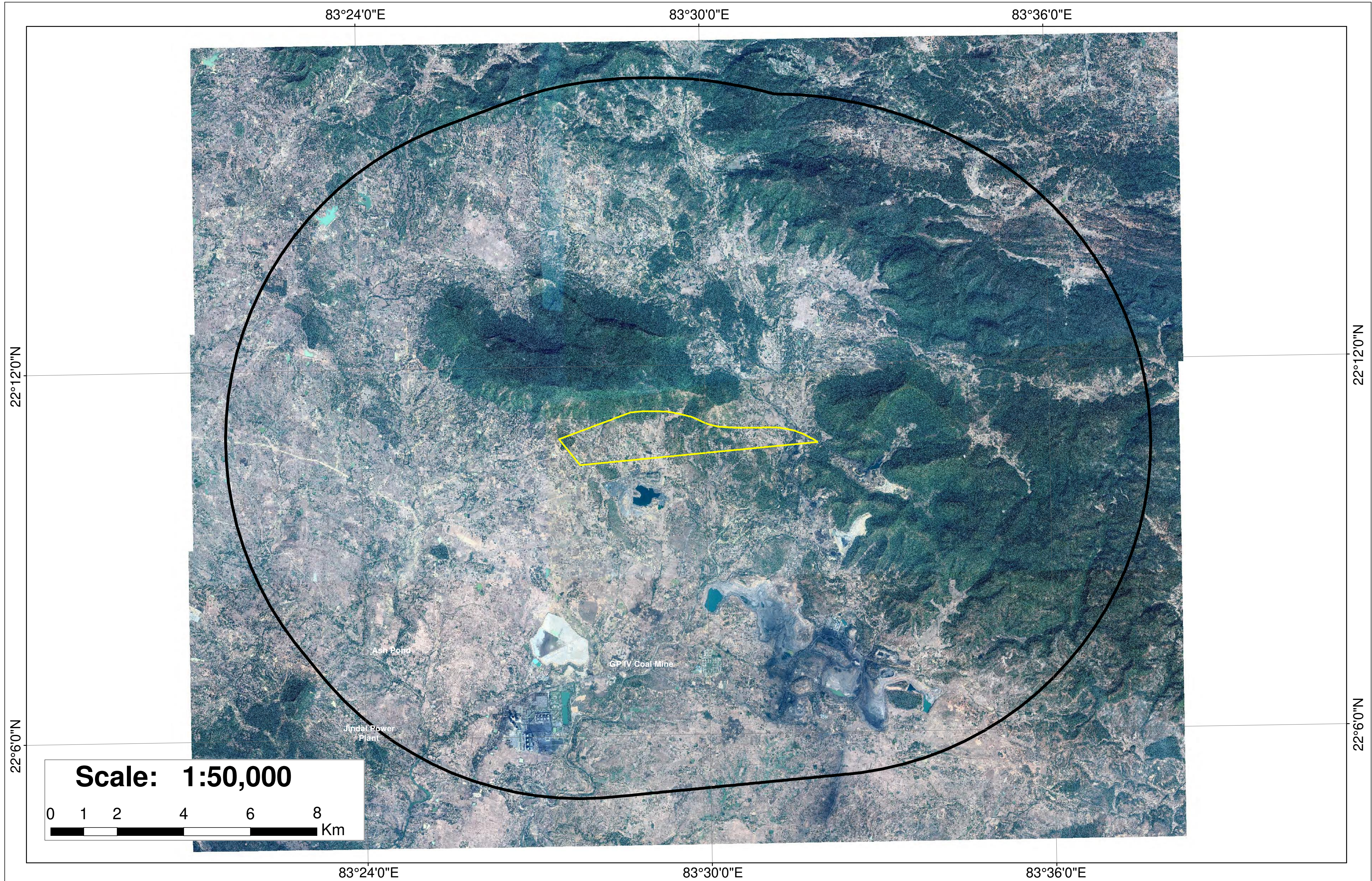
Table 4.2: Area of Land-use/ Land Cover of Study Area

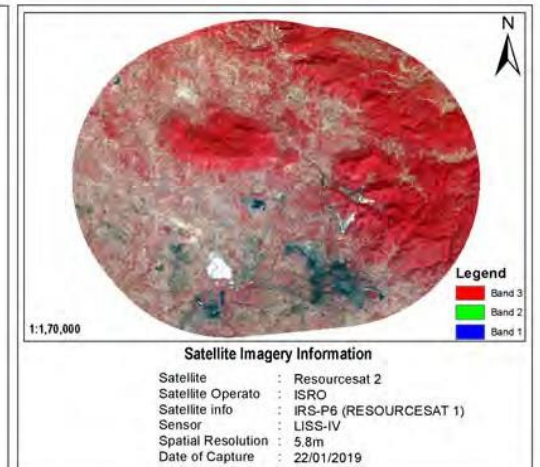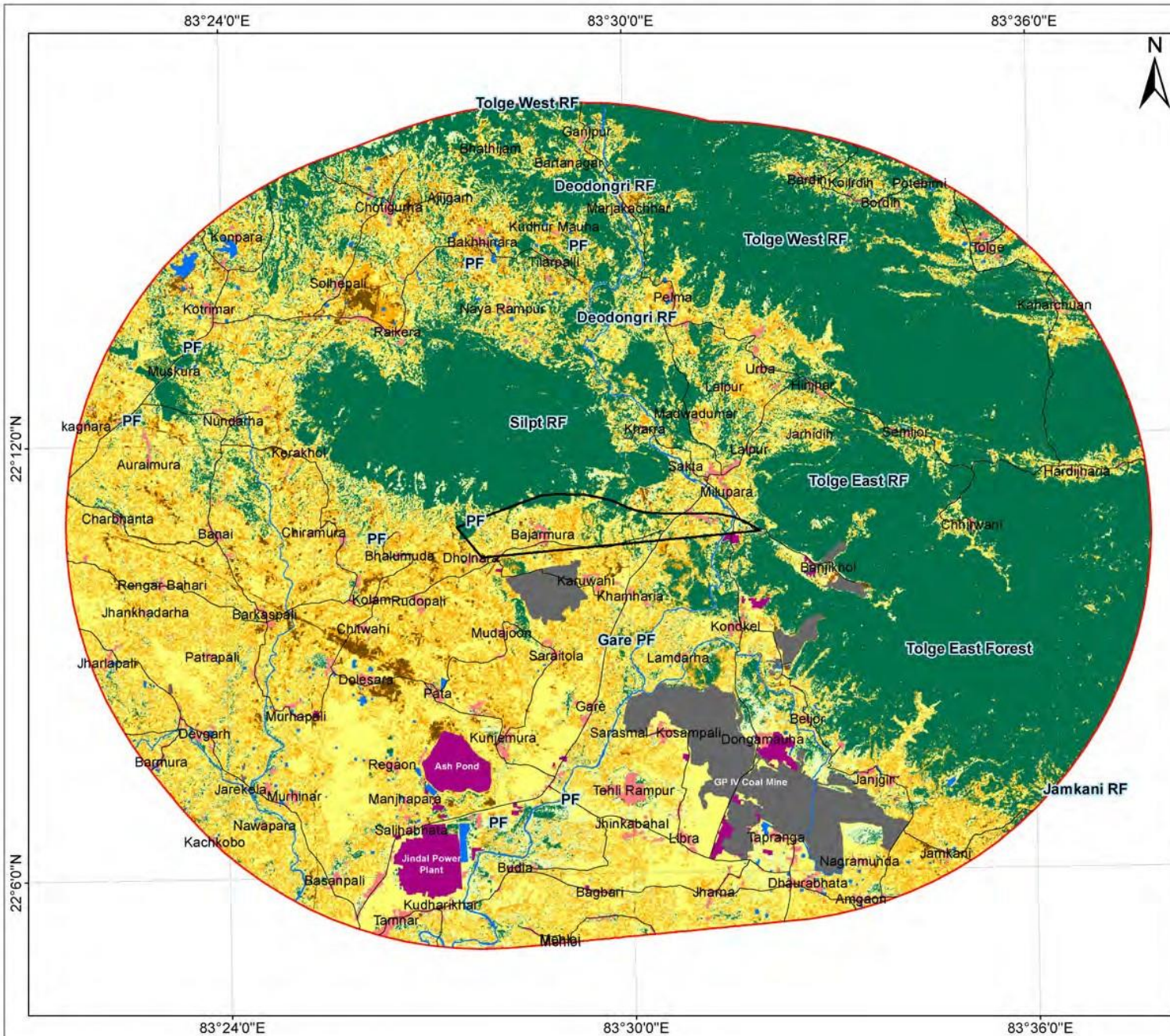| Land Type	Area (in Ha)	Area (in %)
Built-up	778.79	1.61
Crop Land	12,369.39	25.62
Fallow Land	8,053.51	16.68
Forest/ Natural Vegetation Cover	20,213.09	41.87
Industrial Area	566.18	1.17
Mining Area	1,468.80	3.04
Scrub Land	4,148.93	8.59
Waste Land	458.86	0.95
Waterbodies	218.73	0.45
Total	**48,276.28**	**100.00**

Source: i) LISS IV Satellite Imagery of Study Area, 2019; (ii) SOI Toposheet Map Sheet No. 64N/7, 64N/8, 64N/11 & 64N/12, First Edition, 1975, Published under direction of Surveyor General of India, printed on 1975; (iii) Site Visit Conducted by GreencIndia Consulting Private Limited, 2019.
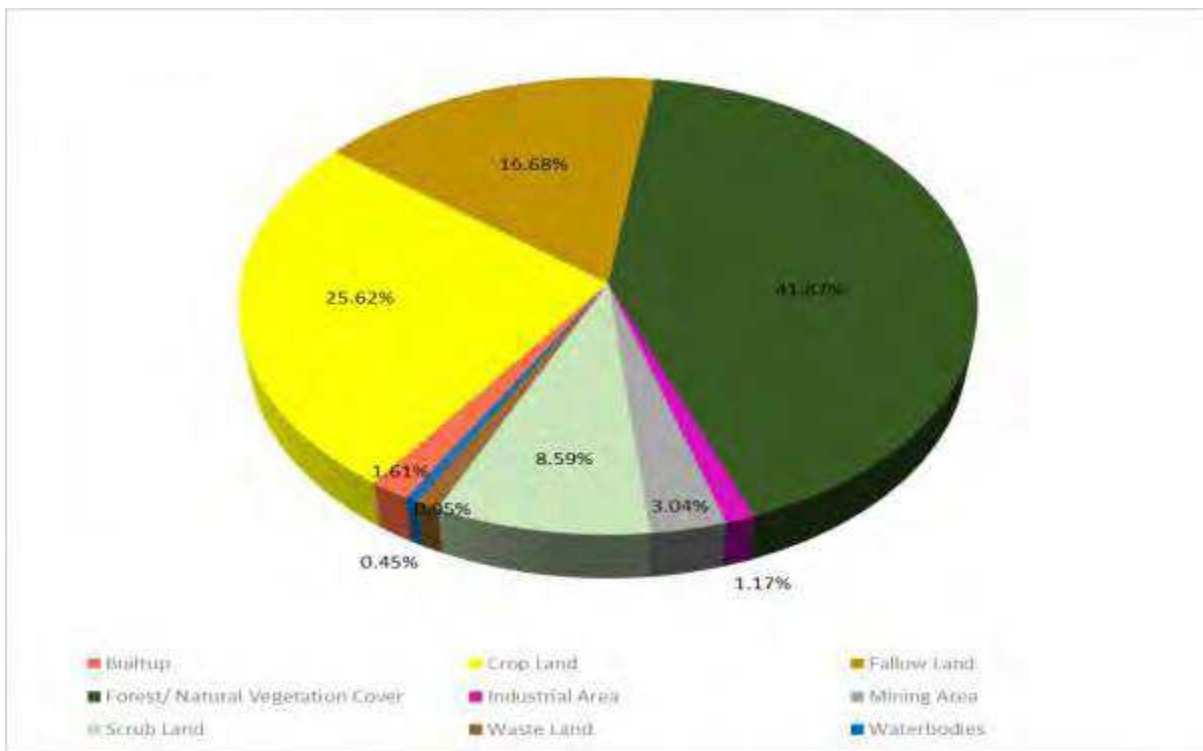
Figure 4.4: Pie Diagram of Land-use/ Land Cover of Study Area

The Built-up, Crop Land, Fallow Land, Forest/ Natural Vegetation Cover, Industrial Area, Industrial Area, Scrub Land, Waste Land and Waterbodies are the lands cover inside the project site boundary whereas the agricultural land, Industries, plantation and built-up are the land use inside the project site boundary. The given categories of land use and land cover pattern covers an area of about **631.22 Ha**. The percentage of land area

LAND USE/ LAND COVER CLASSIFICATION (GPIII- STUDY AREA)
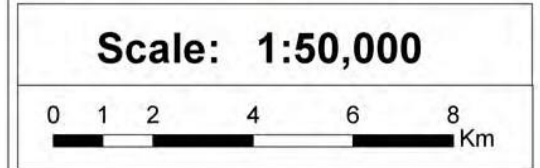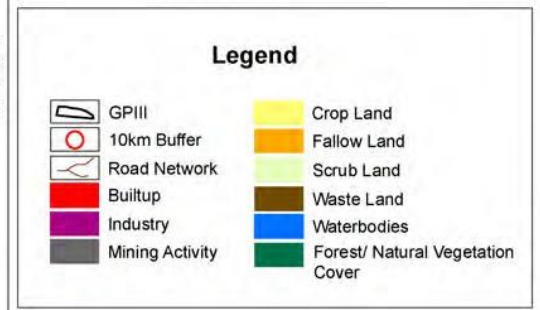
Satellite Imagery Information

Satellite	:	Resourcesat 2
Satellite Operato	:	ISRO
Satellite info	:	IRS-P6 (RESOURCESAT 1)
Sensor	:	LISS-IV
Spatial Resolution	:	5.8m
Date of Capture	:	22/01/2019

Legend

- GPIII
- 10km Buffer
- Road Network
- Builtup
- Industry
- Mining Activity
- Crop Land
- Fallow Land
- Scrub Land
- Waste Land
- Waterbodies
- Forest/ Natural Vegetation Cover

Scale: 1:50,000

0 1 2 4 6 8 Km

PREPARED BY

GREENCINDIA CONSULTING PVT. LTD.
Ghaziabad, Uttar Pradesh

(An ISO:9001 QMS, ISO: 14001 EMS & OHSAS: 18001 H&S MS Certified by BSI)
QCI-NABET Accrediate Environment Consultant
Certificate No.

NABET/EIA/1619/RA0058

covered in figures is mentioned in the **Table 4.3** and has been illustrated in the pie diagram in **Figure 4.6** and Land use/ land cover map of project site shown in **Figure 4.7**.

Table 4.3: Land-use/ Land Cover of inside the Project Site Boundary

Land Type	Area (in Ha)	Area (in %)
Built-up	16.25	2.57
Crop Land	219.59	34.79
Fallow Land	161.84	25.64
Forest/ Natural Vegetation Cover	156.57	24.80
Industrial Area	0.36	0.06
Scrub Land	73.53	11.65
Waste Land	2.37	0.38
Waterbodies	0.71	0.11
Total Area	**631.22**	**100.00**

Source: i) LISS IV Satellite Imagery of Study Area, 2019; (ii) SOI Toposheet Map Sheet No. 64N/7, 64N/8, 64N/11 & 64N/12, First Edition, 1975, Published under direction of Surveyor General of India, printed on 1975; (iii) Site Visit Conducted by GreencIndia Consulting Private Limited, 2019.
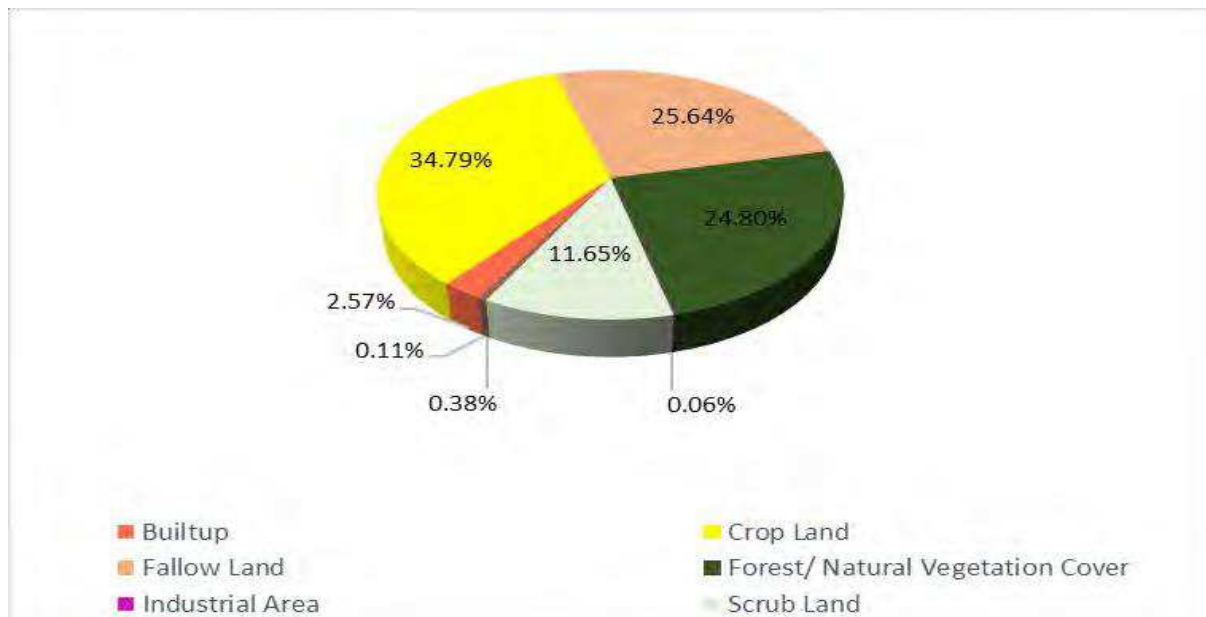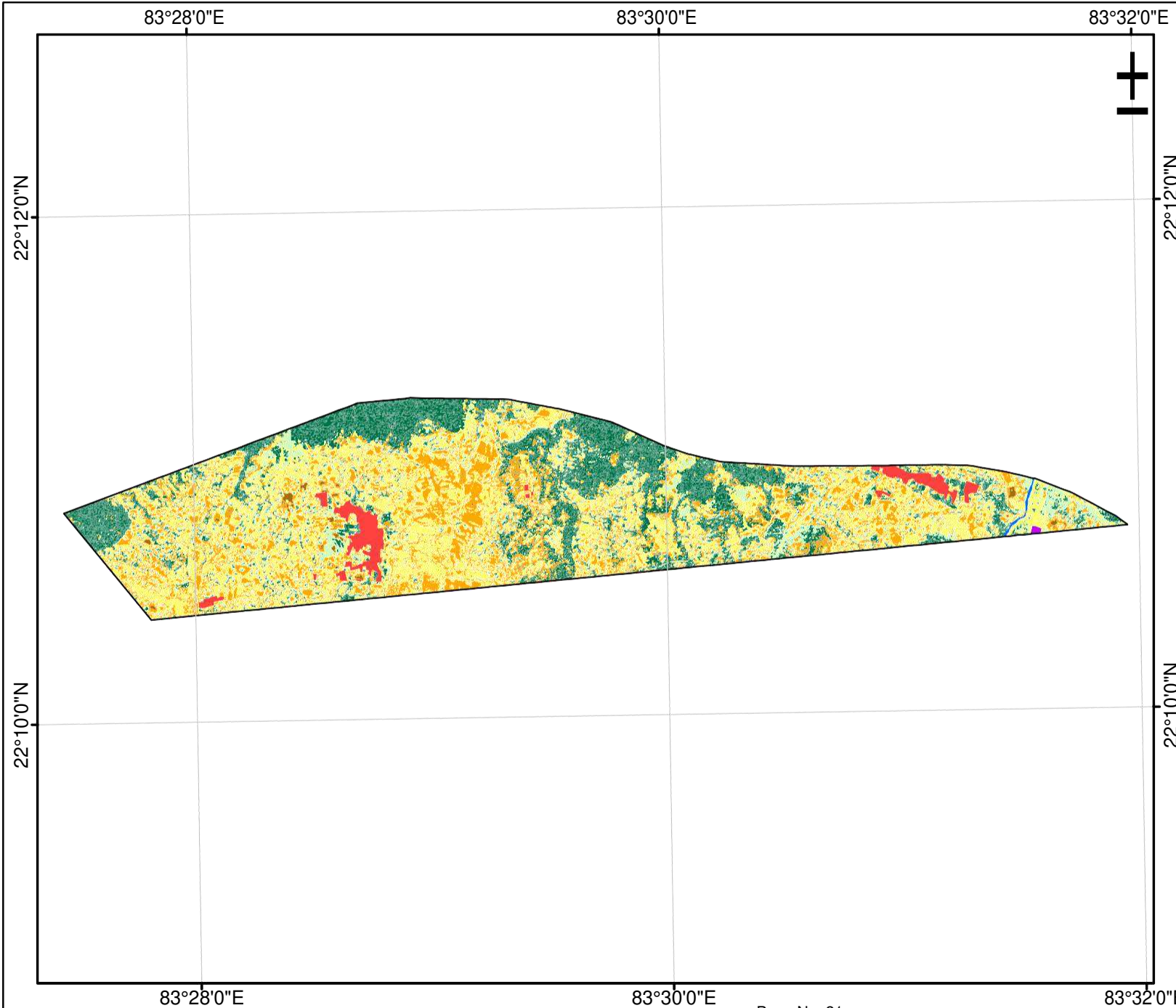

Figure 4.6: Pie Diagram of Land-use/ Land Cover of Project Site

The Study area under different land-use/land cover is presented in the following points.

4.9.2.1 Forest Area

Forest covers a major portion of the study area. The forest land in the study area consists mostly of Reserved Forest and Protected Forest. Some open jungle and dense mixed and unnamed PF are situated in the in-study area. There are total 5 Reserved

LAND USE/ LAND COVER CLASSIFICATION (GPIII- CORE AREA)

83°28'0"E   83°30'0"E   83°32'0"E

22°12'0"N

22°10'0"N

Satellite Imagery Information

Satellite	:	Resourcesat 2
Satellite Operato	:	ISRO
Satellite info	:	IRS-P6 (RESOURCESAT 1)
Sensor	:	LISS-IV
Spatial Resolution	:	5.8m
Date of Capture	:	22/01/2019

Legend

Band 3
Band 2
Band 1

1:5,50,000

Legend

- GPIII
- Builtup
- Industry
- Crop Land
- Forest/ Natural Vegetation Cover
- Fallow Land
- Scrub Land
- Waste Land
- Waterbodies

Scale: 1:40,000

0   410   820   1,640   2,460
m

Forests are present within the study area- Silot RF, Tolge West RF, Tolge East RF, Deodongar RF and Jamkhani RF. There are total 15 Protected Forests are present within the study area- Gare PF, Rampur PF and unnamed 13 PFs. Distance and direction of Reserved Forest from the Project boundary are shown in **Table 4.4**. In the study area total **20,213.09 Ha** area covers by forest land which is **41.87 %** of the total land area and about **156.57 Ha** of forest land which is **24.8%** inside the project site boundary.

Forests in the Study Area

Environment Baseline Study, Flora & Fauna Study & Land Use/ Land Cover Report
GARE PELMA SECTOR III COAL BLOCK ,TAMNAR TEHSIL, RAIGARH DISTRICT, CHHATTISGARH

LAND USE / LAND COVER STUDY

Table 4.4: Distance and Direction of Forests from Project Site

Sl. No.	Name of Forest	Type of Forest	Distance (in km)	Direction
1	Silot RF	Reserved Forest (Dense Mixed Jungle)	Inside Project Site Boundary	N
2	Tolge West RF	Reserved Forest (Dense Mixed Jungle)	4.5	NE
3	Tolge East RF	Reserved Forest (Dense Mixed Jungle)	0.2	E
4	Rampur PF	Protected Forest (Open Mixed Jungle)	3.4	N
5	Deodongar RF	Reserved Forest (Open Mixed Jungle)	3.7	N
6	Jamkhani RF	Reserved Forest (Dense Mixed Jungle)	9.9	SE
7	Gare PF	Dense Mixed Jungle	2.2	S
8	PF	Open Mixed Jungle	Inside Project Site Boundary	SW
9	PF	Open Mixed Jungle	0.6	SW

Source: i) LISS IV Satellite Imagery of Study Area, 2019; (ii) SOI Toposheet Map Sheet No. 64N/7, 64N/8, 64N/11 & 64N/12, First Edition, 1975, Published under direction of Surveyor General of India, printed on 1975; (iii) Site Visit Conducted by GreencIndia Consulting Private Limited, 2019.

4.9.2.2   Built-up

Settlements in the study area refers to the village as well as small settlements with all infrastructural facilities like roads, railways, markets and various other facilities. In the study area the settlements are mostly rural settlements scattered throughout the study area in patches. Total area comes under built-up is **778.79 Ha** of total study area, which is **1.61%** of the total land area. We can see some prominent settlements areas in the study area like Tehli Rampur, Libra, Tamnar, Pata, Banai, Kunjemura, Tolge, Pelma, Chotigurha, Budia, Kotrimar, Jharna, Bajarmura, Dolesara, Kondkel, Tapranga, Dongamauha, Regaon, Amgaon, Jhinkabahal, Hinjhar, Rudopali, Dholnara, Basanpali, Sarasmal Kosampali, Dhaurabhata, Murhinar, Beijor, Bagbari, Jamkani, Saraitola, Urba, Barkaspali, Gare, Tilarpalli, Jarekela, Solhepali, Karuwahi, Bakhhinara, Chitwahi, Raikera, kagnara, Bardih, Milupara, Devgarh, Nundarha, Charbhanta, Mudajoon, Barmura, Kharra, Kaharchuan, Kolam, Rengar Bahari, Janjgir, Konpara, Lalpur, Salihabhata, Kachkobo, Nagramunda, Bhalumuda, Chiramura, Kerakhol, Chhirwani, Hardijharia, Lalpur, Potebirni, Nawapara, Sakta, Auraimura, Jharlapali, Manjhapara, Khamharia, Marjakachhar, Lamdarha, Patrapali, Murhapali, Ajijgarh, Semijor, Kudharikhar, Bordih, Mehloi, Jhankhadarha, Naya Rampur, Koilrdih, Kudhur Mauha, Bhathijam, Jarhidih, Madwadumar, Banjikhol, Bartanagar, Muskura, Ganjpur, Mehloiand etc.

In the project site boundary 5 villages are fall namely Dholnara, Bajarmuda, Karwahi, Khamariya & Milupara. Total **16.25 Ha** area comes under built-up of total project site boundary area, which is **2.57 %** of the total project site boundary.

A View of Village Settlement

4.9.2.3   Industrial Area

The Industrial land covers an area of about **566.18 Ha.** That is **1.17%** of the total land area. Main industries in the study area are Jindal Thermal Power Plant and their Ash pond & some Coal washery plants found in study area. Total **0.36 Ha** area comes under

built-up of total project site boundary area, which is **0.06 %** of the total project site boundary.

A View of Industrial Area in Study Area

4.9.2.4   Mining Area

Mining is the extraction of valuable minerals or other geological materials from the Earth, usually from an ore body, lode, vein, seam, reef or placer deposit. These deposits

form a mineralized package that is of economic interest to the miner. Chhattisgarh is very reach state when it's about mining minerals. And Tamnar region is mainly known for coal mining area. The area of mining activities is about 1,**468.8 Ha.** That is **3.04%** of the total land area which mostly found in southern part of the project site. There is no mining activity found inside the project site boundary.

Mining Area Near the Project Area in Study Area

4.9.2.5   Crop Land/ Agriculture Land

The Agricultural land covers the major portion of the land area of about **12,369.39 Ha.** That is about **25.62%** of the total area. The land has single and double cropped agricultural practice. Some part of the land has been kept as current fallow where

grasses are grown. This may be attributed to rain fed agricultural practice. These agricultural lands are used for seasonal agricultural purposes. Most of the land is cultivated. Plantation agriculture also found in various places in study area. Total **219.59 Ha** area comes under Cropping land of total project site boundary area, which is **34.79 %** of the total project site boundary.

Agriculture Land and Plantation within Study Area

4.9.2.6   Fallow Land

Fallow Land is farmland that has no crops on it, usually for a year, to recover its fertility to grow crops. This type of land-use and land cover pattern covers about **8,053.51 Ha** of land which is **16.68%** of the total study area. Total **161.84 Ha** area comes under fallow land of total project site boundary area, which is **25.64 %** of the total project site boundary.

4.9.2.7   Open Scrub

Land area with the scrubs covers about **4,148.93 Ha** that is about **8.59%** of total study area. This kind of land cover refers to the land area where the natural vegetation consists of bushes and scrubs/shrubs and scanty growth of grasses. The soil of this type of land area with very little vegetation is unsuitable for agricultural purposes and is classified in the wasteland category. Only small bushes and grasses are sustained in the soil. Generally this type of land cover may be observed to be spread within the agricultural land areas. In the proposed study area also, this category of land cover is spread in patches in the covering most of the land area.

Total **73.53 Ha** area comes under scrub land of total project site boundary area, which is **11.65 %** of the total project site boundary.

Open Scrub Area

4.9.2.8   Waste Land

Wastelands are lands which are unproductive, unfit for cultivation, grazing and other economic uses due to rough terrain and eroded soils. The soil of this type of land area with very little vegetation is unsuitable for agricultural purposes. This type of land-use and land cover pattern covers about **458.86 Ha** of land which is **0.95%** of the total study area.

Total **2.37 Ha** area comes under waste land of total project site boundary area, which is **0.38 %** of the total project site boundary.

4.9.2.9   Water Bodies

Water bodies refer to the collection of water in any ditches or manmade storages like ponds, lakes, tanks, reservoirs etc. In the study areas these water bodies are present in very small patches near some settlements in the whole study area except Northern part. Major River Kelo passed towards East from the project site boundary and NE to SSE of the study area. Such types of water bodies are very few covering only **218.73 Ha** of land area which is **0.45%** of total study area.

Total **0.71 Ha** area comes under water bodies of total project site boundary area, which is **0.11 %** of the total project site boundary.

Rivers in the Study Area

4.10 DRAINAGE PATTERN

The area is drained by 2 major river/ nadi named Kelo Nadi and Pajhar Nadi. Kelo River flows on the eastern part of the block in NE to SSE direction, Pajhar Nadi matched with Kelo near Kasdol village. Several small streams all flowing from North and North-East to South direction. Major Nadi Kelo flowing in the area and it found up to 4th order of streams of this river in this study area. Some nalas and tributary found in study area nemed Bendra Nala, Chini Nala, Dumer Nala, Timki Nala, Sukha Nala, Karanara Nala, Pajhar Nadi, Digi Nala, Tedipara Nala. **(Figure 4.8)**.

4.11 TRENDS IN LAND-USE CHANGE IN CURRENT SCENARIO

There are changes in the buffer zone of the project Site. The changes in the Study Area are observed with increase in the size of some settlements and some Kutcha roads have become pucca and mining area.

General land use changes as observed in the study are as follows:

- Major land use change which can be observed in the study area is the installation of industries.

DRAINAGE PATTERN MAP (GPIII- STUDY AREA)
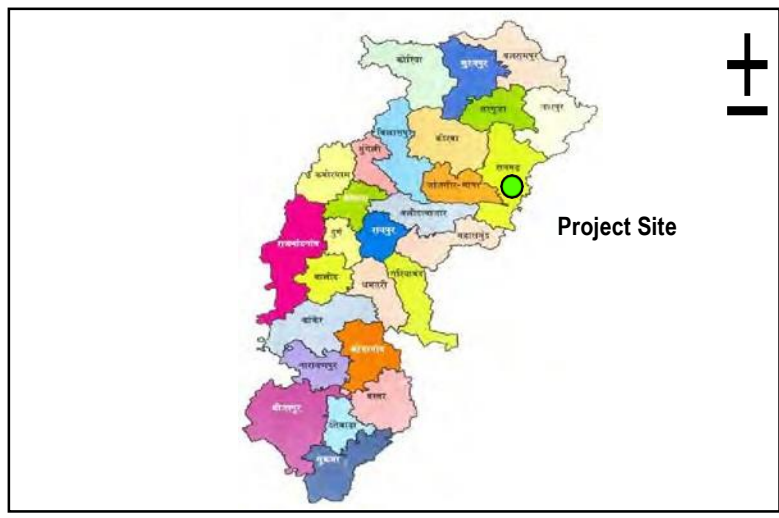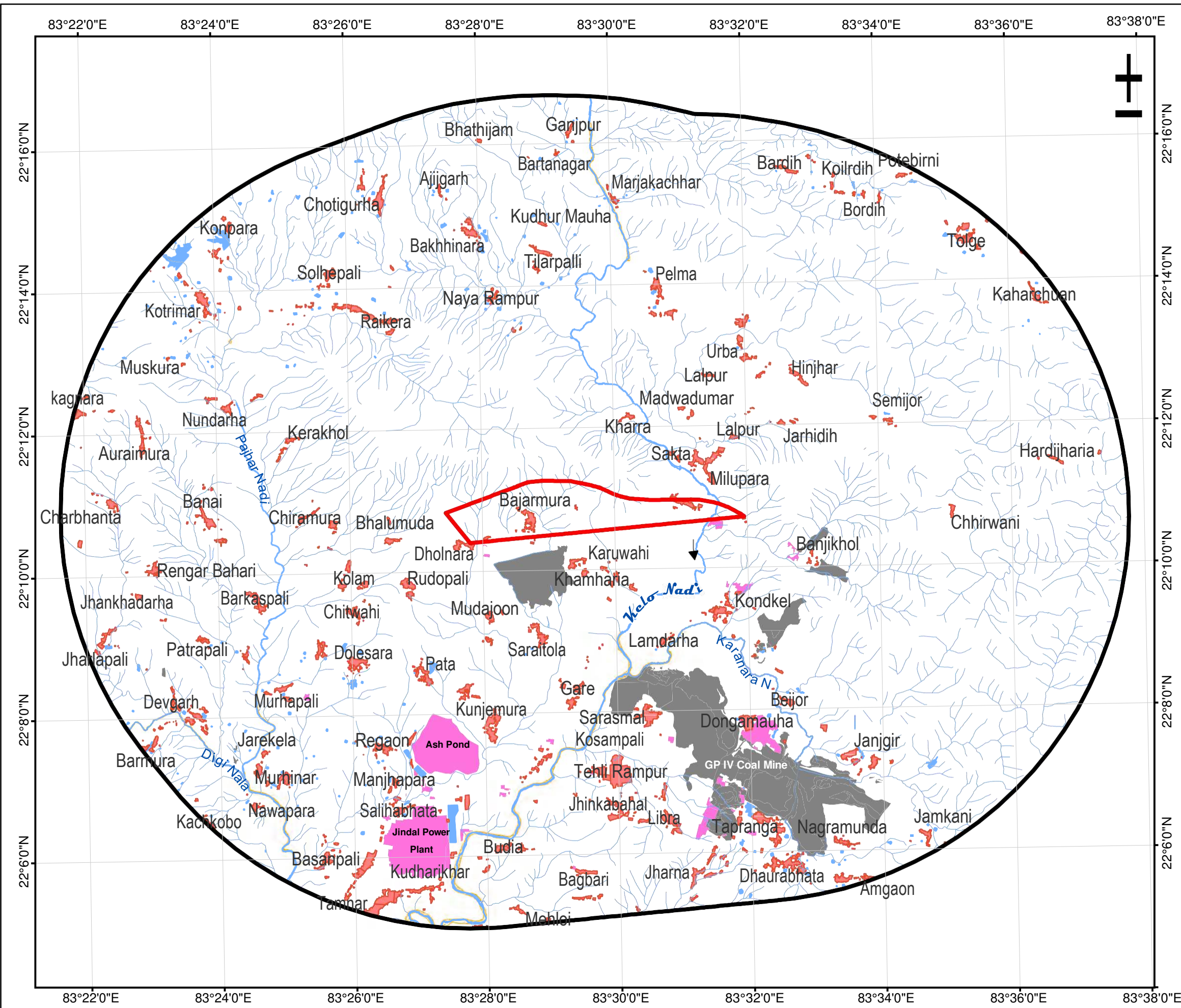
Source:
SOI Toposheet No.: 64N/7, 64N/8, 64N/11 & 64N/12
Google Satellite Imagery, 2018

Legend

- Stream/ Nala/ Drain
- GP III Project Site
- Study Area
- Builtup
- Industrial Area
- Mining Area
- Waterbodies
- Sandy Area

Scale: 1:1,00,000

0   1.5   3   6   9 Km

Project:
GARE-PELMA SECTOR- III COAL BLOCK
TEHSIL- TAMNAR, DISTRICT- RAIGARH, CHHATTISGARH

CHHTTISGARH STATE POWER GENERATION COMPANY LIMITED

PREPARED BY

GREENCINDIA CONSULTING PVT. LTD.
Ghaziabad, Uttar Pradesh
(An ISO:9001 QMS, ISO: 14001 EMS & OHSAS: 18001 H&S MS Certified by BSI)
QCI-NABET Accreditate Environment Consultant
Certificate No.
NABET/EIA/1619/RA0058

- Increment of mining activities and reduction in the forest land and agricultural land found in study area.

- A railway line being installed in study area for industrial transport and process.

- It observed that increase in the size of some settlements.

For GPIII CL

M Anand
Dy. Manager - Environment