ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT OF CITY GAS DISTRIBUTION FOR ANUPPUR GEOGRAPHICAL AREA (GA)

ANUPPUR, BILASPUR & KORBA DISTRICTS IN MADHYA PRADESH AND CHHATTISGARH

ET-005665

Client:
Adani Gas Limited

Date:
25/02/2020

CONTENTS

1 INTRODUCTION

1.1 BACKGROUND

Adani Gas Ltd. (hereinafter referred to as "AGL) is developing and operating City Gas Distribution (CGD) networks to supply Piped Natural Gas (PNG) to industrial, commercial and domestic (residential) customers and Compressed Natural Gas (CNG) to the transport sector in Anuppur, Bilaspur & Korba, in the states of Madhya Pradesh & Chhattisgarh in India. The company has already set up city gas distribution networks in Ahmedabad and Vadodara in Gujarat, Faridabad in Haryana and Khurja in Uttar Pradesh.

With the Government of India planning to offer additional geographical areas for gas distribution in the Xth round involving 50 (Gas Agencies) GAs comprising of 123 districts coupled with rapid urbanization, AGL is on track to become one of the largest private sector CGD companies of the world. AGL is committed to achieve approximately 23 lakh domestic piped natural gas connections and install approximately 500 CNG stations in these 13 new GAs.

List of 15 GAs (state-wise) for which Adani Gas Limited has been granted authorization to lay city gas infrastructure and supply natural gas in the IXth round of CGD bidding is as under:

1. Surendranagar District (Except areas already authorized) -Gujarat
2. Kheda (except areas already authorized), Morbi (Except areas already authorized) & Mahisagar Districts- Gujarat
3. Porbandar District-Gujarat
4. Barwala & Ranpur Talukas-Gujarat
5. Navsari (Except areas already authorized), Surat (Except areas already authorized), Tapi (Except areas already authorized) & The Dangs Districts-Gujarat
6. Nuh & Palwal Districts (Project Area) - Haryana
7. Bhiwani, Charkhi Dadri & Mahendragarh Districts- Haryana
8. Jhansi, Lalitpur, Jalaun, Dati anad Bhind districts in Uttar Pradesh and Madhya Pradesh
9. **Anuppur, Bilaspur and Korba districts in State of Madhtya Pradesh and Chhatisgarh**
10. Udupi District- Karnataka
11. Cuddalore, Nagapattinam & Tiruvarur Districts- Tamil Nadu
12. Tiruppur District- Tamil Nadu

13. Bhilwara & Bundi Districts- Rajasthan
14. Chittorgarh (Other than Rawatbhata Taluka) & Udaipur Districts- Rajasthan
15. Balasore, Bhadrak & Mayurbhanj Districts- Odisha

AGL group has been granted authorization for laying, building, operating or expanding the CGD Network in Anuppur, Bilaspur & Korba, in the states of Madhya Pradesh & Chhattisgarh. The grant has been authorized subject to the petroleum and natural gas regulatory board (authorizing entities to lay, build, operate or expand city or local natural gas distribution networks) regulations, 2008. Under this, the CGD network will be covering 18,617 square kilometers of area. 20 CNG Stations, 77,033 PNG Connections and 1289 Steel Pipe (Inch-km). The activities of laying, building and operating or expansion of the CGD network had to commence immediately after signing and issuance of authority dated, 28th September 2018. Also, the activities must be completed as per the mentioned schedule in tenure of 8 contract years.

1.2 PROJECT BRIEF

Adani Gas Ltd (AGL) has been granted authorization for laying, building, operating or expanding the CGD Network in Anuppur, Bilaspur, and Korba, districts in Madhya Pradesh and Chhattisgarh. The authorized area for laying, building, operating, or expanding the proposed network shall cover an area of 18617 square kilometers.

Table 1-1: Description of Work

Sr. No	Description of Work	Numbers
1	Number of CNG stations (Online and daughter booster stations) to be installed within 8 contract years from the date of authorization	20
2	Number of domestic piped natural gas connections to be achieved within 8 years from 28th September, 2018	77,033
3	Inch-km of steel pipeline to be laid within 8 years from 28th September, 2018	1289
4	Total Population	46,19,504
5	Total Geographical Area (Sq Km)	18617
6	Total Household	10,51,610
7	No. of Charge Area	17

Source: PNGRB issued Grant of Authorization

Adani group is responsible for designing and installation of optimal size of the infrastructure in terms of pipeline of various types including steel belting of the authorized area, online compressors of adequate capacity for compressing of natural gas into CNG, allied equipment

and facilities in the CGD network depending upon the potential demand for natural gas. The infrastructure in the CGD network will be adequate to maintain uninterrupted flow of natural gas in the pipelines and will also be able to maintain supplies at adequate pressure to online CNG stations.

Adani has planned to lay 8" & 4" diameter steel pipeline, approx. 280 km for the gas distribution throughout Anuppur, Bilaspur, and Korba, districts in Madhya Pradesh and Chhattisgarh. The pipeline runs from Compressor station of Reliance Gas Pipelines Limited (RGPL) in Shahdol MP for tap off to various towns in Anuppur, Bilaspur, and Korba districts in MP and Chhattisgarh.

1.3 NEED & SCOPE OF EIA

The purpose of this EIA is to assess the potential environmental impacts due to the proposed project in a study area of 10 km radius around and 500 m on both sides of the pipeline. The assessment covers both construction and operation phases of the project. The EIA forecasts changes (positive and negative) that may occur as a result of key project activities to the baseline environmental conditions in the study area. Early identification of impacts and their mitigation reduces the risk of long-term adverse environmental effects.

Scope of EIA:

- Assessment of the present status of environmental components such as air, water, noise, soil, topography and drainage, traffic and socio- economic conditions based on field data/ secondary data.
- Identification of the potential impacts of various activities proposed to be undertaken during construction and operation phases of the project.
- Prediction and evaluation of the impact of activities.
- Identifying the mitigation measures, management plan and monitoring schedule, if any

1.4 REGULATORY FRAMEWORK

The Ministry of Environment, Forest and Climate Change (MoEF&CC) has notified the Environmental Impact Assessment (EIA) Notification, 2006 under the provisions of the Environment (Protection) Act, 1986, which regulates development and their expansion/modernization of 39 sectors/activities listed in the Schedule to the EIA Notification, 2006. There are two Categories of the projects in the notification namely Category 'A' and Category 'B' projects. Category 'A' projects are appraised at the level of MoEF&CC and Category 'B' projects are appraised by the respective State Environment Impact Assessment Authority (SEIAA) following the procedure prescribed under the EIA Notification, 2006.

As per project/ activity 6 (a) of Schedule of EIA Notification 2006, oil and gas transportation pipelines which pass through national parks, sanctuaries, coral reefs or ecologically sensitive areas sites require Environmental Clearance (EC).

However a recent notification by dated 7th November 2014 by MoEFCC (Annexure-1) accorded general approval under the Forest (Conservation) Act, 1980 (FC Act) for underground laying of optical fibre cables, telephone lines, drinking water supply pipeline and CNG/ PNG pipelines along the petroleum pipelines within existing right of way not falling in National Parks and Wildlife Sanctuaries, without felling of trees, where the maximum size of the trench is not more than 2.00 meter depth and 1.00 meter width.

The present project passes through Amarkantak Hill Range and Reserved Forest near Belpat and Nawapara in the districts of Bilaspur and Korba respectively in Chhattisgarh hence clearance is required from the forest department. Upon discussion at the office of District Forest Office Bilaspur it was informed that the client needs to intimate the project detail to the circle offices of Forest department at Bilaspur and Korba. Also, to the respective State Environment Impact Assessment Authority (SEIAA) following the procedure prescribed under the EIA Notification, 2006.

The project falls in notified protected forest areas and clearance are required to be obtained from Chhattisgarh forest department and MoEFCC, and intimation is to be sent to them detailing the project intent. The Pipeline further passes along main district roads, state and national highway hence it is required to obtain clearance from the National Highway Authority of India (NHAI). It also crosses railway lines hence will be requiring clearance from Indian Railways.

The project also require permission from irrigation department of MP and Chhattisgarh associated with all the rivers passing through the Anuppur, Bilaspur, and Korba districts that falls in the pipeline route.

Also if the pipeline is passing through the land under the control of PWD (Building and roads) as on either side of the flowing water course of all canals, branches, distributaries, major-minor channels etc., under the control of irrigation department, the land along the railway track and station yards under the control of Indian railways, and land under the control of national or state highway – the client is advised to take permission from the concerned authority.

Table 1-2: Applicability of all Act, Laws & Rules to the project

S. No.	Legal Instrument	Objective	Reason for Applicability	Authority	Applicable Yes/No
1.	Environmental (Protection) Act & Rules, 1986	To protect and improve overall environment	As all environmental notifications, rules and schedules are issued under this act	MoEF&CC GoI, Forest, Ecology & Environment Department, CPCB, MPPCB & Chhattisgarh Environment Conservation Board (CECB)	No
2.	The Irrigation Laws (Amendment) Act, 1964	To maintain the uninterrupted flow of natural water ways and canals	For using land under the right of way basis for laying the CNG PNG pipeline across a either side of the flowing water course of all canals, branches, distributaries, major-minor channels etc.	Water Resources Department, Govt. of MP & Chhattisgarh (PWD)	Yes Application to be made to the Water Resources Department, Odisha
3.	The Railways Act, 1989	To manage safety of railways	For using land under the right of way basis for laying the CNG PNG pipeline	Indian Railways (IR)	Yes, Application for NOC to be made
4.	The Control of National Highways (Land And Traffic) Act, 2002	To manage safety National Highway, State Highway	For using land along the highway on right of way basis for laying the CNG PNG pipeline	National Highway Authority of India (NHAI)	Yes, Application for NOC to be made

S. No.	Legal Instrument	Objective	Reason for Applicability	Authority	Applicable Yes/No
2.	Environmental Impact Assessment (EIA) Notification, 2006	To provide environmental clearance to new development activities following environmental impact assessment	As per project/ activity 6 (a) of Schedule of EIA Notification 2006, oil and gas transportation pipelines which pass through national parks, sanctuaries, coral reefs or ecologically sensitive areas sites require Environmental Clearance (EC). The project lies in Category A of the notification.	MoEFCC	No
3.	Forest (Conservation) Act, 1980	To check deforestation by restricting conversion of forested areas into non-forested areas	The project lies along and in the protected forest area.	Forest Department Bilaspur and Korba, MoEFCC	Yes
4.	National Forest Policy (Revised), 1988	To maintain ecological stability through preservation and restoration of biological diversity	Eco sensitive zone exists along the project corridor, from which the pipeline passes through	Forest Department Bilaspur and Korba	Yes
5.	Wildlife Protection Act, 1972	To Protect wildlife sanctuaries and National Park	Achanakmar wildlife sanctuary falls within 10 km of the project road.	NBWL, SBWL & Chief Wildlife Warden, MoEFCC	Yes
6.	Water (Prevention and Control of Pollution) Act, 1974	To control water pollution by controlling emission & Water pollutants as per the prescribed standards	This act will be applicable during construction, for establishments of hot mix plant, construction camp, workers' camp, etc	MPPCB & Chhattisgarh Environment Conservation Board (CECB)	Yes

S. No.	Legal Instrument	Objective	Reason for Applicability	Authority	Applicable Yes/No
7.	Air (Prevention and Control of Pollution) Act as amended in 1987	To control air pollution by controlling emission and air pollutants according to prescribed standards	This act will be applicable during construction; for obtaining NOC for establishment of hot mix plant, workers' camp, stone crusher, construction camp, & other heavy machinery.	MPPCB & Chhattisgarh Environment Conservation Board (CECB)	Yes
8.	Noise Pollution (Regulation and Control) rules, 2000	Noise pollution regulation and controls	This act will be applicable as vehicular noise on project routes required to assess for future years and necessary protection measure need to be considered in design.	MPPCB & Chhattisgarh Environment Conservation Board (CECB)	Yes
9.	The Explosives Act (& Rules), 1884	An Act to regulate the manufacture, possession, use, sale, transport, import and export of Explosives	For transporting and storing diesel, bitumen etc.	MPPCB & Chhattisgarh Environment Conservation Board (CECB)	Yes
10.	Public Liability Insurance Act, 1991	Insurance for the purpose of providing immediate relief to the persons affected by accident occurring while handling any hazardous substance and for matters connected therewith or incidental thereto	Contractor need to stock hazardous material like diesel, Bitumen, Emulsions etc. safely in designated locations within the construction camp	MPPCB & Chhattisgarh Environment Conservation Board (CECB)	Yes

S. No.	Legal Instrument	Objective	Reason for Applicability	Authority	Applicable Yes/No
11.	Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016	Storage, handling, transportation and disposal of hazardous waste	Storage and handling of hazardous waste during construction	MPPCB & Chhattisgarh Environment Conservation Board (CECB)	Yes
12.	Solid Waste Management Rules, 2016	Management and handling of solid waste	For disposal of solid waste generated during construction	MPPCB & Chhattisgarh Environment Conservation Board (CECB)	Yes
13.	Construction and Demolition Waste Management Rules	Management of construction and demolition waste	For disposal of solid waste generated due to construction and demolition	MPPCB & Chhattisgarh Environment Conservation Board (CECB)	Yes
14.	Batteries (Management & Handling) Amendment Rules, 2016	Management and handling of used lead acid batteries	Safe disposal of used lead batteries through authorized e waste recyclers	MPPCB & Chhattisgarh Environment Conservation Board (CECB)	Yes
15.	E-Waste (Management) Rules, 2016	Effective mechanism to regulate generation, collection, storage, transport, import, export, recycling, treatment and disposal of e-wastes	Handling of e-waste	MPPCB & Chhattisgarh Environment Conservation Board (CECB)	Yes

S. No.	Legal Instrument	Objective	Reason for Applicability	Authority	Applicable Yes/No
16.	Central Motor Vehicles Act , 1988	To control vehicular air and noise pollution	This rule will be applicable to road users and construction machinery	Motor Vehicle Department	Yes
17.	The Petroleum Act 1934, as amended in August 1976 The Petroleum Rules 1976, as amended in March 2002.	Operation, Storage and transportation of Petroleum products	The rule is applicable for as the transportation and distribution of compressed natural gas will take place	Ministry of Petroleum & Natural Gas	Yes
19.	Petroleum and Natural Gas Rules, 1959, amended 2009	As states own the blocks found within their territory and are therefore, responsible for awarding the licenses for onshore blocks,	The rule is applicable for as the transportation and distribution of compressed natural gas will take place through the state of Madhya Pradesh and Chhatisgarh	Ministry of Petroleum & Natural Gas & MP, Chhatisgarh State Govt	Yes

S. No.	Legal Instrument	Objective	Reason for Applicability	Authority	Applicable Yes/No
20.	The Petroleum and minerals pipeline (acquisition of right of user in land) act, 1962	Acquisition of right of user in land [for laying pipelines for the transport of petroleum and minerals] and Provision of compensation in case of any damage, loss or injury is sustained by any person interested in the land under which the pipeline is proposed to be, or is being, or has been laid	The pipeline passes through residential and commercial areas, it may even passes from or near to private property.	Ministry of Petroleum & Natural Gas	Yes
21.	NOC from Gram Panchayat	As per M.P. Panchayat Raj Act 1992 Chhattisgarh Panchayat Raj Adhiniyam, 1993	M.P. Panchayat Raj Act 1992 Chhattisgarh Panchayat Raj Adhiniyam, 1993	Village Sarpanch	Application to village Panchayat falling in the stretch is to be made

S. No.	Legal Instrument	Objective	Reason for Applicability	Authority	Applicable Yes/No
22.	Petroleum and Natural Gas Regulatory Board Act, 2006	Regulation of refining, processing, storage, transportation, distribution, marketing and sale of petroleum, petroleum products and natural gas excluding production of crude oil and natural gas so as to protect the interests of consumers and entities engaged in specified activities	The project is proposed under this act and is bid out by PNGRB for uninterrupted and adequate supply of petroleum, petroleum products and natural gas in all parts of the country	PNGRB	Yes
23.	The Irrigation Laws (Amendment) Act, 1964	To maintain the uninterrupted flow of natural water ways and canals	For using land under the Right of Way basis for laying the CNG PNG pipeline across a either side of the flowing water course of all canals, branches, distributaries, major-minor channels etc.	Water Resources Department, Govt. of MP and Chhatisgarh (PWD)	Yes Application needs to be made

Environmental issues during pipeline laying & construction stage generally involve equity, safety and public health issues. The construction agencies require complying with laws mentioned below as well:

- **Workmen's Compensation Act 1923** (the Act provides for compensation in case of injury by accident arising out of and during the course of employment);
- **Payment of Gratuity Act, 1972** (gratuity is payable to an employee under the Act on satisfaction of certain conditions on separation if an employee has completed 5 years);
- **Employees PF and Miscellaneous Provision Act 1952** (the Act provides for monthly contributions by the employer plus workers);
- **Maternity Benefit Act, 1951** (the Act provides for leave and some other benefits to women employees in case of confinement or miscarriage, etc.);
- **Contact Labor (Regulation and Abolition) Act, 1970** (the Act provides for certain welfare measures to be provided by the contractor to contract labour);
- **Minimum Wages Act, 1948** (the employer is supposed to pay not less than the Minimum Wages fixed by appropriate Government as per provisions);
- **Payment of Wages Act, 1936** (it lays down as to by what date the wages are to be paid, when it will' be paid and what deductions can be made from the wages of the workers);
- **Equal Remuneration Act, 1979** (the Act provides for payment of equal wages for work of equal nature to Male and Female workers and not for making discrimination against Female employees);
- **Payment of Bonus Act, 1965** (the Act provides for payments of annual bonus subject to a minimum of 83.3% of wages and maximum of 20% of wages);
- **Industrial Disputes Act, 1947** (the Act lays down the machinery and procedure for resolution of industrial disputes, in what situations a strike or lock-out becomes illegal and what are the requirements for laying off or retrenching the employees or closing down the establishment);
- **Industrial Employment (Standing Orders) Act; 1946** (the Act provides for laying down rules governing the conditions of employment);
- **Trade Unions Act, 1926** (the Act lays down the procedure for registration of trade unions of workers and employers. The trade unions registered under the Act have been given certain immunities from civil and criminal liabilities);
- **The Child Labour (Prohibition and Regulation) Amendment Act, 2016** An Act further to amend the Child Labour (Prohibition and Regulation) Act, 1986. (the Act prohibits employment of children below 14 years of age in certain occupations and processes and provides for regulation of employment of children in all other occupations and processes. Employment of child labour is prohibited in Building and Construction Industry);

- **Inter-State Migrant Workmen's (Regulation of Employment and Conditions of Service) Act, 1979** (the inter-state migrant workers, in an establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, traveling expenses from home to the establishment and back, etc.);
- **The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996** and the Cess Act of 1996 (all the establishments who carry on any building or other construction work and employs 10 or more workers are covered under this Act; the employer of the establishment is required to provide safety measures at the building or construction work and other welfare measures, such as canteens, first-aid facilities, ambulance, housing accommodation for Workers near the workplace, etc.);
- **The Factories Act, 1948** (the Act lays down the procedure for approval of plans before setting up a factory, health and safety provisions, welfare provisions, working hours and rendering information-regarding accidents or dangerous occurrences to designated authorities).

1.5 CONTENTS OF THE EIA REPORT

The report has been divided in to the following chapters

Chapter 1: Introduction

This chapter provides background information of the existing pipeline, brief description and objectives of the project, scope of the study.

Chapter-2: Project Description

This chapter presents the details of the proposed project with description of the resources required and emissions, waste and wastewater anticipated to be generated.

Chapter-3: Description of Environment

This chapter describes the existing baseline status of environment components collected in a pre-defined study area based on primary and secondary data collection.

Chapter 4: Anticipated environment impacts and mitigation measures

This chapter describes the potential impacts of the proposed project and evaluates their significance based on parameters such as Intensity, Spatial extension, Temporal duration and Environmental Vulnerability. Impact avoidance and mitigation measures are delineated.

Chapter 5: Additional Studies

This chapter assesses the potential risks involved in the construction and operation of proposed facilities and presents a Disaster Management Plan (DMP).

Chapter 6: Analysis of Alternatives

The chapter entails the alternative options for the project.

Chapter 7: Project Benefits

This chapter presents the details of direct and indirect benefits due to proposed project.

Chapter 8: Environment Monitoring & Management Plan

This chapter describes the details of the monitoring schedule to be implemented for checking the effectiveness of mitigation measures. It covers the parameters, frequency and location of monitoring. If existing monitoring schedule is sufficient to cover the proposed development, the same has been clearly mentioned.

The chapter also describes the organizational structure and resources planned for implementing the mitigation measures and monitoring schedule.

Chapter 9: Summary & Conclusions

This chapter summarizes the potential positive and negative environmental impacts of the project.

2 PROJECT DESCRIPTION

2.1 DESCRIPTION OF THE CITY GAS DISTRIBUTION PIPELINE

Adani Gas Limited has been granted authorization for laying, building, operating or expanding the CGD Network in Anuppur, Bilaspur, and Korba, districts in Madhya Pradesh and Chhattisgarh. The authorized area for laying, building, operating, or expanding the proposed network shall cover an area of 18617 square kilometers.

Table 2-1: Description of Work

Sr. No	Description of Work	Numbers
1	Number of CNG stations (Online and daughter booster stations) to be installed within 8 contract years from the date of authorization	20
2	Number of domestic piped natural gas connections to be achieved within 8 years from 28th September, 2018	77,033
3	Inch-km of steel pipeline to be laid within 8 years from 28th September, 2018	1289
4	Total Population	46,19,504
5	Total Geographical Area (Sq Km)	18617
6	Total Household	10,51,610
7	No. of Charge Area	17

Source: PNGRB issued Grant of Authorization for Anuppur CGD

Adani Gas Limited is responsible for designing and installation of optimal size of the infrastructure in terms of pipeline of various types including steel belting of the authorized area, online compressors of adequate capacity for compressing of natural gas into CNG, allied equipment and facilities in the CGD network depending upon the potential demand for natural gas. The infrastructure in the CGD network will be adequate to maintain uninterrupted flow of natural gas in the pipelines and will also be able to maintain supplies at adequate pressure to online CNG stations.

Adani Gas Limited has planned to lay 8” & 4” diameter steel pipeline, approx. 280 km for the gas distribution throughout Anuppur, Bilaspur, and Korba, districts in Madhya Pradesh and Chhattisgarh. The pipeline runs from Compressor station of Reliance Gas Pipelines Limited (RGPL) in Shahdol MP for tap off to various towns in Anuppur, Bilaspur, and Korba districts in MP and Chhattisgarh.

The proposed project will provide 20 CNG stations throughout the project. There are total 17 charge areas for the entire project. 3 acre of un-rrigated farmland for one LNG station has been identified on in Anuppur town and will be acquired on willing buyer-willing seller mode.
The project falls in notified protected forest areas and clearance are required to be obtained from Chhattisgarh forest department and MoEFCC, and intimation is to be sent to them detailing the project intent.

Pipeline passes along main district roads, state and national highway hence it is required to obtain clearance from the National Highway Authority of India (NHAI). It also crosses railway lines hence will be requiring clearance from Indian Railways.

The project also require permission from irrigation department of MP and Chhattisgarh associated with all the rivers passing through the Anuppur, Bilaspur, and Korba districts that falls in the pipeline route.

2.2 PROJECT IMPLEMENTATION SCHEDULE

A grant of authorization was signed on 29th March 2019 by Petroleum and Natural Gas Regulatory Board (PNGRB) vide a letter of authorization to AGL group, which was accepted by them on 1st April 2019. The letter schedule D of the letter stated the year wise work program within the 8-contract year period. The details on which are given in table below:

Table 2-2: Project Implementation Schedule

Implementation Schedule					
Approximate PNG Connections (Cumulative)		**Approximate CNG Stations (Cumulative)**		**Approximate Inch-km of steel pipeline (Cumulative)**	
By the end of contract year	% of work program	By the end of contract year	% of work program	By the end of contract year	% of work program
1st	NIL	1st	NIL	1st	5
2nd	10	2nd	15	2nd	20
3rd	20	3rd	30	3rd	40
4th	30	4th	45	4th	60
5th	40	5th	60	5th	70
6th	60	6th	75	6th	80
7th	80	7th	90	7th	90
8th	100	8th	100	8th	100

Source: Adani Gas Limited

Adani Gas Limited has been granted authorization for laying, building, operating or expanding the CGD Network in Anuppur, Bilaspur, and Korba, districts in Madhya Pradesh and

Chhattisgarh. The authorized area for laying, building, operating, or expanding the proposed network shall cover an area of 5,187 square kilometers.

The project is still in conceptual stage and required regulatory permits are being obtained. No work has started yet on the any stage of the project.

Anuppur, Bilaspur, and Korba districts Stretch runs within the city on the connecting National Highway (NH 130) in Chhattisgarh and NH78 in MP including state highways and district roads . The details of pipeline loop and charge head is given in following table:

Table 2-3: Details with Charge Area of the pipeline project

Charge Area ID	Name
CA 01	Pushparajgarh
CA 02	Anuppur
CA 03	Kotma
CA 04	Jaitihari
CA 05	Marwahi
CA 06	Pendra Road Gaurella
CA 07	Pendra Road
CA 08	Kota
CA 09	Takhatpur
CA 10	Uslapur
CA 11	Delha
CA 12	Mastori
CA 13	Podi Uproda
CA 14	Pali
CA 15	Katchoila
CA 16	Korba
CA 17	Kartala

A Map of Geographical Area of the three districts approved by PNGRB shows the following loops of the proposed pipeline routes.

Table 2-4: Details of the loops and their length of the pipeline project

Loop Name	Road	Approximate Distance	Approximate Indication in Map
Anuppur - Bilaspur	NH 43, SH -130, Bilaspur- Marwah Road	198 km	Blue Line
Bilaspur – Korba	NTPC-Sipat Road,	82 km	Blue Line

Source: Primary Survey, TUV SUD

The proposed project was started in June-July 2019 and is expected to be completed in approximately 36 months from the date of approval environmental & other statutory clearances.

2.3 PIPELINE ROUTE & ACCESSIBILITY

Pipeline runs parallel along the main roads hence accessibility is not an issue. Project pipeline runs along major national and state highway connecting Anuppur, Bilaspur, and Korba districts. The route covers 93 villages in 8 talukas and 3 districts and 2 States.

Table 2-5: List of villages, cities, talukas and districts of Anuppur, Bilaspur and Korba districts falling in the project area

S. No	City/ Village		Taluka	District	State
1	1. Shahdol 2. Burhar 3. Lakeran Tola 4. Saabo 5. Amlai 6. Batura	7. Kodaili 8. Bakeli 9. Pondi 10. Manpur 11. Sitapur	Manpur	Anuppur	Madhya Pradesh
2	1. Barbaspur 2. Anuppur City 3. Kusmahai	4. Belia 5. Chullah	Gunderdehi	Anuppur	Chattisgarh
3	1. Jaithari 2. Lahapur 3. Pachauha 4. Jhangawan 5. Shaktitola 6. Khuntatola 7. Paprauri	8. Lapta 9. Amdand 10. Munda 11. Kadamsara 12. Khairi 13. Venkat Nagar	Jaithari	Anuppur	Chahttisgarh

4	1. Kusumkheda 2. Sodha Khurd 3. Parsapani	4. Amamuda 5. Banabel 6. Majhwani	Budni	Anuppur	Chahttisgarh
5	1. Bansajhal 2. Chapora 3. Khaira 4. Pondi 5. Ghansipur 6. Ratanpur 7. Dulhara	8. Pandwara 9. Mohtarai 10. Gatauri 11. Sendri 12. Badi Kon 13. Sarkanda	Kota	Bilaspur	Chahttisgarh
6	1. Khairjiti 2. Lalapur 3. Andu 4. Sadhwari 5. Ranijhap 6. Barjorkha 7. Jogisar 8. Belpat 9. Dungra 10. Semra	11. Bilaspur City 12. Torwa 13. Mopka 14. Charpara 15. Baloda 16. Jhharradih 17. Bhilai 18. Sarai Shringar 19. Kenda	Bilaspur City	Bilaspur City	Chahttisgarh
7	1. Lagra 2. Khaira 3. Pandhi 4. Janji 5. Sipat 6. Gudi 7. Khanda	8. Dhaniya 9. Bhauradih 10. Lathara 11. Khamhariya 12. Kuli 13. Sultanar	Masturi	Bilaspur	Chahttisgarh
8	1. Dongri 2. Nagwa 3. Hardibisal 4. Khirosa 5. Nawapara 6. Pantora 7. Bhada	8. Tarda 9. Kudurmal 10. Urga 11. Bharbaspur 12. Bilaikhurd 13. Korba Town	Korba	Korba	Chahttisgarh

Source: Primary Survey, TUV SUD

Figure 2-1: Location Map of Project Site

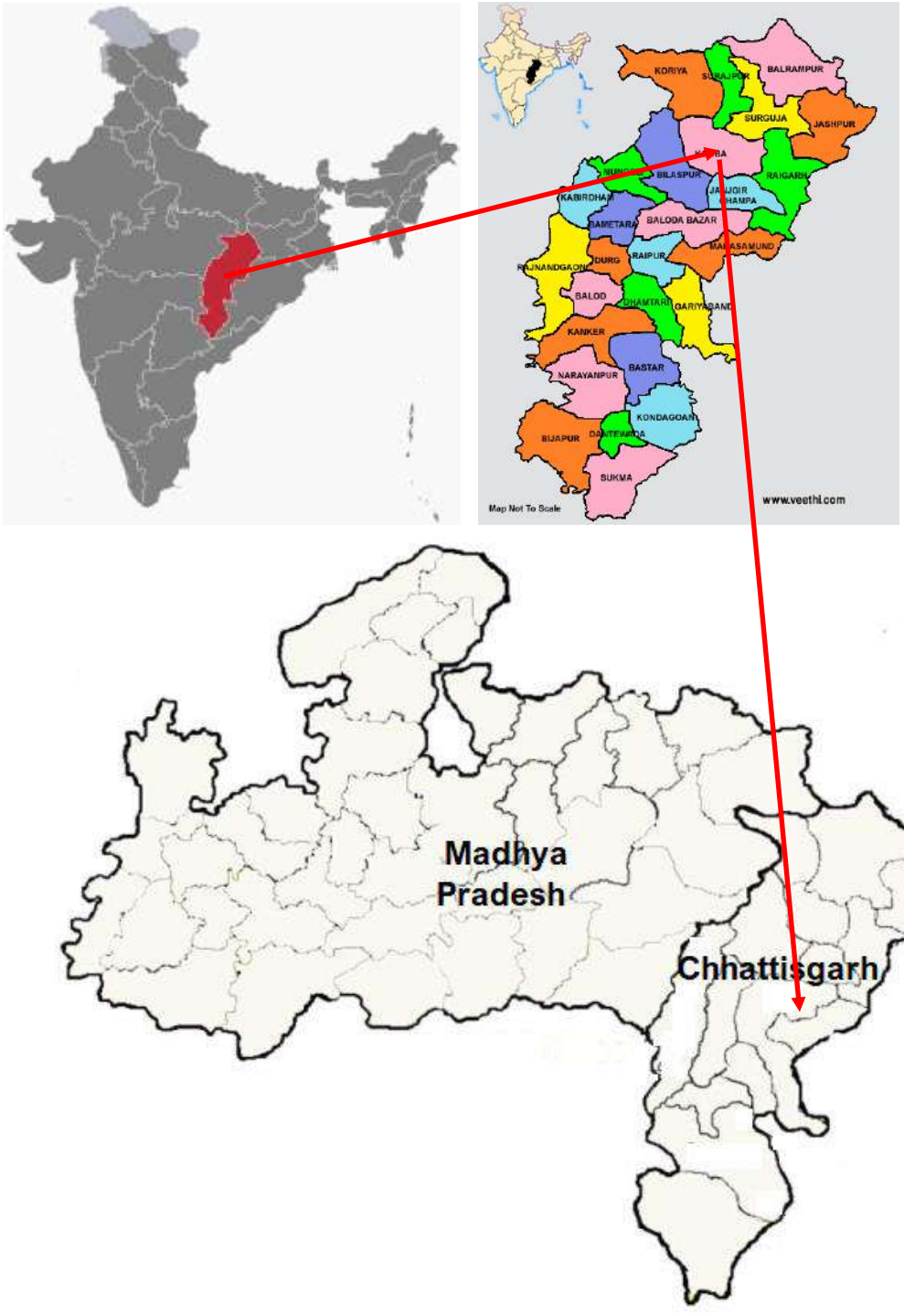
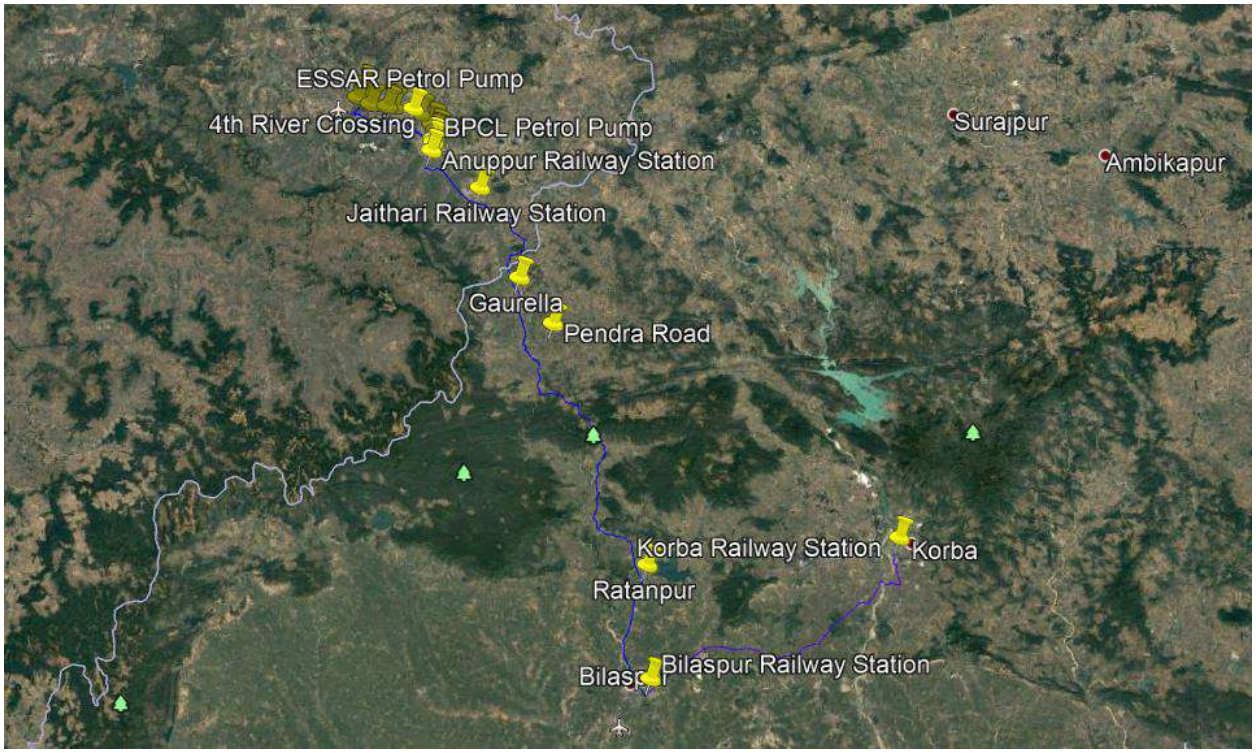


Figure 2-2: Route Map for the pipeline in Anuppur, Bilaspur, Korba



Source: Adani Gas Limited

First Minor River Crossing at Saabo in Anuppur start point

Anuppur Railway Crossing

Tipan River Crossing Anuppur District Road

Pendra Road Railway Crossing near Belia Village, Anuppur

River Crossing near Kenda Village, Bilaspur

A lake near Amarkantak Hill Range, Bilaspur-Marwahi Bypass Road

Bilaspur District Forest office

Arpa River Crossing in Bilaspur Town, Mopka Bypass Road

Table 2-6: List of Rivers, Canal, & Ponds falling in the pipeline route in the districts of Anuppur, Bilaspur, and Korba

Sr. No	River/Canal/Rivulet	Project Phase
Anuppur		
1	Unnamed River Near Start Point at RPGL, Kotma Marg	Blue Line
2	Sone River Bridge Crossing, Anuppur	Blue Line
3	Minor River Crossing at Kodaili, on NH 78	Blue Line
4	Sone River Bridge Crossing at Sitapur, Anuppur	Blue Line
5	Tipan River Crossing, Anuppur	Blue Line
6	Minor River Crossing at Venkat Nagar	Blue Line
7	Minor River Crossing at Bhaskura	Blue Line
8	Pond Crossing at Gaurella	Blue Line
Bilaspur		
9	River Crossing at Bhadaura Marg in Khondri, Bilaspur	Violet Line
10	River Crossing at Khodri	Violet Line
11	Bhaduara River Bridge Crossing	Violet Line
12	Monor River Crossing at Belpar	Violet Line
13	Arpa River Crossing at Semra	Violet Line
14	River Crossing at Paraspani	Violet Line
15	River Crossing at Jarga	Violet Line
16	Arpa River crossing at New Sarkanda	
17	Arpa River Crossing at Chhath Ghat	Violet Line
18	Unnamed tributary of Arpa River	Violet Line
Korba		
19	Lilagar River	Violet Line
20	Hasdo River Irrigation Canal on Kanki Road Bhada	Violet Line
21	Hasdo River	Violet Line
22	Hasdo River Irrigation Canal at Urga	Violet Line
23	Hasdo River Irrigation Canal at Bharbaspur	Violet Line
24	Unnamed Nala at Bharbaspur on Korba-Champa Road SH (1498)	Violet Line
25	Hasdo River Irrigation Canal at Manikpur Coal Mines	Violet Line
26	Hasdo River Irrigation Canal at Champa	Violet Line
27	Hasdo River Irrigation Canal at Korba Railway Station	Violet Line

Source: Primary Survey, TUV SUD

Table 2-7: List of Railway crossing falling in the pipeline route in the districts of Anuppur, Bilaspur, and Korba

Sr. No	Railway Crossings	Project Phase
Anuppur		
1	Railway crossing in Anuppu City	Blue Line
2	Pendra Road Railway Crossing near Belia Village, Anuppur	Blue Line
Korba		
1	NTPC Cargo Railway Crossing at Dhaniya, Korba	Violet Line

Source: Primary Survey, TUV SUD

Table 2-8: Forest falling in the pipeline route in the districts of Bhadrak, Balasore, and Mayurbhanj

Sr. No	Forest Area (Ha)	Project Phase
Baripada		
1	Amarkantak Hill Range Forest	Blue Line
2	Achanakmar Wild Life Sanctuary	Blue Line

2.4 PIPELINE DESIGN & CODE

As stated in PNGRB Notification 2008, the design, materials and equipment, welding, fabrication, installation, testing, operation and maintenance and corrosion control of CGD network shall be in accordance with requirements of ASME B31.8 except insofar as such requirements are specifically cancelled, replaced or modified by the requirements specified in these regulations.

The CNG Station, CNG Mother Station, CNG On-Line Station and CNG Daughter Station shall be designed, operated and maintained in line with the requirements of the Chief Controller of Explosives as detailed in the Gas Cylinder Rules, 2004 as modified or amended from time to time. This includes compression, handling and transportation activities of compressed natural gas.

It is intended to apply these regulations to all new and such aspects of already existing networks as design, fabrication, installation, testing at the time of construction and commissioning. However, if an Adani has laid, built, constructed or expanded the CGD infrastructure based on some other standard or is not meeting the standards specified in these regulations, then it needs to carry out a detailed technical audit of its infrastructure through a Board authorized or approved third party agency by the Board. Adani thereafter shall submit the recommendations made by the third party along-with its time-based mitigation plan and implementation schedule to the Board for authorization within six months from the date of notification of these regulations.

Technical standards and specifications mentioned in PNGRB notification, 2008 including safety standards (hereinafter referred to as standards) for city or local natural gas distribution networks are as specified in Schedule–I which cover material and equipment (Schedule–1A), welding (Schedule–1B), piping system components and fabrication (Schedule– 1C), design, installation

and testing (Schedule–1D), operating and maintenance procedures (Schedule–1E), corrosion control (Schedule–1F) and miscellaneous (Schedule–1G).

Table 2-9: Applicable Standards & Codes

S. No	Standards & Schedule	Applicability
1	ASME B 16.25	Butt welding Ends
2	ASME B 31.8	Gas Transmission and Distribution Piping Systems
3	ASME B 16.11	Forged Fittings, Socket Welding and Threaded
4	ASME B 31.3	Process Piping
5	ASME B 31.4	Pipeline Transportation System for Liquid Hydrocarbons and Others
6	ASME B 16.5	Pipe line flanges and flanged fittings
7	ASME B 16.9	Factory made- Wrought Steel Butt welding Fittings
8	ASME PTC 10	Performance Test Code on Compressors and Exhausters
9	PNGRB T4S	Pipeline Design & Material Selection
10	PNGRB Regulation, 2008- Schedule–I A	material and equipment
11	PNGRB Regulation, 2008- Schedule–1B	welding
12	PNGRB Regulation, 2008- Schedule–I C	piping system components and fabrication
13	PNGRB Regulation, 2008- Schedule–I D	design, installation and testing
14	PNGRB Regulation, 2008- Schedule–I E	operating and maintenance procedures
15	PNGRB Regulation, 2008- Schedule–I F	corrosion control
16	PNGRB Regulation, 2008- Schedule–I E	miscellaneous

Source: Secondary Data Survey, TUV SUD

Table 2-10: Technical details for the proposed pipeline

S.No	Description	Piping Details
1	Pipeline internal Diameter (Inches)	8” & 4”
2	Pipeline wall thickness (mm)	6.4
3	Piping material specification	API 5L X42
4	Normal operating pressure	19-40 kg/cm^2
5	Maximum allowable operating pressure	40 kg/cm^2
6	External Coating type & specification	3 LPE
7	Design Throughput (MMSCMD)	0.3 MMSCMD

8	Pipeline Design Life	25 years
11	Design Temperature (C)	0-60 degree centigrate
12	Rating of Piping Components	Schedule 40 (API 5L *42)
13	Mainline Valve Stations	Will be installed at every 3 kms for the complete length of the pipeline

Source: Adani Gas Limited

2.5 ASSOCIATED FACILITIES

2.5.1 SCADA, TELECOMMUNICATION & LEAK DETECTION

The Master Control Station shall be equipped with Supervisory Control and Data Acquisition (SCADA) software running under multi-programming, multitasking real time operating system environment. The SCADA software shall incorporate control & monitoring of all locations including Block valves. Leak Detection system shall be provided, and the Leak Detection Software shall run in a separate machine at Master Control Station. This package will enable the operator to take optimal control actions and thus ensure the safety and security of the pipeline network.

The CGD system should have leak detection system in position and should be operative. For pipeline network it shall be odorisation based and for enclosures such as CGS, above ground DPRS, it shall be gas leak detection based. Gas detectors shall be installed at strategic locations covering to detect any gas leakage.

2.5.2 FIRE ALARM & FIRE FIGHTING SYSTEMS

As per the Petroleum and natural gas regulatory board notification 2008, Schedule 1 D, after construction activities relevant warning signs shall be displayed in the area. A proper Emergency Response Plan shall be in place and emergency contact numbers of relevant agencies should be visible. Firefighting equipment's should be available during commissioning.
As per the PNGRB notification, 2008 AGL operating CGD Networks shall provide for an Emergency Control Room, manned round the clock and equipped with effective communication system and emergency vehicles fitted with communication facilities, first aid equipment, fire extinguishers, gas detectors, repair kits and tools, maps, plans, material safety data sheets etc. at its disposal. The CGD entity shall put in place an Emergency Response Plan, a Disaster Management Plan and a Pandemic Plan. While preparing these plans the entity shall take into confidence the various local authorities (i.e. The Fire authorities, Police authorities, Health authorities, local administration, Disaster Management authorities, Mutual aid, Factory inspectorate etc) and clearly elaborate on their role in case of an incident.

2.5.3 CORROSION PROTECTION

Underground carbon steel section beyond transition fitting is below ground, it shall be protected against corrosion by minimum 400 micron thick 2 pack high build epoxy coating. Above ground service piping shall be Galvanized Iron or copper or carbon steel protected by anti-corrosive coating.

2.6 LAYING OF PIPELINE

The pipeline construction is proposed to be carried out through deployment of 4 to 5 spreads. The sequence and methodology of construction of new pipeline is given below:

- Clearing and grading - A 30 m wide Right of Use (RoU) area will be cleared off vegetation and other obstacles such as boulders. Tree felling will not take place.
- Stringing–Pipes are transported to the site on trucks will be offloaded using side booms. Pipes are then strung adjacent to the trench. Trailers and cranes will be used for maneuvering of pipes. This activity may be done before or after trenching.
- Trenching - Trenchers and backhoe type excavators will be used to dig the trench for laying the pipeline. The topsoil in agricultural areas will be removed and stockpiled for restoration. The excavated sub-soil will be stockpiled separately for backfill.
- Bending – Pipes will be bent using a bending machine to the appropriate angle to match the vertical and horizontal alignment of the trench.
- Welding - Welding will be done using conventional manual/ semi-automatic welding involving a crew of welders and fitters. Once the pipe is strung a line-up crew will position the pipe using side booms in preparation for welding. Pipe strings to be welded will be effectively earthed. During welding, at least one end of the pipe string will be closed to prevent a forced draught effect.
- Non-Destructive Inspection - Mechanized Ultrasonic Testing (MUT) is the specified method to be applied for the execution of NDT. Each field weld will be 100% radiographed to test for soundness of the weld in compliance with specifications. NDT and its evaluation shall be performed in accordance with API Standard 1104.
- Coating: After welding at each weld joint, coating of field joints of bare pipes and the repair of coating shall be done by.
- Burial - General burial depth of the pipeline along the route will be with a minimum 1.0 m cover. Burial cover will be compacted to avoid future erosion by all weathers.
- Backfilling - The excavated sub-soil will be returned to the trench. The topsoil, which has been preserved on the side of the ROU, will be spread over the filledup trench. A crown of soil will be kept on top of the trenched portion to allow for future settlement. Backfilling will be managed so that damage from sizable rocks is not used or any other materials that may damage the pipeline.

- Crossings - The method used for the crossing of waterways and other infrastructure facilities will vary from place to place depending on the environmental setting and the geo-technical features of the area. The detail method of various types of crossings is specified below.

Table 2-11: Type of crossings required for various type of infrastructure

S.No	Type of Crossing	Method of Crossing
1	National Highway	Conventional Trenching/ Horizontal Directional Drilling (HDD)
2	State Highway	Conventional Trenching/ HDD
3	Other Roads	Conventional Trenching/ HDD
4	Railway Crossing	HDD
5	Major Lined Canal	HDD
6	Unlined Canal	HDD

Source: PNRGB Notification, 2008

- Restoration - Restoration of the ROU will be conducted progressively following the completion of construction work. This will involve removal of foreign materials such as construction debris and wastes. The ROU will be returned to its original condition by spreading the topsoil over the areas from where it was stripped, so that agricultural activities will be restored. Special focus will be given to restoration of side slopes and beds of natural water body crossings.
- Pipeline warning markers–In the final stages of construction, warning marker posts will be erected indicating the location of the pipeline and the crossing of other pipelines, cables and features. A marker tape will be placed in the trench 500 mm above the pipeline to indicate to future excavators that a pipeline is below and that they are nearing

The major construction activity involved during laying of pipeline are as follows:

- Transport of pipes from the place of availability to stock/lining yard.
- Transporting of pipes from the stock / lining yard to suitable places along the route of the pipeline.
- Application of lining and coating.
- Fabrication of fittings and special lining and coating of the same.
- Excavation and preparation of trenches for the pipes. Topsoil to be kept separately.
- Lowering the pipes into the trench.
- Jointing of pipes inside the trench.
- Welding of pipes.
- Rectification of defects and re-testing
- Finishing the coating and lining at weld joints.
- Back-filling of the trench with topsoil layer.
- Construction of valve chambers and erection of valve.
- Construction of necessary pipe supports, anchor blocks.

- Providing line markers

2.6.1 SITE PREPARATION & LAYING METHODOLOGY

The project is for laying of a Gas pipeline with open trenching. However, for the Portion passing through, train tracks, Canals, ponds bridges will be done by Horizontal Directional Drilling Method (HDD) to reduce the environmental impacts to minimum.

The usual approach to pipeline installation is to dig an open trench, place the pipeline and then bury it. Proposed pipeline is passing through commercial, industrial residential, agricultural areas, water bodies, public spaces etc. shall be laid by:

1. Horizontal Directional Drilling (HDD) method for pipeline.
2. Open cut method for remaining portion of pipeline.

Horizontal Directional Drilling (HDD) is a Trench-less methodology that provides an installation alternative that can offer a number of benefits over traditional open-cut method.

• In a sensitive wetland environment such as a river/creek crossing, wildlife habitats would be destroyed, and extensive mitigation efforts would be required while pipe laying by open cut method. As a result, trenchless or "no-dig" technology has been used extensively worldwide.

• HDD can be implemented with very little disruption to surface activities, requires less working space, and may be performed more quickly than open-cut methods.

• 8” Nominal bore & 4” Nominal bore pipelines Steel Pipelines laid together by HDD methodology and remaining length of CRZ portion by Open Cut Method.

Open Cut Method is a usual approach to pipeline installation is to dig an open trench, place the pipeline and then bury it.

• Pressure shall be between 16-40 Bar, 3 layers of PE coated steel pipes for the transportation of gas to its delivery centers.

2.6.2 PIPELINE BURIAL

As per the Petroleum and natural gas regulatory board notification 2008, all types of pipes (plastic and steel) and fittings shall be laid underground and shall not be exposed. The buried service lines are provided with a minimum cover of 1.0- 1.5 m. Where it is impractical to provide 1.0 m cover due to physical constraints, additional protective measures such as concrete slabs or high impact resistance plastic sheets shall be installed at least 300 mm above the service line. In no case the depth of cover shall be less than 600mm. For transition from plastic pipe to GI pipe, transition fittings shall be used. Plastic part of transition fitting protruding above ground shall be protected by encasing it with concrete guard.

In case carbon steel section beyond transition fitting is below ground, it shall be protected against corrosion by minimum 400 micron thick 2 packs high build epoxy coating. Above ground service piping shall be Galvanized Iron or copper or carbon steel protected by anti-corrosive coating.

In cases where HDD is used for pipeline burial, plastic or carbon steel, adequate depth of 2-2.5m shall be maintained under if the pipeline is going below from any of the listed features, I.e River/ canal beds, highways, roads, houses and industries.

Table 2-12: Minimum depth of cover for buried steel pipeline

S.No	Location	Minimum Cover (m)
1	Normal/ Rocky Terrain	1.0
2	Minor River/ unlined canal/ nala crossing/ tidal areas/ other water courses	1.5
3	Major River Crossings	2.5
4	Rivers with rocky bed	1.5
5	Lined canals/ drains/ nalahs	1.5
6	Drainage ditches at roadways and railways	1.0
7	Rocky Areas	1.0
8	Cased/ uncased road crossing	1.2
9	Cased railroad crossing	1.7

Source: PNGRB Notification, 2008

2.7 PROJECT REQUIREMENT

2.7.1 LAND

The land required for the project is only for CNG Stations and Tap off points. 60 CNG stations have to be setup for this project and one tap off point. The land for the Tap off point has been bought near to the GAIL Tap off point, as the LPG/CNG will be bought from Gail and converted to CNG and transported further. Vacant land has already been bought with an area of 1.5 Acres. Rest all the required land will be bought in the near future.

2.7.2 MANPOWER RESOURCES

During the construction phase, local skilled and unskilled labour will get temporary employment based on required skill sets. However, as the development will be phase wise, the total number of locals employed at any one time may not be more than 500- 600. Adani, has contracted out the construction work and management of labour to contractors, local skilled and unskilled workers and service providers are preferred in order to boost local employment generation. As far as operation phase is considered, guards will be employed to patrol the pipeline areas, which will be around 20-30 people for this stretch. Skilled workers will be employed for the operation and maintenance. All these will also be contracted out to the subcontractors.

2.7.3 POWER REQUIREMENT

Power requirement will be bet from DG Sets during construction phase of the project.

2.7.4 WATER REQUIREMENT

Water requirement will be minimal for the project associated only with domestic use by the workers during construction and office staff during constructions and operations period at the distribution centers. The water requirement for construction phase will be contracted out to private tankers. During the operation phase, water requirement will only be at the CNG stations.

2.7.5 EMISSION AND DISCHARGES

Fugitive dust shall be the main air pollutant, from the small diesel engines used for the construction works & movement of vehicles for which dust suppression system will be used as relevant points. No effluent will be generated during operation of the proposed project.

3 ENVIRONMENTAL DESCRIPTION

3.1 STUDY AREA

This chapter summarises the available baseline data on physical and biological resources within the principal area of interest i.e. the project area that would comprise of project components and associated facilities. Key existing sources of information used for this section comprises of government departments, analysis of available research papers and secondary data review from established sources such as Indian Meteorological Department, etc. Reconnaissance visits and physical, social and biological field surveys were carried out in January 2020 to supplement the existing baseline data.

The scope of environmental assessment, existing features of the project and proposed improvement, methodology and regulations applicable to environmental assessment is highlighted in the previous sections. In this chapter, an attempt has been made to prepare a baseline environmental setting to meet out the applicability of Government of India (GoI) regulatory requirements. Considering the existing environmental scenario, potential impacts of road improvement will be identified and accordingly management plan will be proposed in forthcoming sections. The baseline environmental conditions will help in comparing and to monitor the predicted negative and positive impacts resulting from the project during construction and operation phases.

The area falling within 10 km radius from the project boundary has been considered as “Study Area” for the purpose of conducting EIA Study. The baseline data generation includes site visits, ecological surveys, social surveys and interviews, and secondary data review from established sources such as Indian Meteorological Department, Census of India.

The details pertaining to both the project taluka and district, from authentic government sources, have been presented where project area / project site specific information was not available in public domain.

3.2 TOPOGRAPHY

Anuppur district lies on the eastern side of Madhya Pradesh while Bilaspir and Korba lies on the northern part of Chhattisgarh. Anuppur and Bilaspur are situated alongside connecting the two states MP and Chhattisgarh.

Anuppur is situated in eastern corner of Madhya Pradesh. It came into existence on 15th August 2003, by reorganization of Shahdol district. The Anuppur is one of the tribal district of Madhya Pradesh. Anuppur is also famous for Amarkantak hill and pilgrim station, where from two important rivers namely, Narmada and the son originates. District Anuppur is surrounded by Shahdol district in north, Umariya and Dindori districts in west and south-west, Bilaspur and Korea districts of Chhattishgarh State in south and east sides. The district lies between North latitude 22º 7' and 23º25' and East longitude 81º10' and 82º 10'. It extends for about 86 Km from north to south and 117 Km from east to west. The area of district is 3724 Sq. Km, and it has been divided into four tehsils and blocks. There are 585 villages in the district.

In May 1998 the original **Bilaspur** District was divided into 3 districts namely Bilaspur, Janjgir Champa & Korba. Bilaspur district is located on the northwestern part of the Chhattisgarh state and is bounded by East longitudes 81°29‟02" & 82°27‟44" and by North latitudes 21°42‟40" & 23°06‟58". It covers an area of 8569 sq.km. It is surrounded by Durg and Raipur districts on the south, Kawardha and Mandla districts (Madhya Pradesh) in the west, Koriya district in the north, Korba and Janjgir-Champa districts in the east. Bilaspur is the district headquarters and is 120 km away form the State capital Raipur. It is well connected with State capital by road and railways. National Highway No. 200 passes through the town. It is on the Mumbai- Howrah main railway line. The district is well connected by all weathered roads.For the convenience of administration, the district is divided into 8 no. of tehsils, 10 no. of Community Development blocks & 858 no. of gram panchayats

In the district there are 16 urban centers. The Bilaspur town is managed by Municipal Corporation, Mungeli town is managed by Municipality and rest 14 towns (Baitalpur, Belha, Bodri, Deori, Ghutku, Gaurela, Kota, Lingiyadih, Lormi, Mahmand, Ratanpur, Sirgiti, Pendra and Takhatpur,) are covered by Nagar Panchayats. The urban population constitutes 25.50% of the total population in the district and the Bilaspur town is having a population of 4, 54,000. There are no major industries except one in Belha block. Dolomite is the major mineral mined around Hirri area. Laterites and limestones are used as building materials and are mined at isolated patches.

The **Korba** district covers an area of 7145.44 sq. km. It consists of 717 no of villages. For administrative convenience these villages are grouped into 5 tehsils and 5 development blocks. Korba is the district headquarters. The block head quarters are Korba, Pali, Poudi Uprora, Katghora and Kartala. The district is known mainly for its industrial development and mineral wealth. It is one of the leading Hydro and Thermal electricity producing districts of Chhattisgarh state. Fig.1 shows the location of the district along with the drainage, block head quarters, location of NHS established by CGWB and exploratory wells drilled.

The entire area of the district is drained by River Hasdo except small area in eastern part. The tributaries are Tan, Teti Sondi Charnoi and Aharan Rivers. River Hasdo flows north to south throughout its length in the district and eventually joins the Mahanadi River. The River Mand flows through eastern boundary of Korba district with Raigarh district. The tributaries for Mand River are Bijakera Nala, Chula Nala, Dhuwan Nala Korumsara Nala and Aonra Nala. The drainage pattern is typically dendritic in central and north western part and trellis in eastern part of the district controlled by initial slope. The drainage density is very high in the hilly areas of north and north-west part of the district indicating that the infiltration is low.

3.3 GEOMORPHOLOGY

Anuppur

Anuppur is predominantly hilly and forested district. It is picturesque with certain pockets and belt of Sal and mixed forest. From Geomorphological point of view, the district consists of series of mountain ranges and rivers. It can be divided into three geographical divisions:

1. High land of mountain ranges
2. The central plateau and
3. Low land of valley areas

In general, Anuppur district is characterized by hilly to undulating terrain with altitude ranging between 470 m and 1170 m, above mean sea level. The main high relief features of the area are the Maikal Range and Maikal Plateau (Amarkantak Plateau) in south-east part of the district covered with deccan Trap Basalts. Some denudational hills/ hillocks are at foot hills of Rajendragram plateau. Linear ridges of intrusives (Dolerites) at northern and north-eastern part, and Plateaus in remaining part of the district. The river Son is forming valley in the district.

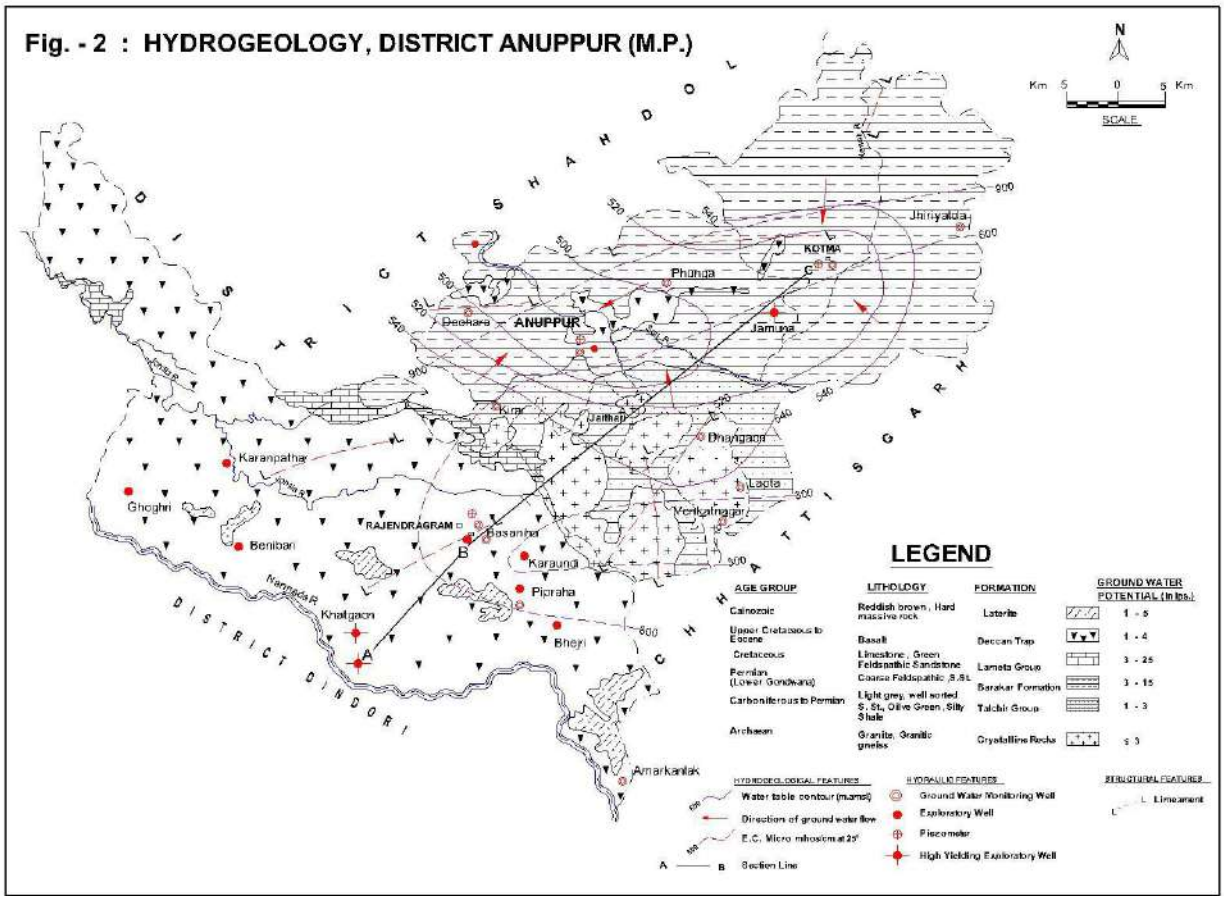
Bilaspur

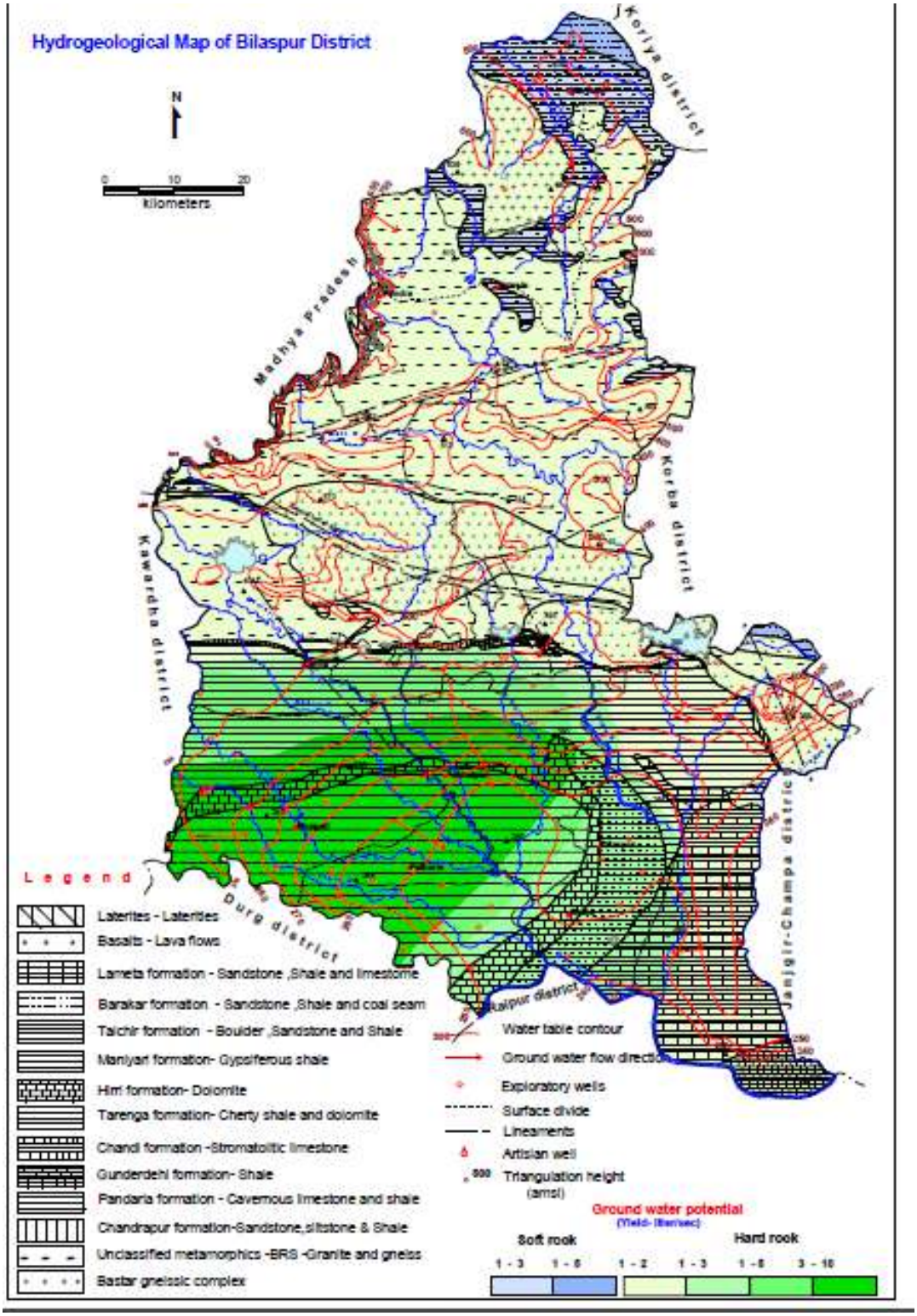
Physiographically the Bilaspur district can be divided into two parts. The first part consists high plateau area covering north and central part of the district (covering Lormi, Kota, Gaurela, Pendra and Marwahi blocks) separated by the intermittent narrow valleys and steeply slopping plains. The second part is the gently slopping plain land covering southern parts of the district (Takhatpur, Mungeli, Pathariya, Belha and Masturi blocks). The high topographic area on the northern part of the district forms water divide between the rivers Ganges and Mahanadi. The hill ranges on the northwestern part is the water divide between Mahanadi and Narmada Rivers. Major part of the Chhattisgarh basin is drained by Mahanadi River. The topography varies between 250 m amsl in the southern plains and 1120 m amsl in the northern hills. The hill ranges on the northwestern boundary of the district forms part of the Amarkantak ranges. The Deccan traps along the western boundary forms high peaks. Basically the hill ranges on

northern part are due to structural activities and the area on southern part (Chhattisgarh plain) can be categorised as pediplain.

Korba

The district is underlain mainly by three distinct geological formations ranging in age from Achaean to recent. The crystalline basement, occupy western and southwestern parts of the district, comprising of granite and granitic gneiss rocks belonging to Chhota Nagpur group, severally intruded by the quartz veins and basic dykes. The rocks of Chhattisgarh Super group are unconformably overlying the basement crystalline and are represented by the sandstone, limestone and shale sequence occupying small area at southern part of the district. The major part of the district is occupied by the rocks of Gondwana of Super Group are overlying the Chhattisgarh Super group and represented by the sandstone, shale and coal seam.




Hydrogeological Map of Bilaspur District
N
0 10 20
kilometers
Korba district
Madhya Pradesh
Kawardha district
Janjgir-Champa district
Durg district
Raipur district
Legend
Laterites - Laterites
Basalts - Lava flows
Lameta formation - Sandstone ,Shale and limestone
Barakar formation - Sandstone ,Shale and coal seam
Talchir formation - Boulder ,Sandstone and Shale
Maniyari formation- Gypsiferous shale
Hirri formation- Dolomite
Tarenga formation- Cherty shale and dolomite
Chandi formation -Stromatolitic limestone
Gunderdehi formation- Shale
Pandaria formation - Cavernous limestone and shale
Chandrapur formation-Sandstone,siltstone & Shale
Unclassified metamorphics -BRS -Granite and gneiss
Bastar gneissic complex
Water table contour
Ground water flow direction
Exploratory wells
Surface divide
Lineaments
Artisian well
Triangulation height (amsl)
Ground water potential
Soft rock
Hard rock
1 - 3
1 - 6
1 - 2
1 - 3
1 - 6
3 - 10

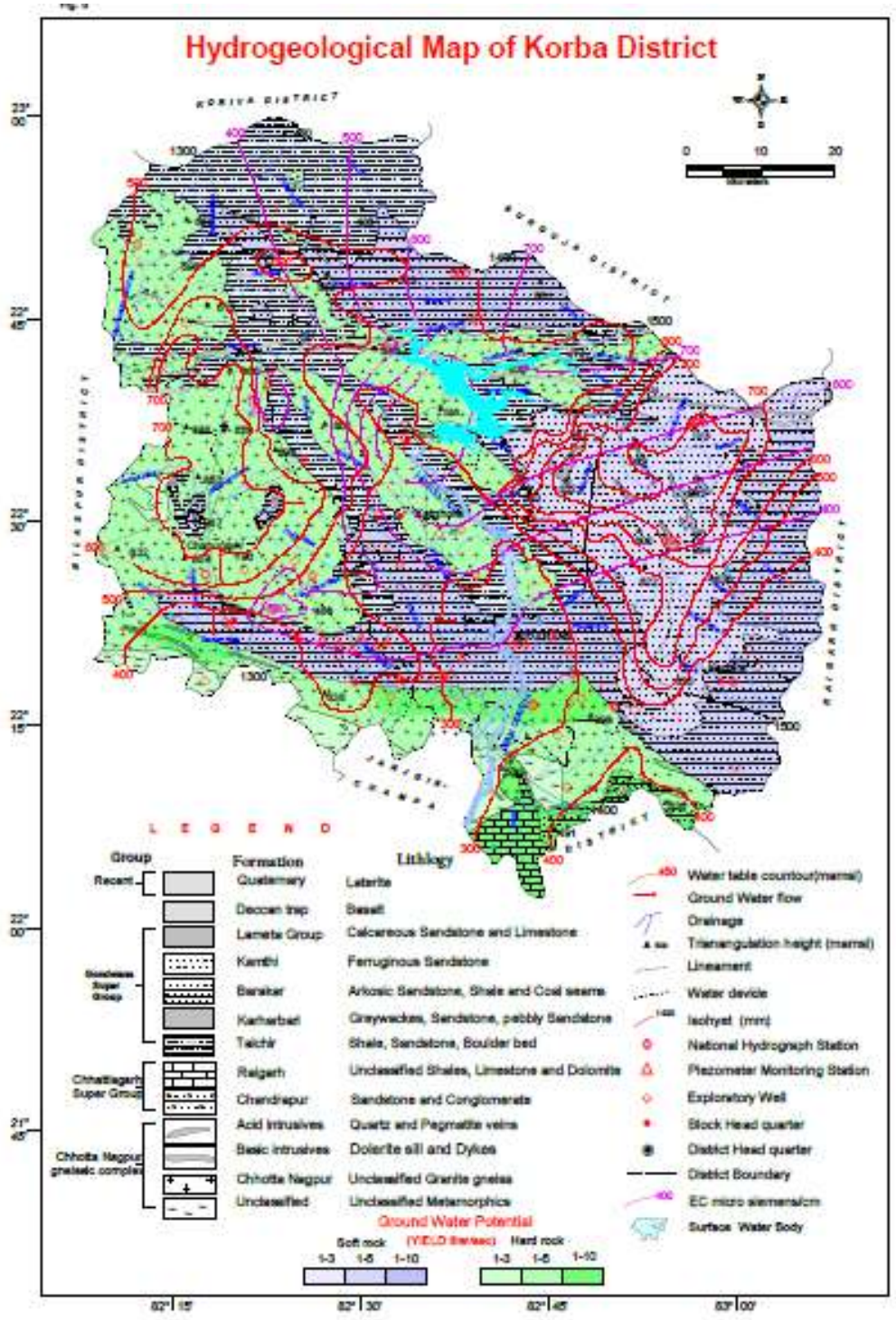


Figure 3-1 : Geomorphology Map of Anuppur, Bilaspur, and Korba Districts

3.4 HYDROGEOLOGY

Anuppur

Anuppur district is underlain by various geological formations, forming different types of aquifers in the area. Main lithological units of the area are, Archaeans, Gondwanas, Lametas and Basalts. Occurrence and movement of ground water in hard rocks is essentially by development and nature of secondary porosity through joints and fractures. Primary porosity in Gondwana rocks and vesicularity in basalts play and important role. Lametas are also potential aquifers made up of relatively loose and friable material. Ground water in general occurs under unconfined to semi-confined conditions.

Bilaspur

Hydrogeologically the district can be categorised into three groups.

i) The Archaean rocks consisting of granites, gneisses, schists, phyllites and quartzites.

ii) Proterozoic sediments belonging to Chhattisgarh Supergroup mainly consisting of limestone, shales and dolomites and

iii) a) Semiconsolidated sediments belonging to Gondwana Supergroup consisting of Barakars sandstones and Talchir shales.

b) The unconsolidated alluvium along the major river courses of Arpa, Maniari, Khurung, Lilagar and Agar.

Archaean Crystallines

The Archaean crystallines and the Proterozoic sediments cover 93% of the area of the district. The ground water in crystallines occurs under water table conditions in the weathered formation and within fractures and fissures below weathered zones. On an average the thickness of the weathered formation in the area is around 15 m with the maximum thickness goes up to 32 m. The occurrence of fractures at depth in the area is not common. Therefore the ground water potential depend on the thickness of the weathered formation in a well. The ground water development in these formations is mostly by way of large diameter dug wells located at favourable places.

Precambrian Sedimentaries

The Precambrain sediments of Chhattisgarh Supergroup are marine in origin and mainly consist of sandstone, limestone, shale and dolomites. The primary porosity and permeability of these formations is very poor. The ground water in these formations occurs under water table, semi confined and confined conditions. The weathered and the cavernous part of the formation and also the fractured zones constitute the aquifers in the area. These formations are most potential in the district and are well developed. The maximum thickness of the weathered formation in the area is around 30 m. The cavernous zones are occurring mostly

in the depth range of 10 to 70 m. The fractures are productive even at depths of 150 to 200 m. Chandrapur sandstone is basically hard and compact in nature and is less potential.

Korba

The district is underlain mainly by three distinct geological formations ranging in age from Achaean to recent. The crystalline basement, occupy western and southwestern parts of the district, comprising of granite and granitic gneiss rocks belonging to Chhota Nagpur group, severally intruded by the quartz veins and basic dykes. The rocks of Chhattisgarh Super group are unconformably overlying the basement crystalline and are represented by the sandstone, limestone and shale sequence occupying small area at southern part of the district. The major part of the district is occupied by the rocks of Gondwana of Super Group are overlying the Chhattisgarh Super group and represented by the sandstone, shale and coal seam.

The ground water mainly occurs in phreatic (water table) conditions and at places under semi-confined conditions. In granites the weathered thickness varies from 18 to 40 m. and the weathered and fractured formation constitutes the aquifers. Invariably the fractures are limited to a depth of 9 to 133 m. In sedimentary formations, mainly in Barakar and Kampti sandstone, primary porosity constitutes the good aquifers. In limestone, the fractures/caverns are limited to a depth of 102-106 m.

3.5 DEPTH TO WATER LEVELS

Anuppur

Central Ground Water Board has been carrying out water level monitoring of Ground Water Monitoring Wells (GWMW), since year 1990 in the district. There are 21 monitoring wells in the district including 5 piezometers. Water levels of these monitoring wells are being monitored four times in a year; Viz during the month of January, May, August and November. To study ground water regime of the area, pre-monsoon and post-monsoon depth to water level maps of the district has been prepared. South-west part of Anuppur district is highly undulating and forest covered. In that area there are no Ground water Monitoring Well for observation and preparation of maps. In general depth to water level is less than 18 mbgl during all seasons.

Bilaspur

As a part of National Hydrograph Network Observation Stations (NHS), 43 no of dug wells and 17 no of piezometers are established to monitor water levels four times in a year i.e. in January, May (Pre-monsoon), August and in November (post-monsoon). The dug well depths are varying from 3.76 to 19.82 mbgl. These monitoring wells are distributed throughout the district covering all the lithological formations.

Korba

The ground water resources for Korba district were estimated based on the GEC 1997 methodology and were projected to the year 2009. The estimates indicate that the annual replenishable ground water resource for the district was 456.15 mcm. . The net annual ground water availability was 424.83 mcm The gross annual draft was estimated as 63.65 mcm, out of which draft for irrigation was 40.34 mcm and for domestic purpose was 23.30 mcm.

3.6 GEOLOGY

Anuppur

The anuppur district is mainly occupied by four types of rocks, namely Basalts, Lametas, Gondwanas and Archaeans. Soils are also depending upon lithology of the area. Hence soils of the area are mainly:Black Cotton, Sandy-Loamy and Clayey-Loamy.

Bilaspur

In the district four types of soil are observed as per US soil taxonomy.

The vertisol are mostly found in south and southeastern parts of the district. Theyrange from grey/red to deep black colour and are almost impermeable when saturated. They are sticky in wet season and are very hard in dry season.

The ultisol types of soil are found in east and northern parts of the district and is red to yellow in colour. This colour is attained mainly due to accumulation of iron oxide, which is highly insoluble in water. Inceptisol soils occupy mostly hill slopes and are found along the western boundary of the district.

Alfisol soils are fertile leached soils found in humid areas where annually dropping leaves form a thick humus layer. These soils cover maximum area in the northern and central parts of the district. In general it can be said that the district is covered by red gravely soils, red sandy soils, lateritic soils, red and yellow soils and black soils.

Soil Classification

US soil taxonomy	Indian equivalents
Vertisol	Deep black soil
	Medium black soil
Ultisol	Lateritic soil
	Red and yellow soil
Inceptisol	Shallow black soil

Alfisol	Red gravelly soil
	Red sandy soil

Korba

The soils in the district are having wide variations. About 83% of the district area, is covered by yellowish to reddish Alfisols, These soils are derived from weathering of crystallines and metamorphic rocks. About 14% area of the district in north and eastern parts is covered by Ultisols in the form of laterites. The remaining part of the district is represented by light grey and shallow black inceptisols, covering small parts of Pondi Upreda blocks. Inceptisols are soils of relatively new origin.

3.6.1 SURFACE WATER

Anuppur

Anuppur district falls under two river basins i.e. the Ganga and the Narmada. Excepting small and narrow belt along the south-west boundary, in Pushprajgarh tehsil, which is drained by the river Narmada, entire Anuppur district forms the part of the Ganga river system. The river Son is an important tributary of the Ganga river. Both the Narmada and the Son originates from Amarkantak hill of Maikal Range (1057 mamsl) at 22º40' N 81º46'E from Anuppur district. The river Narmada flows in west word direction in the district, while the river Son flows from south-east to north-west direction. The important tributaries of Son river in the district are Johila, Gujar Kewai and Tipan rivers. The Samrar nadi is only important tributary of river the Narmada in the district.

Bilaspur

The Mahanadi River drains about 90% of the area in the district and the rest is by the Ganges River. The Major tributaries of Mahanadi are Seonath, Maghdhara, Sukhad, Jaswa, Sagar, Teswa, Agar, Maniari, Chhotinarmada, Gongha, Arpa, Khurung and Lilagar. Son is the major tributary to the Ganges. The Tipan and Alan nalas are the tributaries to the Son River. The northern part of the district is characterised by dendritic pattern and the southern part by trellis (sub-parallel drainage pattern). The drainage density drastically reduces in the plains suggesting the pervious nature of the underlying formations (shale, limestone and dolomite) than the formations on the northern part of the district (granites, gneisses, schists and quartzites).

Korba

The entire area of the district is drained by River Hasdo except small area in eastern part. The tributaries are Tan, Teti Sondi Charnoi and Aharan Rivers. River Hasdo flows north to south through out its length in the district and eventually joins the Mahanadi River. The River Mand flows through eastern boundary of Korba district with Raigarh district. The tributaries for Mand River are Bijakera Nala, Chula Nala, Dhuwan Nala Korumsara Nala and Aonra Nala. The

drainage pattern is typically dendritic in central and north western part and trellis in eastern part of the district controlled by initial slope. The drainage density is very high in the hilly areas of north and north-west part of the district indicating that the infiltration is low.

3.6.2 GROUND WATER

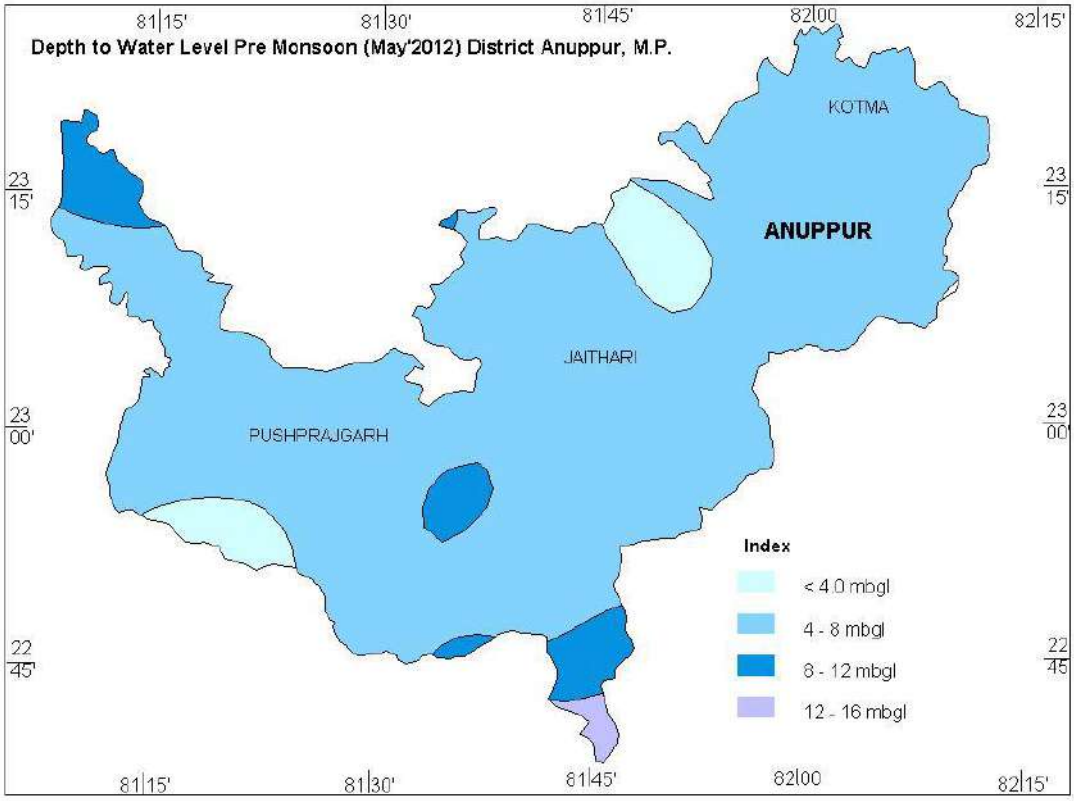
Anuppur

Ground water resource estimation of Anuppur district has been computed for Base Year-2009, on block wise basis. Entire Blocks of this district are falling under non-command category, as there are no major irrigation projects in the district, and medium irrigation project is not irrigating the area to its designed capacity.

All blocks of the district are categorized as safe blocks, and highest stage of ground water development is computed as 10 % for Jaitahri Block. The net ground water availability in the district is 37,730 ham and ground water draft for all uses is 2,250 ham, making stage of ground water development 6 % (8 % in 2003/04) as a whole for district . After making allocation for future domestic and industrial supply for next 25 years, balance available ground water for future irrigation would be 35,352 ham at 50 % stage of ground water development's safe limits in the district.

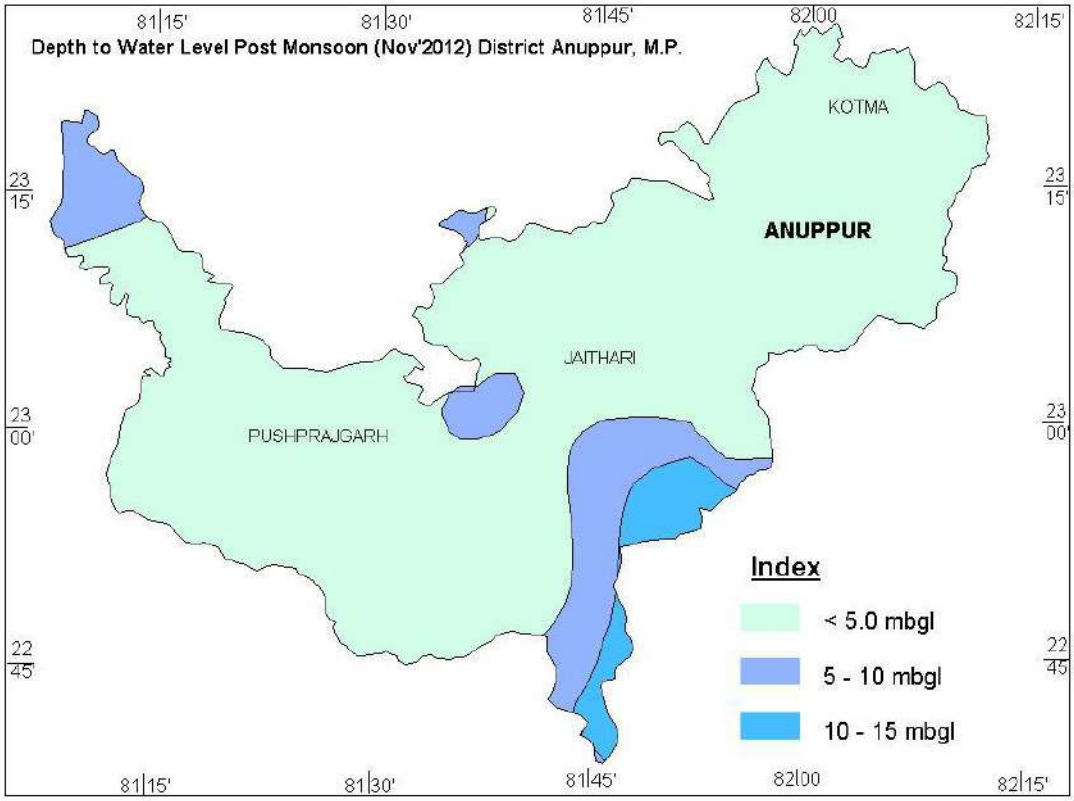
Pre-monsoon (May 2012) :

The depth to water level map for premonsoon period (May 2012) is prepared and is presented as figure 3. A perusal of the map reveals that the depth to water level ranges from less than 4 mbgl to 16 mbgl. However, in major part the depth to water level ranges from 4 to 8 mbgl. The minimum depth to water level recorded is 3.03 whereas maximum water level recorded is 13.75 mbgl.



Post-monsoon (November 2012) :

The depth to water for post monsoon period is prepared and is presented as figure 4. A perusal of the map reveals that the depth to water level ranges from less than 5 mbgl to 15 mbgl. However in major part the depth to water level is less than 5 mbgl. The minimum water level recorded is 1.66 mbgl whereas maximum water level recorded is 17.86 mbgl.

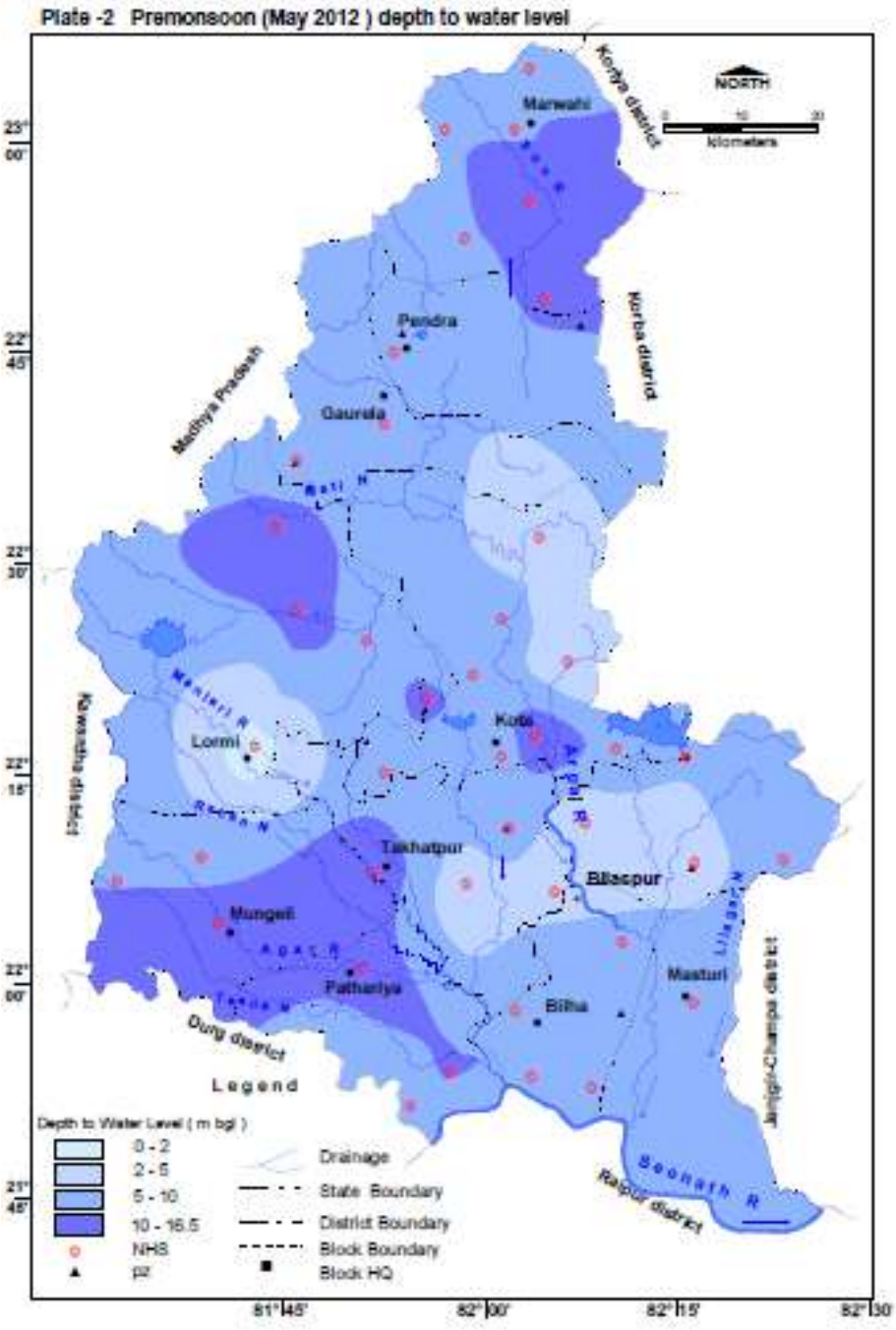


Bilaspur

The total ground water recharge from all the sources is 52353.99 ham. The net available resources after the natural discharge of 2617.17 ham is 49736.28 ham. Existing gross ground water draft for all purposes is 23229.37ham out of which 18419.52ham is for irrigation and 6392.43ham is for domestic and industrial water supply. The stage of the ground water development in the district is 46.71 %. The Belha block (89.19 %) has the highest stage of ground water development followed by the Takhatpur (64.18 %) and the Pendra Road (51.66 %) blocks. Belha has been categorised as semicritical and all other blocks are safe for future groundwater development.

Depth to Water Level- Pre-monsoon (May 2012)

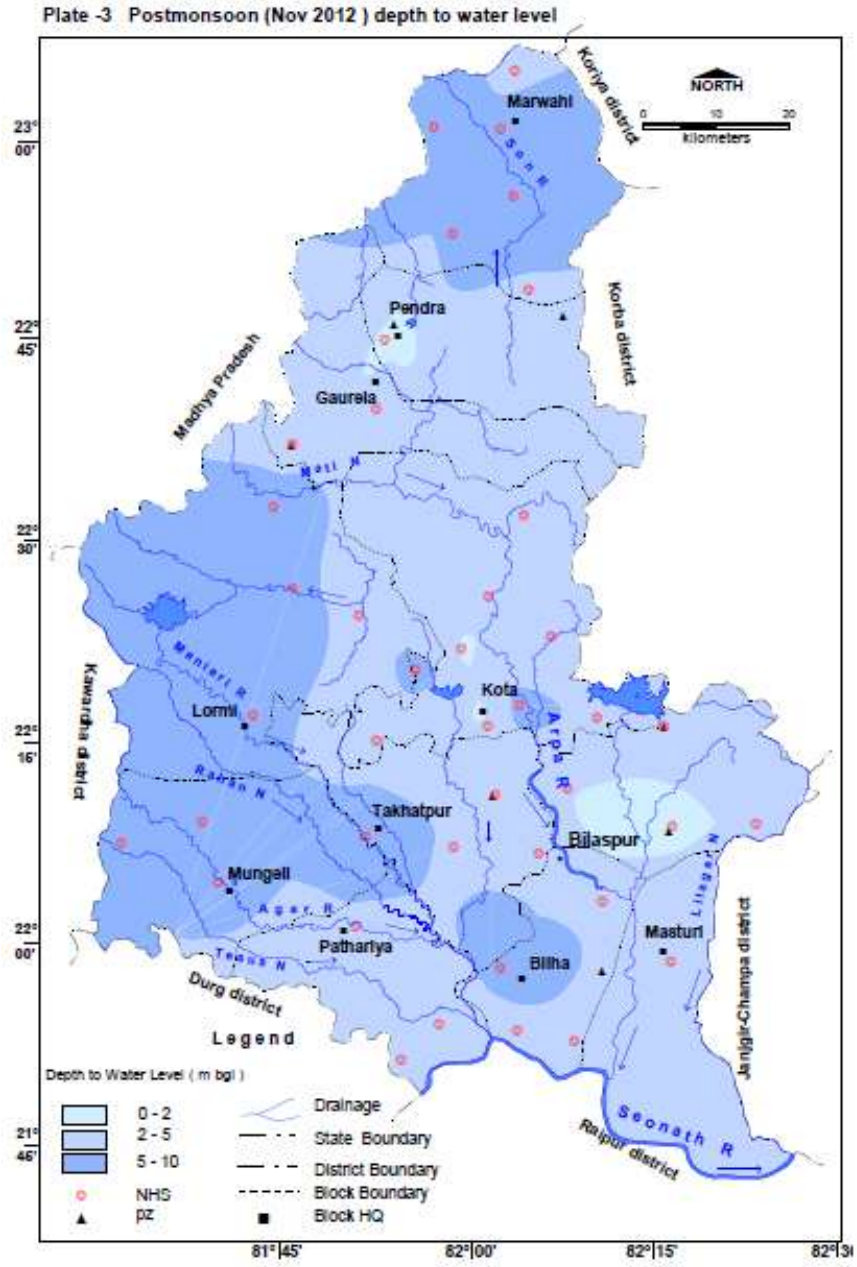
The depth to water (DTW) level observed during pre-monsoon period in the monthof May 2007 is presented in Plate- 2. The average depth to water level in the district during pre-monsoon period is 8.30 m bgl. The water level varies between 5 to 16.5 m in the area. The shallow water levels are observed in the central parts of Takhatpur block and also in Setganga area. The water levels in the range of 10 to 20 m is observed in 28.9 % of cases and covers mostly in the parts of Patharia and Mungeli blocks which are mostly underlain by formations of the Chhattisgarh Supergroup. In Murwahi block the water levels are more than 15 m in a a small part in the district.



Depth to Water Level- Post-monsoon (November 2012)

The depth to water level measured during the post-monsoon period in the month of November 2011 is presented in Plate- 3 The average depth to water level in the district during post-monsoon period is 4.34m bgl. From the figure it is clear that the water levels during the post-

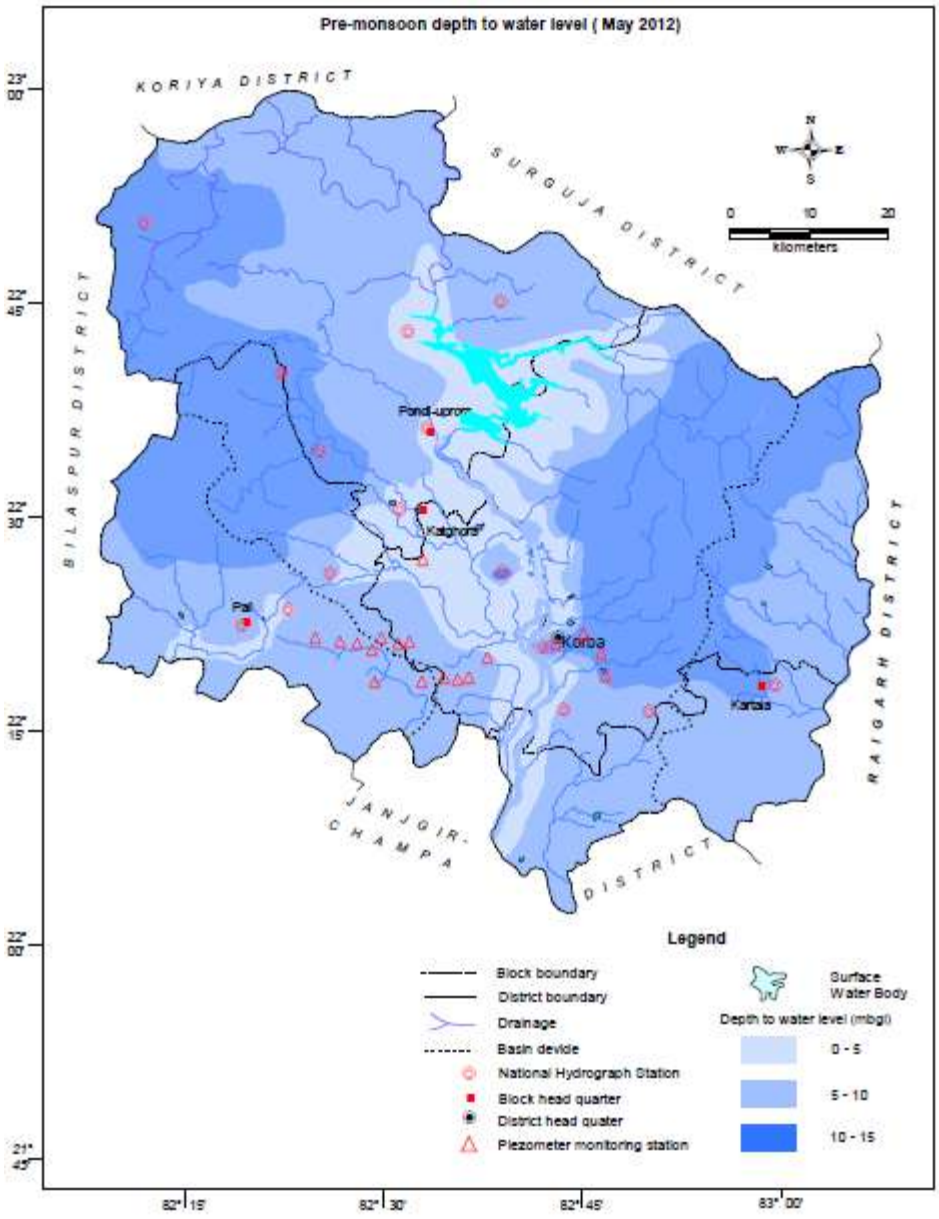
monsoon period are mostly varying from 0 to 5 m. The water levels in the range of 5 to 10 m are observed in Belha, Patharia, Mungeli and Gaurela blocks. The deepest water level is observed at Dhanikundi and is in Barakar sandstone. it is interoperated that nearly in 64% of the cases the water levels are below 5 m.

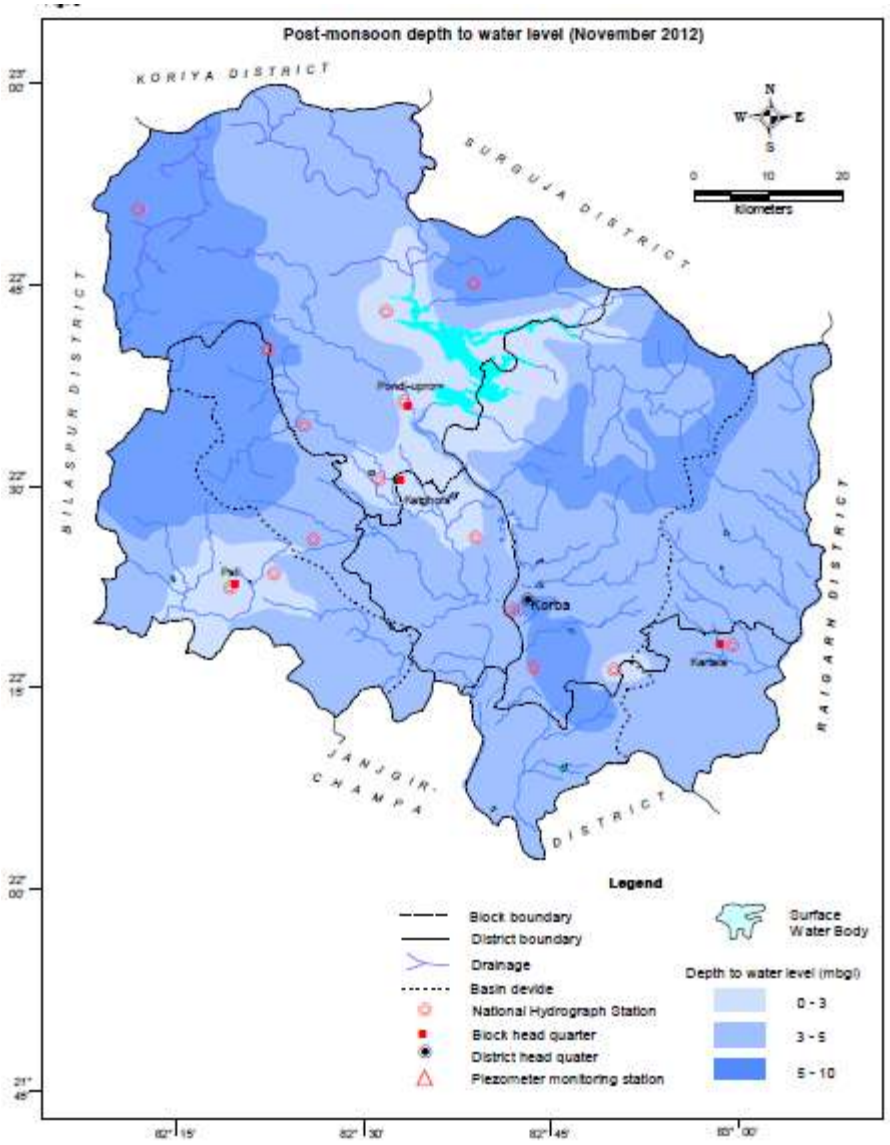


Korba

A major irrigation project, named Minimata hasdeo Bango project is constructed on River Hasdeo, 42 kms away from the district headquarter, Korba and 12 km from Katghora. The main reservoir is spread over an area of 187 sq.kms and the gross catchment area of the reservoir is 6730 sq.kms. The live storage capacity of the reservoir is 3416 mcm and it caters the irrigation requirement of the adjoining districts. A well distributed canal network is spread in Akaltara, Janjgir, Champa, Sakti, Kharsia blocks of the Janjgir Champa district to irrigate 2 lakh 55 thousand hectare agricultural land.

In all, 13 no of observation wells (National Hydrograph Network Stations) and 4 no piezometers were established in the district to monitor water levels 4 times a year and water quality once a year. The pre-monsoon ground water level in the district varies from 3.18 to 13.47 mbgl with average water level of 8.3 mbgl and the post monsoon water level varies from 0.81 to 10.21 mbgl with average water level of 4.5 mbgl. The water level fluctuation varies from 2.5 to 9.36 m with average fluctuation of 4.4 mbgl The water level trend (10 years) for premonsoon period indicates a rising trend in 29% of the stations with no significant rise in any station and a falling trend 71% of stations with significant fall in 2 stations ie: Korba and Salihabhata. The post - monsoon water level trend indicates a rising trend in 29 % of the stations with a significant rise in 1 stations at Pondi and a falling trend in remaining 71% of stations with a significant fall in 1 stations ie: Kartala.


Pre-monsoon depth to water level (May 2012)
KORIYA DISTRICT
SURGUJA DISTRICT
BILASPUR DISTRICT
RAIGARH DISTRICT
JANJGIR-CHAMPA DISTRICT
Pondi-uproni
Katghora
Pali
Korba
Kartala
N
W
E
S
0
10
20
kilometers
Legend
Block boundary
District boundary
Drainage
Basin devide
National Hydrograph Station
Block head quarter
District head quater
Piezometer monitoring station
Surface Water Body
Depth to water level (mbgl)
0 - 5
5 - 10
10 - 15
22° 00'
22° 15'
22° 30'
22° 45'
21° 45'
82° 15'
82° 30'
82° 45'
83° 00'



Summarized block wise estimate of dynamic groundwater resources is given in Table 3-1.

Table 3-1: Ground Water Potential of the Districts

Block	Net Annual Ground Water Availability, mcm	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground Water Draft for domestic & Industrial Supply	Existing Gross Ground Water Draft for all uses	Provision for domestic & industrial requirement supply for next 25 years	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development	Category
Anupur	37730	1039	1211	2250	1540	35152	6 %	Safe
Bilaspur	49736.28	18419.52	4809.85	23229.37	6392.43	24924.33	46.71	Safe
Korba	424.83	--	--	--	--	--	--	Safe

Source: Groundwater Information Booklet, Anuppur, Bilaspur, and Korba Districts, Odisha

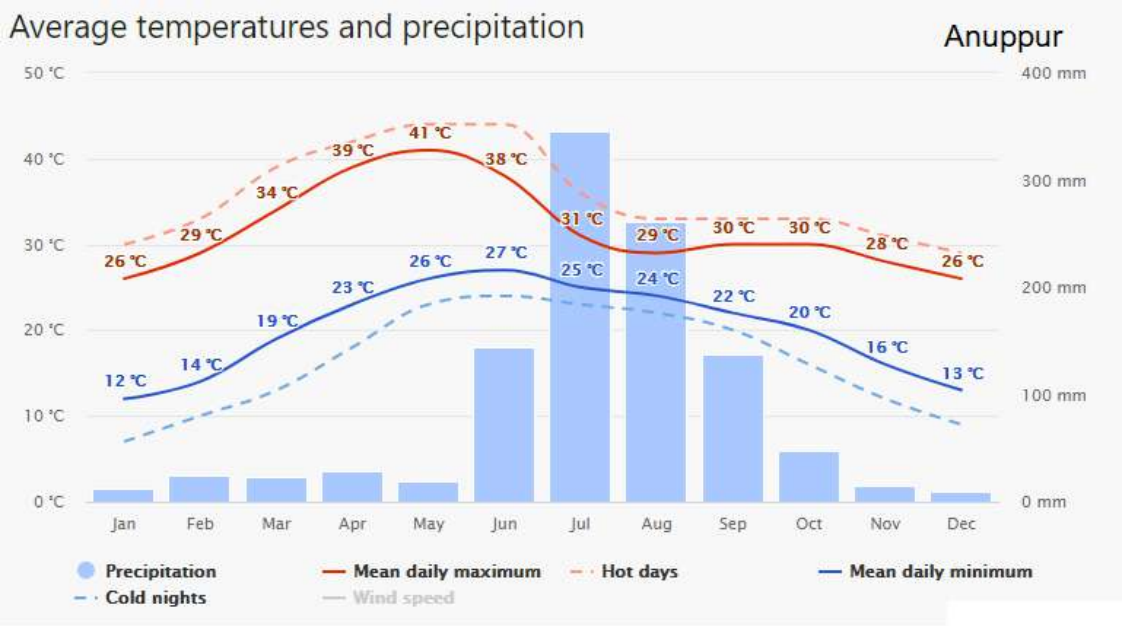
3.7 CLIMATE

Anuppur

The climate of Anuppur district is characterized by a hot summer and general dryness during the south-west monsoon season. The year may be divided into four seasons. The cold season is December to February and followed by the hot season from March to about the middle of June. The period from middle of June to September is the south-west monsoon season. October and November form the post-monsoon or transition period.

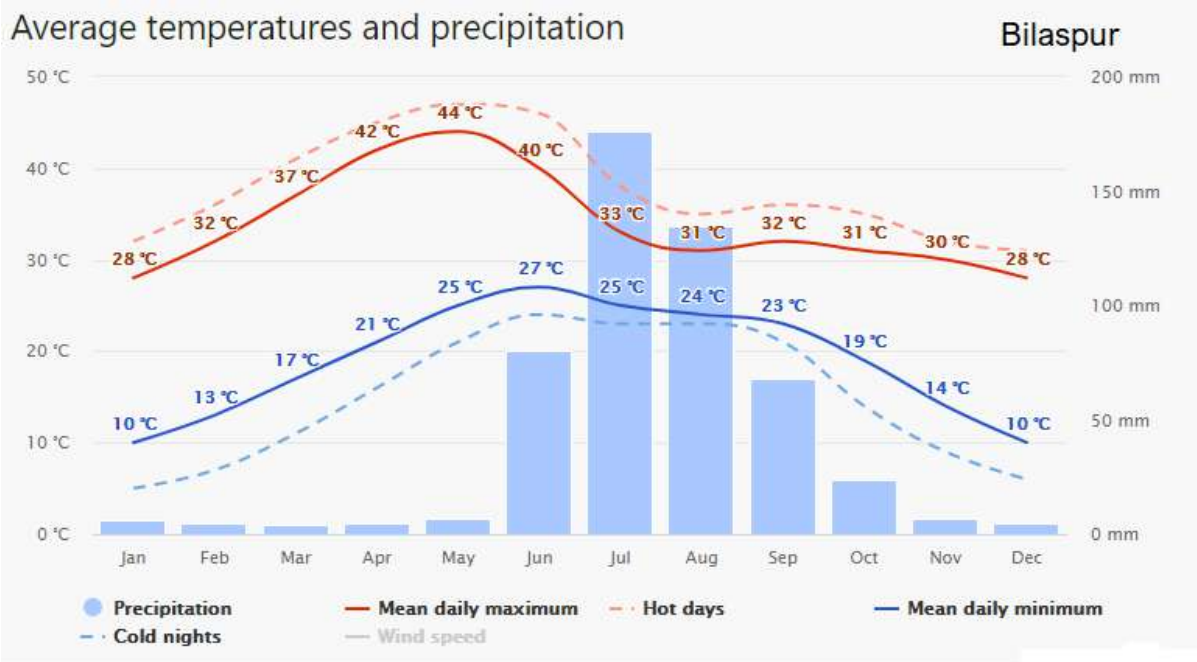
The normal maximum temperature recorded during the month of May is 41.3º C, and minimum during the month of December is 8.4º C. The normal annual means maximum and minimum temperatures of Anuppur district are 31.6º C and 18.2º C respectively.

During the south-west monsoon, the relative humidity generally exceeds 88 % during month of August. Relative humidity decreases during non-monsoon season. In summer season, relative humidity's are less than 38 %. May is the driest month of the year.



Bilaspur

The district experiences a hot and semi-humid climate. The annual temperature varies from 10° C to 45° C. The hottest months are May and June and the minimum temperature is observed in the months of December and January.



Korba

The district experiences Sub-tropical climate characterized by extreme cold in winter and extreme hot in summer.

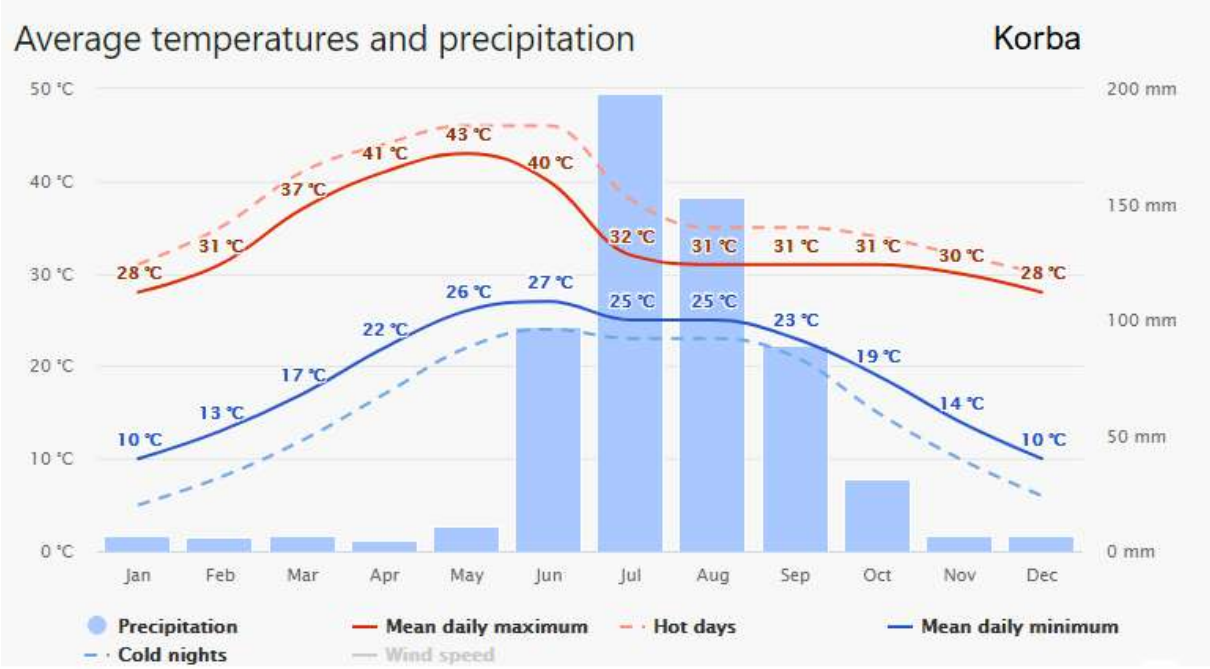


Table 3-2: Temperature details of IMD Odisha (1995 - 2014)

Anuppur

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	17.5	19.6	24.6	29.6	33.4	30.9	26.7	26.2	26.3	24.2	19.8	17.3
Min. Temperature (°C)	10.4	12.1	16.9	22	26.4	26.1	23.6	23.3	22.8	18.6	12.6	9.6
Max. Temperature (°C)	24.6	27.2	32.4	37.2	40.5	35.7	29.9	29.2	29.9	29.8	27.1	25

Bilaspur

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	20.2	22.8	27.3	31.9	35.5	32.6	27.8	27.5	27.7	26.1	22.3	19.9
Min. Temperature	13.3	15.5	19.8	24.6	28.6	27.4	24.7	24.6	24.3	21.2	15.6	12.8

(°C)												
Max. Temperature (°C)	27.1	30.2	34.8	39.3	42.5	37.8	31	30.5	31.2	31.1	29	27.1

Korba

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	19.8	22.5	26.8	31.7	35.2	32.7	27.9	27.5	27.7	26	21.9	19.8
Min. Temperature (°C)	12.9	15.1	19.2	24.2	28.2	27.4	24.7	24.6	24.3	21.2	15.2	12.6
Max. Temperature (°C)	26.7	30	34.5	39.2	42.3	38	31.1	30.5	31.1	30.9	28.6	27

Source: Climatological Normals (1981-2010)

3.7.1 RAINFALL

Anuppur

The normal annual rainfall of the district is 1235.0 mm. The district receives maximum rainfall during south-west monsoon period from June to September. About 89.3 % of annual rainfall is receieved during monsoon season. Only 10.7 % of the annual rainfall occurs during non-monsoon period, from October to May. Thus maximum water available for ground water recharge is during south-west monsoon season.

Bilaspur

The Bilaspur district receives rainfall mainly from the southwest monsoon. It sets in 3rd / 4th week of June and continues till mid-August/ September with heaviest showers in the months of July and August. The average annual rainfall for the district is around 1082 mm (1992-2011). The months of July and August are the heaviest rainfall months and nearly 95% of the annual rainfall is received during June to September months. The rainfall is unevenly distributed in different tehsils and also the amount of rainfall varies from year to year.

Korba

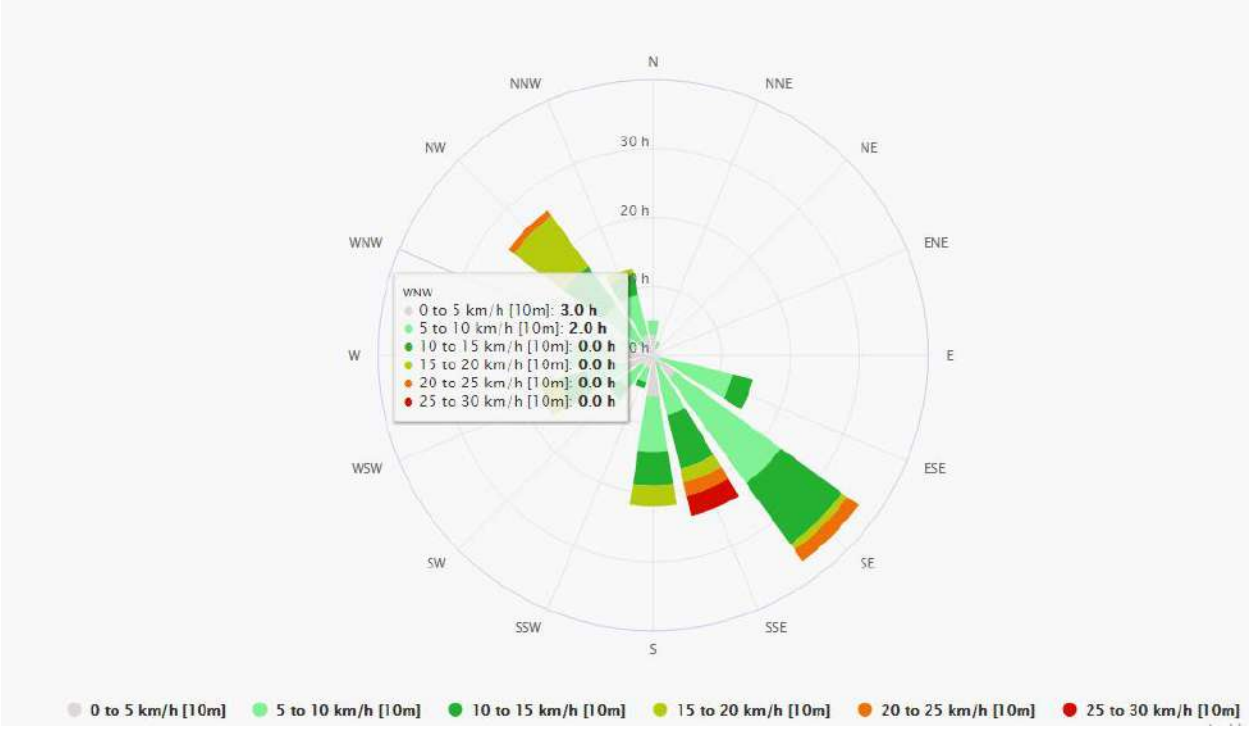
The normal annual rainfall for the district is 1506.7 mm. with 50-65rainy days. The annual temperature varies from 10oC in winter to 46oC in summer. The relative humidity varies from 82 % in rainy season to 35-40 % during winter.

3.7.2 WIND

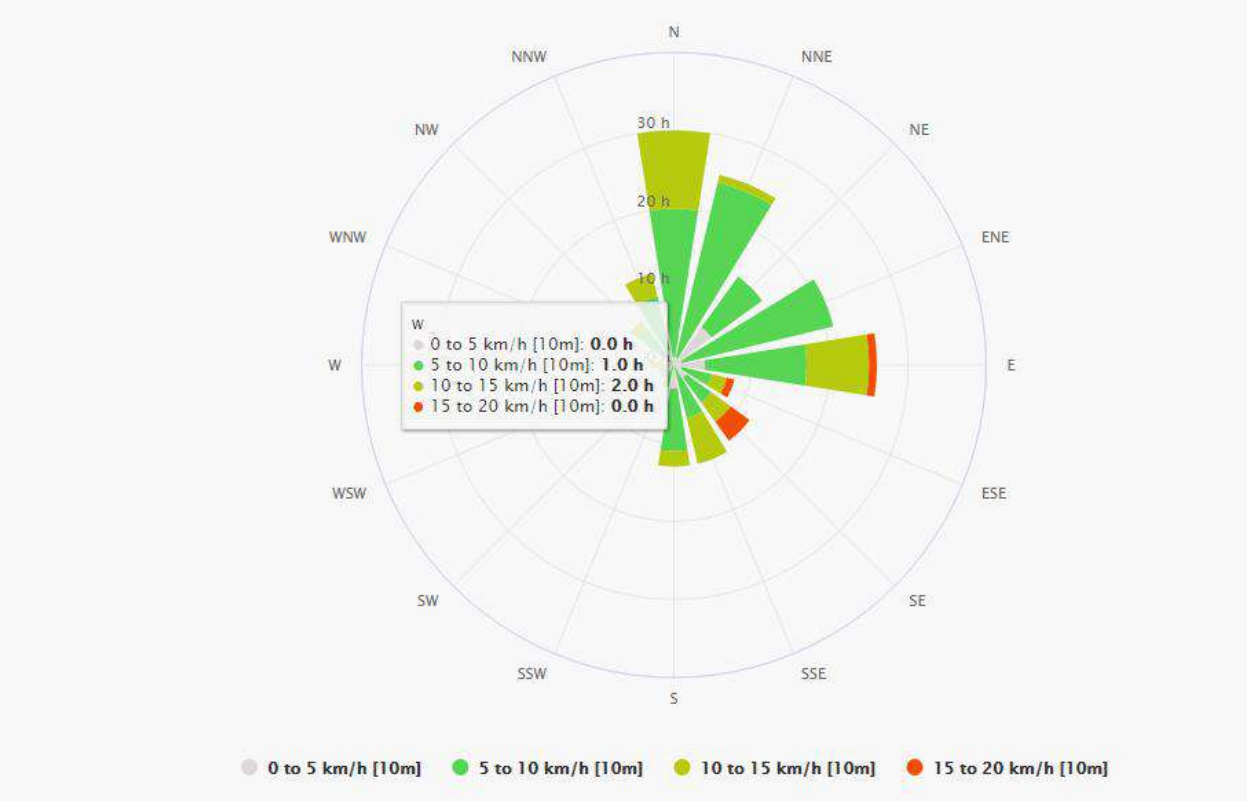
Anuppur

The wind velocity in the area is higher, during pre-monsoon period as compared to post-monsoon season. The maximum wind velocity 6.8 Km/hr is observed during the month of June and minimum 2.3 Km/hr is recorded during month of November. The average normal annual wind velocity of Anuppur district is 4.3 Km/hr.

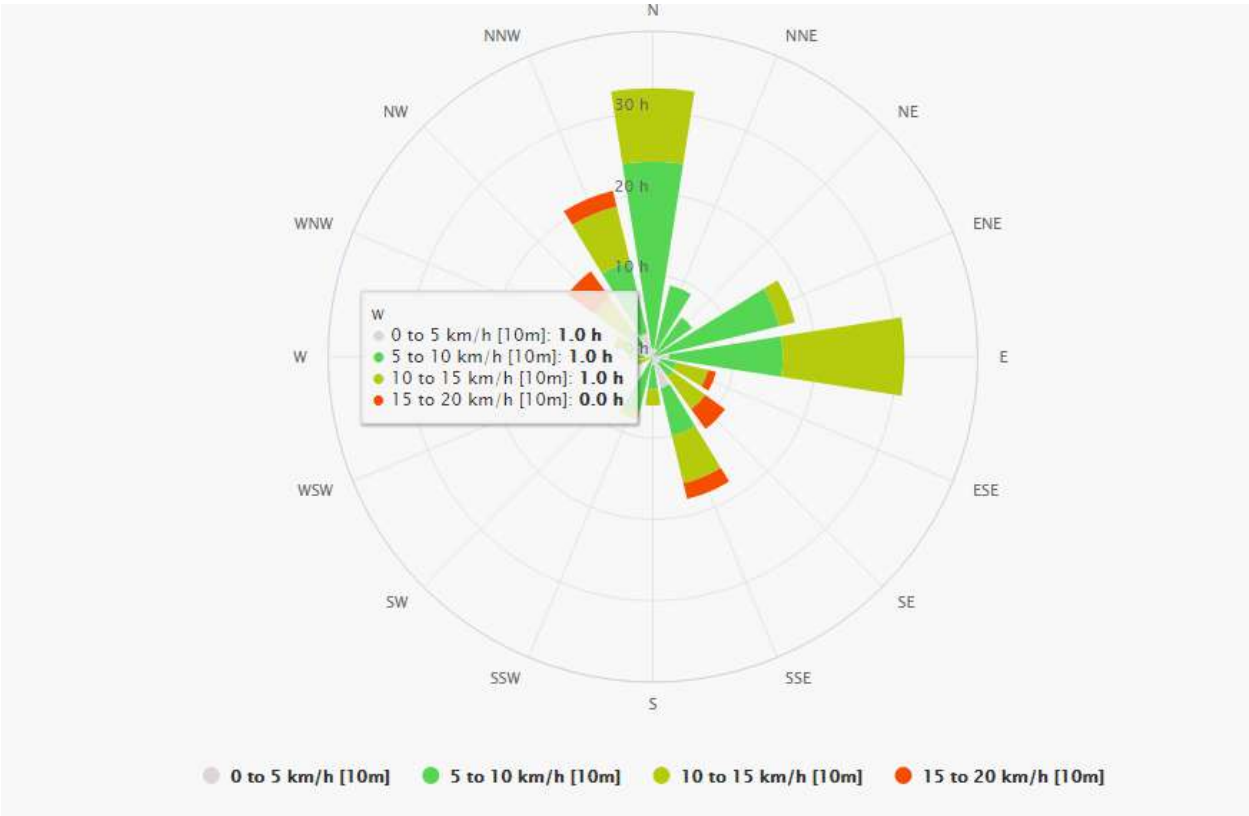
Wind Rose Diagram of Anuppur



Wind Rose Diagram of Bilaspur

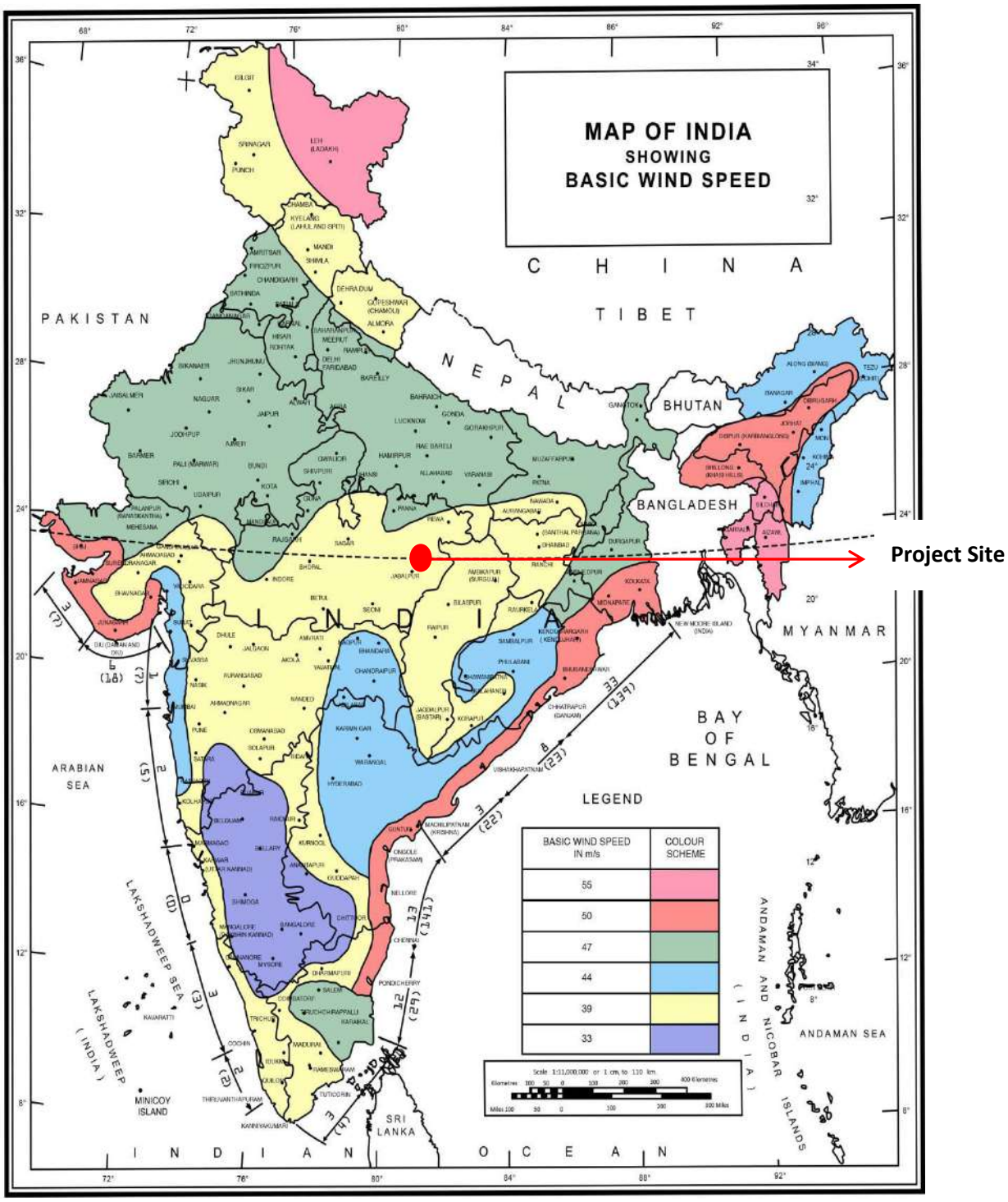


Wind Rose Diagram of Korba



Source: Climatological Normals (1981-2010)

Figure 3-2: Wind Hazard Map showing Project Site



Source: Climatological Normals (1981-2010)

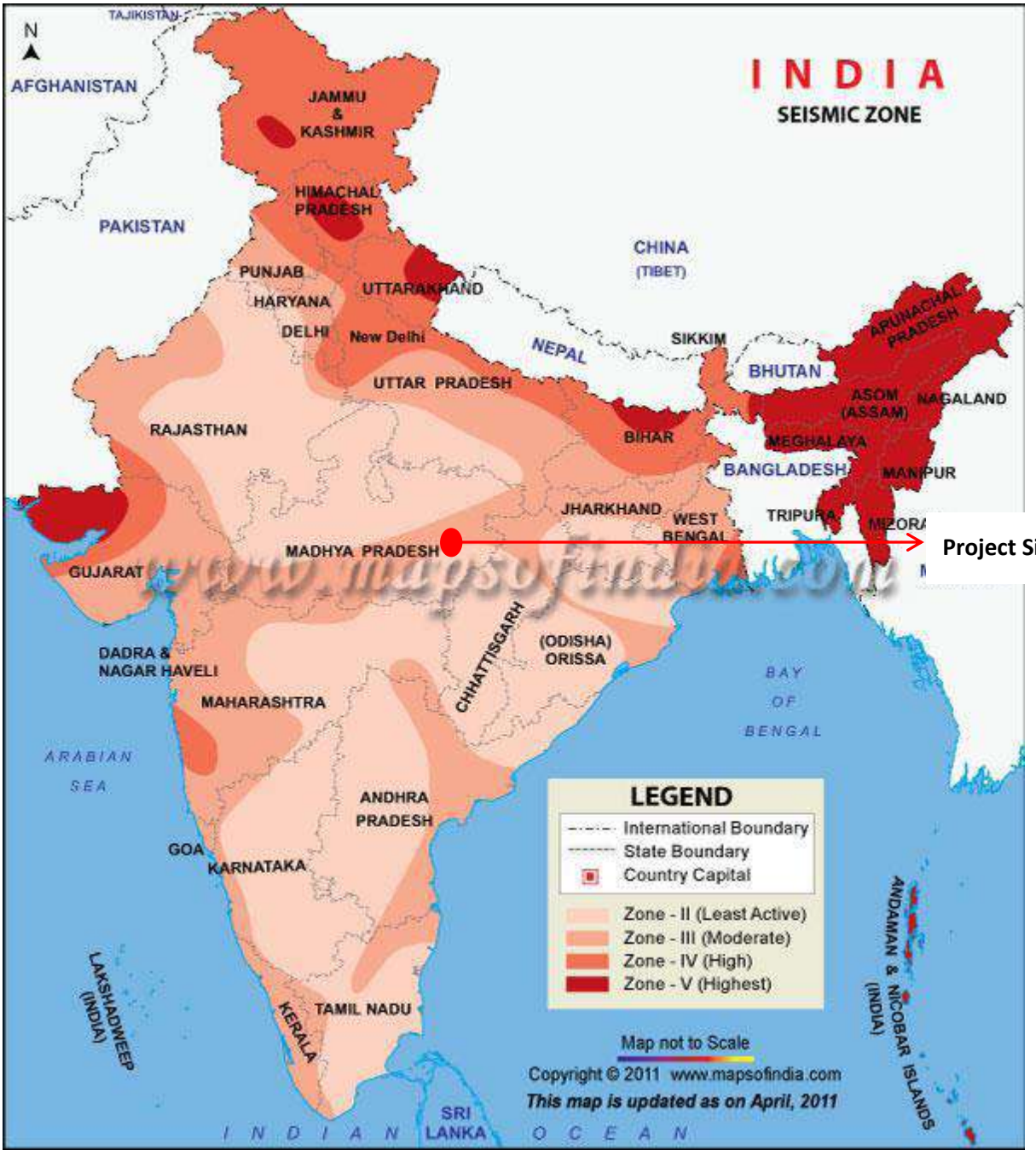
3.7.3 NATURAL HAZARDS

Natural hazards are naturally occurring physical phenomena caused either by rapid or slow onset events which can be geophysical (earthquakes, landslides, tsunamis and volcanic activity), hydrological (floods), climatological (droughts, etc.), meteorological (cyclones and storms/wave surges) or biological (disease epidemics and insect/animal plagues). Natural hazards can have impacts on the developments; hence assessment of the natural hazards in the area is important for any development.

Seismicity

As per the seismic zoning map of India (given in the earthquake resistant design code of India [IS:1893, Part 1, 2002], the project site area falls in seismic Zone II, i.e the least active seismic zone. The IS code assigns zone factor of 0.16 for Zone II. The project under the Anuppur, Bilaspur, and Korba Districts of MP and Chhattisgarh hence lies in seismic zone II (Least Damage Risk Zone (MSK VI) as shown in Figure 3-7 below.

Figure 3-3: Geological Map of India with Seismic Zonation showing Project Site



Source: Map of India, Secondary Research, TUV SUD

3.8 AMBIENT AIR QUALITY

Ambient Air Quality Monitoring (AAQM) was carried out from 5th -8th February 2020 at a frequency of once a week at 3 locations by a NABL and MoEF&CC accredited laboratory. The air samples were analysed as per standard method specified by Central Pollution Control Board (CPCB), IS: 5184, and American Public Health Association. The monitored parameters, sampling frequency, code of practice and methods of measurement are given in **Table 3-3** below.

Table 3-3: Monitored Parameter, Sampling Frequency, Code of Practice and Method of Measurement

Sr. No.	Parameter	Sampling Frequency	Code of Practice	Method of Measurement
1.	Particulate Matter (PM10)	24 hours once a week	IS-5182 (PART-23):2006 & CPCB Guidelines	Gravimetric
2.	Particulate Matter (PM2.5)			
3.	Sulphur Dioxide (SO_2)	24 hours once a week	IS-5182 (Part-II):2001 & CPCB Guidelines	Improved West and Geake
4.	Oxides of Nitrogen (NOx)	24 hours once a week	IS-5182 (Part-VI): 2006 & CPCB Guidelines	Modified Jacob & Hochheiser (Na-Arsenite)
5.	Carbon Monoxide (CO)	8 hourly for 24 hours once a week	IS: 5182 (Part-X) & CPCB Guidelines	Non Dispersive Infra-Red (NDIR) spectroscopy

Table 3-4: Details of Ambient Air Quality Stations

Sr. No.	Monitoring Location	Geographical Coordinates	Location
1	AAQM1	23°08'11.3"N 81°41'51.4"E	Civil Lines, Anuppur
2	AAQM2	22°03'52.5"N 82°10'44.9"E	Railway Colony Bilaspur
3	AAQM3	22°19'49.0"N 82°42'44.1"E	Sitamani, Korba

Table 3-5: Ambient Air Quality Monitoring Results

Parameter	Unit		AAQ1	AAQ2	AAQ2
PM_{10}	µg/m^3	NAAQS (24 hrs)	100	100	100
		Minimum	30.4	41.3	45.2
		Maximum	33.5	43.5	49.5
		Average	31.95	42.4	47.35

		98 Percentile	33.44	43.46	49.41
$PM_{2.5}$	µg/m^3	NAAQS (24 hrs)	60	60	60
		Minimum	22.1	25.6	25.9
		Maximum	24.2	27.1	30.1
		Average	23.15	26.35	28
		98 Percentile	24.16	27.07	30.02
SO_2	µg/m^3	NAAQS (24 hrs)	80	80	80
		Minimum	17	22.1	23.1
		Maximum	19.2	25.1	24.5
		Average	18.1	23.6	23.8
		98 Percentile	19.16	25.04	24.47
NOx	µg/m^3	NAAQS (24 hrs)	80	80	80
		Minimum	7.2	11.4	15.6
		Maximum	9.5	14.3	17.5
		Average	8.35	12.85	16.55
		98 Percentile	9.45	14.24	17.46
CO	mg/m^3	NAAQS (8 hrs)	2	2	2
		Minimum	<1.5	<1.5	<1.5
		Maximum	<1.5	<1.5	<1.5
		Average	<1.5	<1.5	<1.5
		98 Percentile	<1.5	<1.5	<1.5

NAAQS: Revised National Ambient Air Quality Standards dated 18th November 2009
ND: Not Detectable

Particulate Matter (PM_{10})

The Particulate Matter (**$PM_{2.5}$**) concentrations varied from 30.4 µg/m3 to 49.5 µg/m3 in all the three monitoring locations. The highest concentration of 49.5µg/m^3 was observed at Korba location and the lowest concentration of 30.4µg/m3 was observed at Anuppur. However, the **$PM_{2.5}$**concentrations at all the monitoring locations was found to be below permissible limits of CPCB.

Particulate Matter ($PM_{2.5}$)

The Particulate Matter ($PM_{2.5}$) concentrations varied from 30.1 µg/m^3 to 22.1 µg/m^3 in all the three monitoring locations. The lowest concentration 22.1 µg/m^{3}was observed at Anuppur while the highest and lowest concentration 30.1 µg/m^3 was observed at Korba location. However, the **$PM_{2.5}$** concentrations at all the monitoring locations were found to be below permissible limits of CPCB.

Sulphur Dioxide (SO_2)

The Sulphur Dioxide (SO_2) concentrations varied from 25.1 µg/m^3 to 17 µg/m^3 in all the three monitoring locations. The highest concentration of 25.1 µg/m^3 was observed at Bilaspur location and the lowest concentration of 17 µg/m3 was observed at Anuppur. However, the SO_2 concentrations at all the monitoring locations were found to be below permissible limits of CPCB.

Oxides of Nitrogen (NOx)

The concentrations of oxides of Nitrogen (NOx) concentrations varied from 17.2 µg/m^3 to 7.2 \µg/m^3 in three monitoring locations. The highest concentration of 17.2 µg/m^3 was observed at Korba location and the lowest concentration of 7.2 µg/m3 was observed at Anupur. The local Traffic and Vehicle Movement one of the main sources to produce the Nox compounds. However, the NOx concentrations at all the monitoring locations were found to be below permissible limits of CPCB.

Carbon Monoxide (CO)

The Carbon monoxide (CO) concentrations at all locations were found to be below 1.5 mg/m^3 at all locations.

Inferences:

The ambient air quality observed in the area is good as all the parameters observed are considerably below National Ambient Air Quality Standards (NAAQS). The site and surrounding is predominantly rural with no identified major sources of pollution in the area. The movement of traffic was also observed to be limited in the area.

3.9 WATER QUALITY

Anuppur

Ground water quality of the district is accessed annually by CGWB on the basis of water samples collected from Ground Water Monitoring Wells. Electric conductivity varies between 105 to 755 µs/cm at 25º C. The concentration of fluoride is within permissible limits, fluoride ranges between 0.01 mg/l to 1.3 mg/l. The concentration of Nitrate ranges between 0.2 mg/l to 56 mg/l.

However water samples collected from CGWB piezometers located at Anuppur and Kotma are having nitrate concentration 125 and 52 mg/l respectively, which is in excess to permissible limits of 45 mg/l. Excessive nitrate content in ground water system, may be because of seepage from sewage waste or due to high uses of nitrate fertilizers.

Bilaspur

The quality of the ground water in the phreatic zone is suitable for domestic, agriculture and industrial purposes. However higher value of nitrate is found at few places. Ground water in the district is mostly calcium bicarbonate type. The value of electrical conductivity (EC) in the phreatic zone ranges from as low as 101 micro-siemens/ cm to 1133 microsiemens/ cm. Parts

of the Takhatpur, Patharia and Mungeli blocks have high values of SO4 in the ground water in the deeper zones due to the presence of gypsum veins in the underlying Maniari sahle. The Ec value in the deeper zones is found to be as high as 2300 micro-siemens/cm. The range of EC shows that the water has a very less residence time.

Korba

The water analysis shows that the major ions are as per BIS standard and the ground water in the district is suitable for all purposes.

The plot of Piper tri linear diagram and US salinity diagram indicates that the ground water in the district is suitable for drinking, irrigation and all other purposes. The EC values particularly in granitic terrain range between 298 to 785 micro siemens/cm at 25oC. and the pH values range between 7.7 and 8.1. In sedimentary rocks the EC values ranges between 300 and 685 micro siemens /cm at 25°C and the pH values ranges between 7.9 and 8.1. The overall composition of ground water indicates that it is moderately alkaline and predominantly CaHCO3 type (Calcium bicarbonate type).

3.9.1 GROUND WATER QUALITY MONITORING & ANALYSIS

Two groundwater sample and two surface water sample were collected to evaluate the water quality in the study area. Details of the sampling locations are given in the Table 3-6 and 3-7 below.

Table 3-6: Ground Water Quality Sampling Locations

S.No.	Monitoring Location	Geographical Coordinates	Distance and Direction
1	GW1	23°08'11.3"N 81°41'51.4"E	Civil Lines, Anuppur
2	GW2	22°05'00.3"N 82°11'39.2"E	Mopka Bilaspur
3	GW2	22°19'49.0"N 82°42'44.1"E	Sitamani, Korba

The ground water sample was analyzed for parameters as mentioned in IS: 10500:2012 standards and the analysis was undertaken as per IS 10500 and relevant American Public Health Association (APHA) standard methods. The results of the analysis are presented in **Table 3-7** below.

Table 3-7: Results of Ground Water Quality Analysis

Sr. No.	Parameter	IS: 10500 (Drinking Water Standards), 2012*	Unit	Ground Water		
				GW-1	**GW-2**	**GW-3**
1	Color	--	Hazen	2	3	3
2	Electrical Conductivity	--	uS /cm	2150.0	1876.0	264.0

3	Turbidity	1 (5)	NTU	2	4	4
4	pH	6.5-8.5	-	7.9	7.7	7.4
5	TDS	500 (2000)	mg/l	1398.0	1219.0	172.0
6	Total hardness	200 (600)	mg/l	548.8	495.5	73.2
7	Alkalinity	200 (600)	mg/l	405.0	387.5	122.0
8	Chlorides	200 (600)	mg/l	438.0	355.0	7.3
9	Sulphate	200 (400)	mg/l	30.0	26.5	3.5
10	Fluoride	1 (1.5)	mg/l	0.8	0.7	0.2
11	Boron	0.5 (1)	mg/l	0.25	0.18	0.06
12	Manganese	0.01 (0.03)	mg/l	38.6	30.5	6.5
13	Residual Chlorine	0.2 (1)	mg/l	<0.2	<0.2	<0.2
14	Calcium	75 (200)	mg/l	156.0	148.0	18.6
15	Magnesium	30 (100)	mg/l	38.6	30.5	6.5
16	Iron	0.3	mg/l	0.48	0.26	0.08
17	Cadmium	0.003	mg/l	<0.01	<0.01	<0.01
18	Arsenic	0.001 (0.05)	mg/l	<0.01	<0.01	<0.01
19	Lead	0.01	mg/l	<0.01	<0.01	<0.01
20	Zinc	5 (15)	mg/l	0.62	0.35	0.05
21	Chromium Hexavalent	--	mg/l	<0.05	<0.05	<0.05
22	Copper	0.05 (1.5)	mg/l	<0.01	<0.01	<0.01
23	Selenium	0.01	mg/l	<0.01	<0.01	<0.01
24	Total Coliform	Shall not be detectable in any 100 ml sample	MPN	NIL	NIL	NIL

** Values in () indicate permissible limits*
ND: Not Detected
BDL: Below Detectable Limit

Inferences:

- The pH of groundwater samples is alkaline and is 7.4-7.9
- Electrical Conductivity observed between 264-2150
- The total Coliform content in GW-1 was not detected.

3.9.2 SURFACE WATER QUALITY ANALYSIS

The surface water sample was analyzed for parameters as mentioned in IS: 2296-1982 standards and the analysis was undertaken as per IS 12296 and relevant American Public Health Association (APHA) standard methods. The results of Surface Water Quality analysis are given below in Table 3-8.

Table 3-8: Surface Water Quality Sampling Locations

S. No.	Monitoring Location	Geographical Coordinates	Distance and Direction
1	SW1	23°08'22.8"N 81°41'57.3"E	Sone River Anuupur
2	SW2	22°04'15.9"N 82°11'20.0"E	Chhath Ghat, Arpa River
3	SW3	22°22'10.0"N 82°41'52.6"E	Hasdo River, Korba

Table 3-9: Results of Water Quality Analysis

Sr. No.	Parameter	IS: 2296 (Class C)	Unit	Surface Water		
				SW1	**SW2**	**SW2**
1	Color	300	Hazen	2	1	1
2	Electrical Conductivity	--	uS/cm	330.0	974.0	310.0
3	pH	6.5-8.5	-	7.5	7.6	7.6
4	DO	4	mg/l	5.5	3	5.6
5	BOD (27^0C for 3 days)	3.0	mg/l	<3	9	<3
6	Total Dissolved Solids		mg/l	215.8	635.5	205.0
7	Total hardness	200 (600)	mg/l	91.6	238.5	89.2
8	Alkalinity	200 (600)	mg/l	131.2	280.0	126.5
9	Chlorides	600	mg/l	20.5	126.5	16.2
10	Sulphate	200 (400)	mg/l	7.8	18.5	6.2
11	Fluoride	1.5	mg/l	0.4	0.60	0.4
12	Nitrate (as NO_3^-)	50	mg/l	5.0	15.0	4.0
13	Potassium (as K)		mg/l	12.0	25.0	9.0
14	Sodium (as Na)		mg/l	30.8	103.0	27.5
16	Calcium	75 (200)	mg/l	22.5	64.8	22.5
17	Magnesium	30 (100)	mg/l	8.6	18.6	8.0
18	Cadmium	0.01	mg/l	<0.01	<0.01	<0.01
19	Cyanides	0.05	mg/l	<0.02	<0.02	<0.02
20	Arsenic	0.001 (0.05)	mg/l	<0.01	<0.01	<0.01

21	Chromium (as Cr)		mg/l	<0.05	<0.05	<0.05
22	Copper	0.05 (1.5)	mg/l	<0.01	<0.01	<0.01
23	Selenium	0.01	mg/l	<0.01	<0.01	<0.01
24	Mercury		mg/l	<0.001	<0.001	<0.001
25	Lead		mg/l	<0.01	<0.01	<0.01
26	Aluminium (as Al)			<0.01	<0.01	<0.01
27	Total Coliform	5000	MPN/1000 ml	8	12	9
28	Phenolic Compounds (as C_6H_5OH)	0.005	mg/l	<0.001	<0.001	<0.001
29	Anionic detergents (as MBAS)	1.0	mg/l	<0.01	<0.01	<0.01
30	Oils and grease		mg/l	<1	<1	<1
31	Aluminium (as Al)		mg/l	<0.01	<0.01	<0.01
32	Zinc (as Zn)		mg/l	0.08	0.25	0.08

** Values in () indicate permissible limits*
ND: Not Detected
BDL: Below Detectable Limit

Inferences:

The summary of the analysis of water samples results is as follows:

- pH of SW-1 and SW-2 was observed as around 7.5 and 7.6
- The coliform count was observed in the entire sample as the surface water sample collection was carried out from flowing river which may contained some fecal waste due to open defecation and animal waste. Further, runoff from surface soil area during rainy season might have attributed to fecal contamination of the water bodies. Arpa River in Bilaspur was completely eutrophied.

3.10 SOIL QUALITY

The soil quality is described in section 3.6 under Geology of all the three districts.

Table 3-10: Details of the Soil sampling locations

S.No.	Monitoring Location	Geographical Coordinates	Distance and Direction
1	S1	23°08'11.3"N 81°41'51.4"E	Civil Lines, Anuppur
2	S2	22°03'52.5"N 82°10'44.9"E	Railway Colony Bilaspur

3	S3	22°19'49.0"N 82°42'44.1"E	Sitamani, Korba

The soil samples were analyzed for various physical and chemical parameters of soil and the results of the soil quality analysis are given in Table 3-10 below:

Table 3-11: Results of Soil Quality Analysis

S. No.	Parameter	Unit	S1	S2	S3
1	Soil Type		Sandy Clay	Sandy Clay	Sandy Clay
2	pH	---	7.6	7.2	7.5
3	Electrical Conductivity	µS/cm	350.2	410.5	280.0
4	Potassium (as K)	mg/kg	350.2	428.5	285.6
5	Sodium (as Na)	mg/kg	176.0	154.0	162.5
6	Organic Matter	%	0.71	0.82	0.60
7	Sodium Absorption Ratio	meq/kg	0.54	0.51	0.53
8	Carbonate (as CO_3)	mg/kg	<20.0	<20.0	<20.0
9	Chloride (as Cl-)	mg/kg	162.5	138.2	195.6
10	Phosphorus (as P)	mg/kg	3.2	4.3	6.4
11	Sulphate	mg/kg	65.3	43.5	38.5
12	Bulk Density	gm/cc	1	1	1.2
13	Moisture	%	0.4	0.54	0.4
14	Total N	mg/kg	486.79	556.66	417.66
15	Iron (as Fe)	mg/kg	5671	4562	6651
16	Boron [as B]	mg/kg	62.3	42.6	38.5
17	Copper (as Cu)	mg/kg	11.2	21.3	16.2
18	Zinc (as Zn)	mg/kg	80.5	69.5	50.2

The results of the soil quality analysis were compared with the standard soil classification provided by the Indian Council of Agricultural Research (ICAR) and as given in Table 3-12 below.

Table 3-12: Standard Soil Classification

Soil Parameters	Classification	
pH	Normal to saline	6.0 to 8.5
	Tending to become alkaline	8.5-9.0
	Alkaline	Above 9.0
Electrical conductivity (mmhos/cm)	Up to 1.00 – Normal	
	1.01- 2.00 - Critical to germination	
	2.01-4.00 - Critical for growth of the sensitive crops	
	Above 4.00 – Injurious to most crops	

Source: Indian Council of Agricultural Research, New Delhi

Inference

- pH of the soil samples ranged from 7.6 -7.3 showing normal to saline in nature;
- Electrical conductivity of SW-1 was observed in the level of 280-410 mmhos/cm which indicates low EC values may be good to crops

The pH value indicates of the soil indicating that it is neutral to slightly alkaline in nature. The organic carbon content in the study area observed as 0.35 % to 0.54 %, i.e. the soil falls under average to more than sufficient category. Available potassium was observed as 285.6 kg/ha to 428.5 kg/ha in the study region indicating that the soil falls under average to more than sufficient category. Available nitrogen was observed as 417.66 kg/ha to 626.75 kg/ha. The soil in the study area falls under more than sufficient category of nitrogen. Available phosphorous was observed as 30.66 kg/ha to 43.3 kg/ha in the study region shows that the soil falls under less to medium category.

3.11 NOISE ENVIRONMENT

Primary noise monitoring was carried out for continuous 24 hours at the four (03) identified receptor locations to evaluate the baseline noise levels at the project site. The ambient noise monitoring has been undertaken, taking into consideration factors like wind induced noise and human activities such as movement of vehicles. The baseline ambient noise levels represent the background noise levels that would be present in the absence of the proposed Wind power plant.

Ambient noise level was monitored continuously for 24 hours using Sound Level Meter. Sound pressure levels were recorded at every 10 minutes to calculate the Leq (hourly) values. The relevant statistic measured was the LA90 (10min) (The A-weighted sound pressure level exceeded for 90 % of the 10minute interval). The noise levels obtained were analyzed to arrive at the equivalent continuous noise level (Leq) for day and nighttime. The day and nighttime hours ranged from 06:00 to 22:00 hrs and 22:00 to 06:00 hrs respectively. The noise monitoring locations are given below in Table 3-13.

For noise levels measured over a given period of time it is possible to describe important features of noise using statistical quantities. This is calculated using the percent of the time certain noise levels exceeds the time interval. The notation for the statistical quantities of noise levels is described below:

- Hourly Leq values have been computed by integrating sound level meter.

- Lday: As per the CPCB guidelines the daytime limit is between 06:00 hours to 22.00 hours as outlined in Ministry of Environment and Forest Notification S.O. 123 (E) dated 14/02/2000.
- Lnight: As per the CPCB guidelines the nighttime limit is between 22:00 hours to 06.00 hours as outlined in Ministry of Environment and Forest Notification S.O. 123 (E) dated 14/02/2000.

Table 3-13: Details of Noise Level Monitoring Locations

S.No.	Monitoring Location	Geographical Coordinates	Distance and Direction
1	N1	23°08'11.3"N 81°41'51.4"E	Civil Lines, Anuppur
2	N2	22°03'52.5"N 82°10'44.9"E	Railway Colony Bilaspur
3	N3	22°19'49.0"N 82°42'44.1"E	Sitamani, Korba

It was observed that the baseline noise levels ranged from 50.9-58 dB (A) during daytime and 61.7 to 62.5 dB (A) during nighttime. The noise monitoring analysis results are given in Table 3-14.

Table 3-14: Results of Noise Level Monitoring- Residential Areas

S.No.	Parameters	Unit	N1	N2	N3
1	L10	dB(A)	46.4	47.1	47.4
2	L50	dB(A)	42.8	43.3	43.7
3	L90	dB(A)	39.1	39.8	40.1
4	LEQ	dB(A)	43.7	44.2	44.6
5	Ambient Noise Level- Leq day	dB(A)	44.2	44.8	45.1
6	Ambient Noise Level- Leq Night	dB(A)	41.2	41.8	42.2
7	Day-Night Sound Level (Ldn)	dB(A)	48.2	48.8	49.2

3.12 BIOLOGICAL ENVIRONMENT

3.12.1 FOREST AREA/ RESERVED FOREST/ NATIONAL PARKS & SANCTAURIES

Comparative details between the Project Districts & State forest Cover have been presented in below.

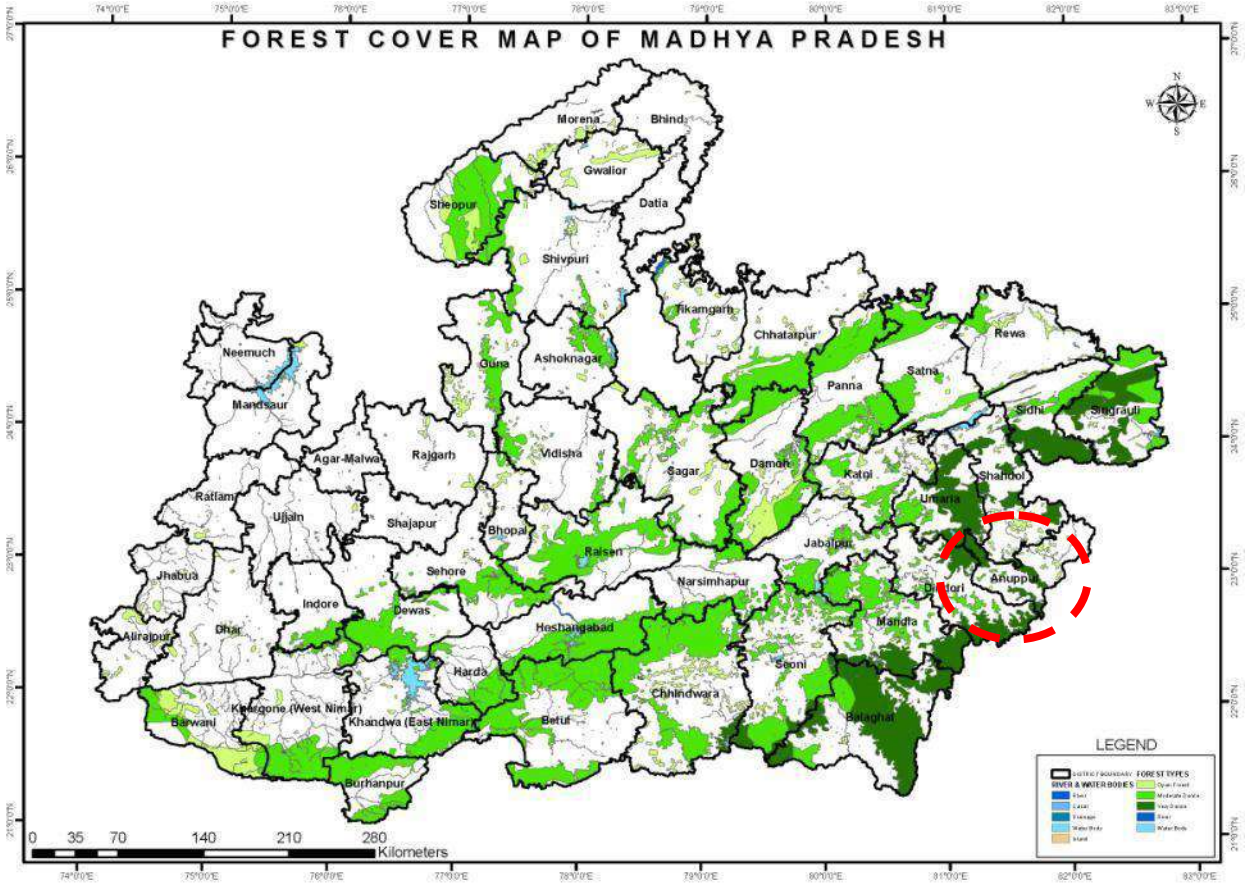
Table 3-15: Forest Cover in Project District and State

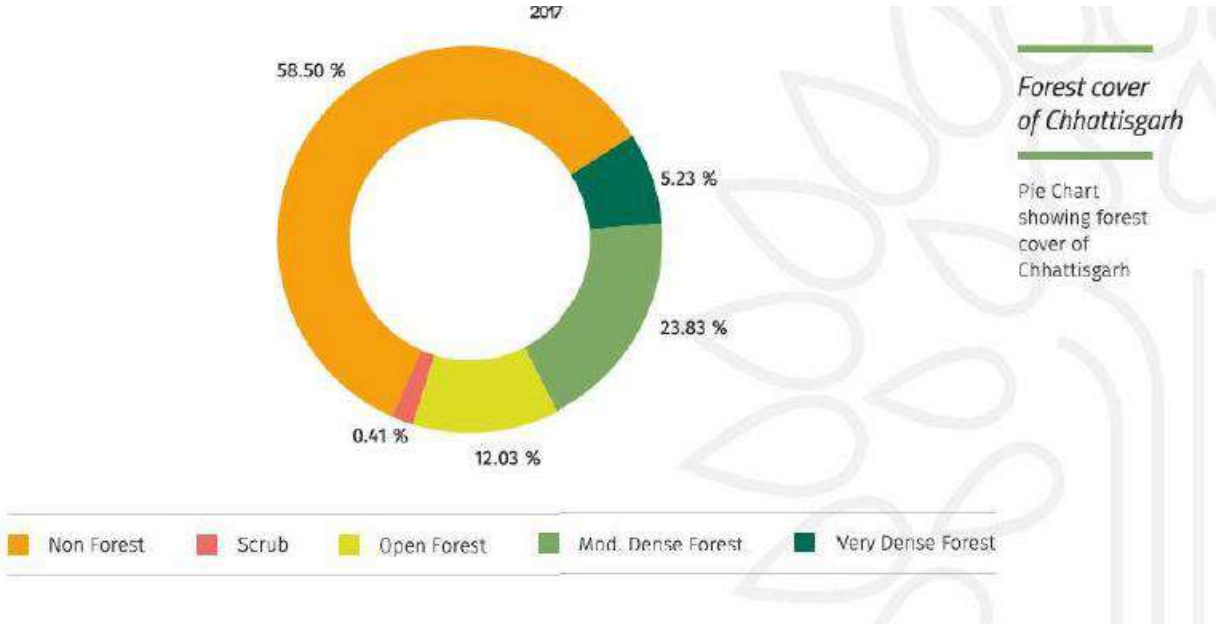
District / State	Area in Km^2					% of Geographical Area
	Geographical Area	**Very Dense Forest**	**Moderately Dense Forest**	**Open Forest**	**Total**	
MP	**3,08,252**	**6,563**	**34,571**	**36,280**	**77,414**	**25.11**
Anuppur	3,182	0	212	463	675	21.21

Chhattisgarh	**1,35,192**	**7,064**	**32,215**	**16,268**	**55,547**	**41.09**
Bilaspur	8,272	395	1,539	522	2,456	29.69
Korba	6,598	203	2,312	875	3,390	51.38

Source: India State of Forest Report, 2017

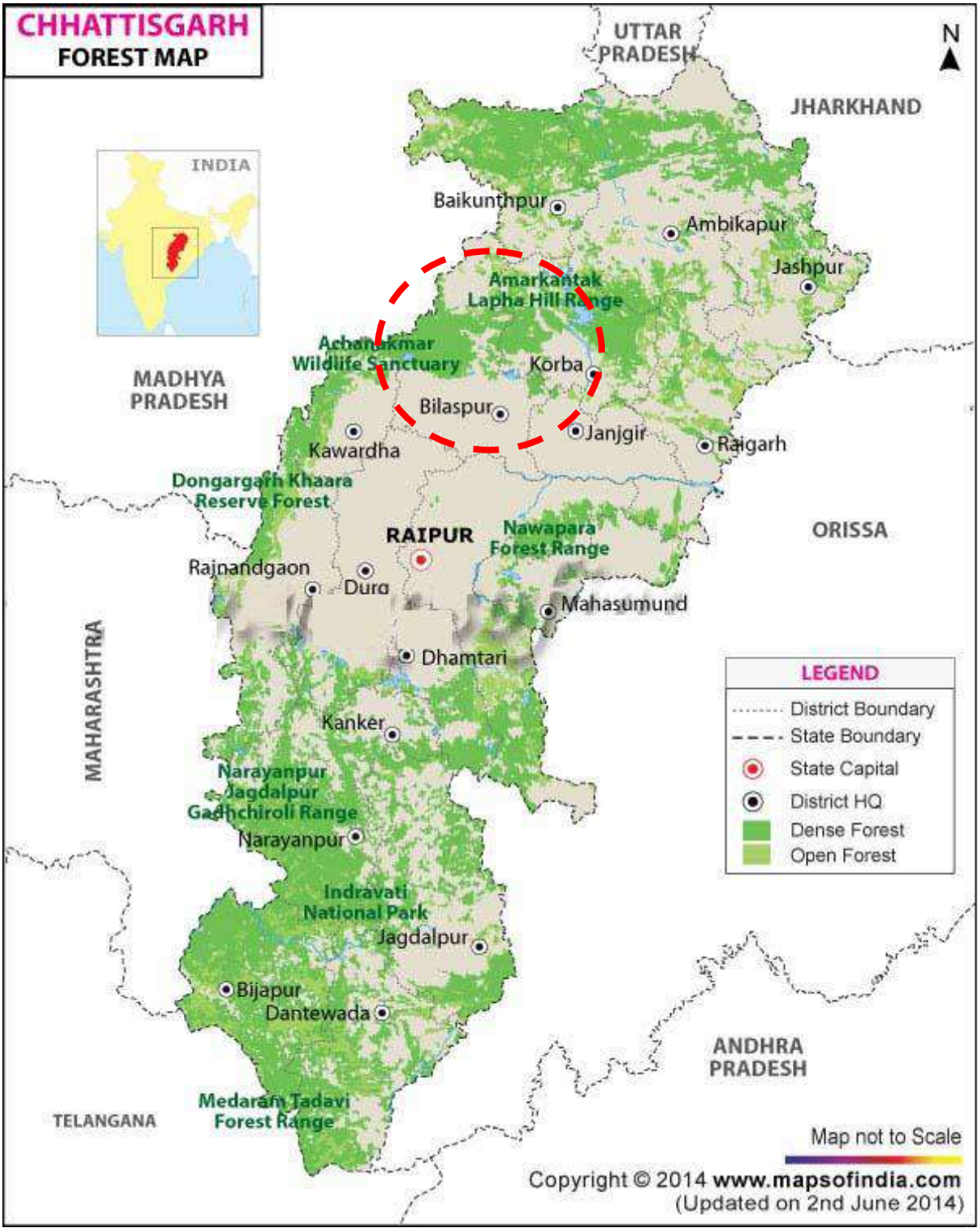
Figure 3-4: Forest Cover Map of Madhya Pradesh and Chhattisgarh State showing project location





Forest cover of Chhattisgarh

Pie Chart showing forest cover of Chhattisgarh


CHHATTISGARH
FOREST MAP
INDIA
UTTAR PRADESH
JHARKHAND
MADHYA PRADESH
ORISSA
MAHARASHTRA
TELANGANA
ANDHRA PRADESH
N
Baikunthpur
Ambikapur
Jashpur
Amarkantak Lapha Hill Range
Achanakmar Wildlife Sanctuary
Korba
Bilaspur
Janjgir
Raigarh
Kawardha
Dongargarh Khaara Reserve Forest
RAIPUR
Nawapara Forest Range
Rajnandgaon
Durg
Mahasumund
Dhamtari
Kanker
Narayanpur Jagdalpur Gadhchiroli Range
Narayanpur
Indravati National Park
Jagdalpur
Bijapur
Dantewada
Medaram Tadavi Forest Range
LEGEND
District Boundary
State Boundary
State Capital
District HQ
Dense Forest
Open Forest
Map not to Scale
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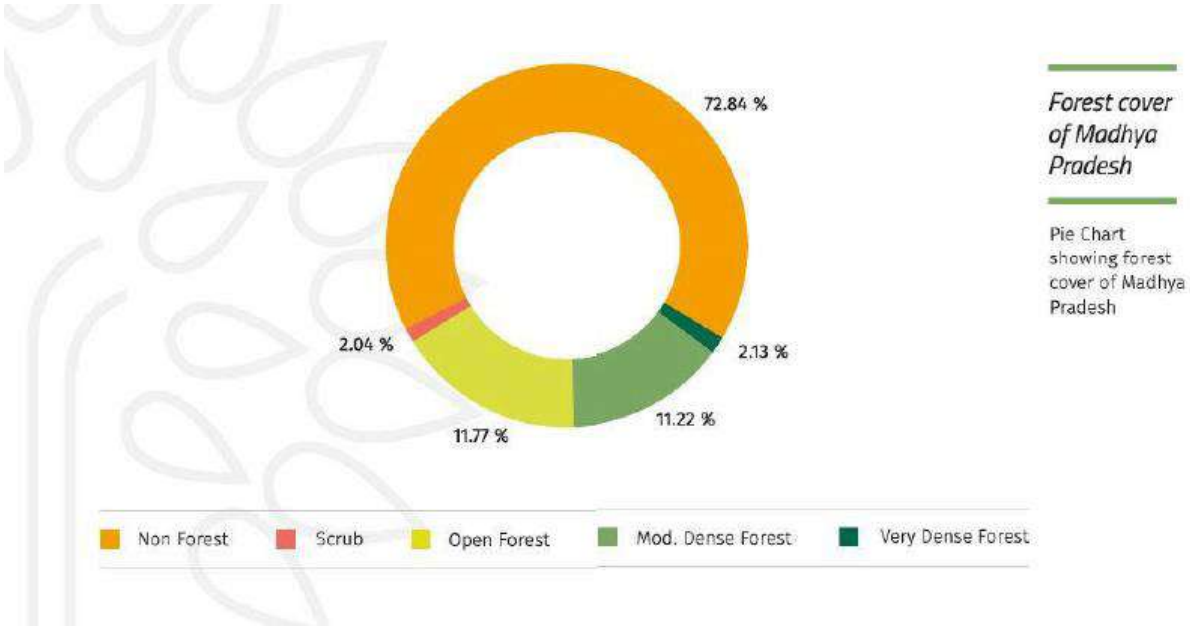
(Updated on 2nd June 2014)



Source: *MP & Chhattisgarh Forest Department*

Ecological studies are one of the important aspects of Environmental and Social Impact Assessment (ESIA) with a view to conserve biodiversity. Ecological systems show complex inter-relationships between biotic and abiotic components including dependence, competition and mutualism. Biotic components comprise of both plant and animal communities, which interact not only within and between themselves but also with the biotic components viz. physical and chemical components of the environment. Generally, biological communities are good indicators of climatic and edaphic factors. Studies on biological aspects of ecosystems are important for safety of flora and fauna. The biological environment includes terrestrial and aquatic ecosystems.

This section of report describes, the methodology adopted for secondary data collection, diversity of higher flora and fauna recorded through primary field studies and the secondary data sourced from published scientific literature, habitat profile and ecosystem services profile and nearest designated areas of the project site.

Review of Secondary Data

The great plant wealth and diversity of Odisha is due to immense variety of climate, altitude and edaphic factors. Vegetation of the state can be broadly divided into four categories.

- Coastal vegetation
- Island vegetation
- Vegetation of the interior plains
- Vegetation of the hills and mountains

Littoral Vegetation

The soil is sea sand often blown and accumulating in low dunes with adequate time, but poor in nitrogen and mineral nutrient. Most of these have been converted into Casuarina plantation. The forest type occurs in reserve forest of Pichavaram, the littoral forests consists of plant species Borasus flabellifer,Anacardium occidentale, Lannia coromandalica, Pandanus tectorius, Opuntia dillenii, Cassia auriculata, Sesuvium portulacastrum, Cyperus arenarius.

Plantation

The division contains plantations of cashes, Eucalyptus sp, Casuarina, Bambusa arundanacea, Prosopis juliflora and other miscellaneous species.

Vegetation of the Interior plains

The vegetation of the plains at the foot or on the undulating slopes of hills and hillocks in the rocky area bordering the coastal plain comes under Southern tropical thorn forests of Champion and Seth (1968). These are often called as Scrub jungles. They are found in Chengalpattu, North and South Arcot, Pudukottai, Tiruchirapalli, Tirunelveli and less so in Salem, Periyar and Coimbatore districts. In these scattered forests, trees hardly reach 10 m in height and area often armed with spines and prickles. Most of the plants manifest several xeromorphic features. The common trees are Acacia chundra, A. horrida, A leucophloe, A nilotica ssp. Indica, Albzia amara, Azadirachta indica, Chloroxylon sweitenia, Dalbergia spinosa, Dichrostachys cineraria, Limonia acidissima, Plecospermum spinarum, Strychnos nux-vomica, Strychnos potatorum, Wrightia tinctoria and Zizyphus spp. The shrubs commonly met with are Cadaba fruticosa, Capparis zeylanica, Carissa congesta, Cassia auriculata, Flacourtia indica, Maytenus emerginata, Pisonia aculeate, Scutia myrtina, Securegenia leucopyrus and Toddalia asiatica. The common climbers are cardiospermum canescens, C.halacacabum, Ceropegia candelabrum, C. juncea, Cissus quadrangularis, C. rependa, Cissampelos pareira var hirsute, Diosoria sp, Leptadenia reticulate, Pergularia daemia and Ventilago madraspatna. During rainy season, a variety of herbaceous plants like Achyranthes aspera, Allamania nodiflora, Apluda mutica, Aristida setacea, Blumea mollis, Cleome angustifolia and species of Cymbopogon, Glinus, Indigofera, Leucas, Mollugo and Oldenlandia are seen.

Tropical thorn forest of Tamilnadu are differentiated into southern thorn forest, Carnatic umbrella thorn forest, Southern Euphorbia scrubs and southern thorn scrubs (Champion and Seth 1968). In southern thorn forest, species of Acacia, Mimosa and Zizyphus are predominantly met with. In Carnatic umbrella thorn forest Acacia planifrons is common. These forests are found in Kanyakumari, Madurai, Ramanathapuram and Tirunelveli.

Southern Euphorbia scrub is full of fleshy euphorbias. Barleria buxifolia, Calotropis gigantea, Euphorbia antiquorum, E.tricalli and Opuntia dillenii are common. Southern thorn scrubs are found in the plains like Chennai and its environs. Sandal bearing scrubs are met within Sirur reserve of Niligiris.

Vegetation of Hills and Mountains

Dry Deciduous forest

These forests are found at about 400 m and above. The canopy is closed. Most of the species are deciduous. The undergrowth is usually dense. The common trees are Albizia amara, A.odorattissima, Anogeissus latifolia, Butea monosperma, Chloroxylon sweitenia, Dalbergia sp, Pterocarpus marsupium, Shorea roxburghii, Strychnos nuxvomica, Terminalia so. The bamoboo, Dendrocalamus stictus is often found. Dodonea viscose, Securinega virosa, Strobilanthes sp are some of the shrubs found in these forests. The common climbers are Combretum madraspatana, Cycas circinalis is occasional. Species of Abutilon, Achyranthes, Aristida, Bulbostylis, Cleome, Cymbopogon, Cyperus Digitaria, Heracleum, Hetropogon, Themeda, Tribulus etc form the ground layer.

South Indian Moist Deciduous forest

This type is below the zone of semi-evergreen forest. The trees reach a height 30-36 m and are deciduous. Bamboos are common. Epiphytes are rare. Bombax ceiba, Dillenia pentagyna, Mitragyna parviflora, Tectona grandis, Terminalia sp, Vitex sp, and Zizyphus xylophorus are the common trees. Cycas circinalis is occasional. Helictris isora, Lantana camara and Zizyphus oenoplia are common shrubs. Common climber is Ipomea sp. Common grass is Imperata sp

Semi-evergreen forest

This type occurs on slopes of hills and mountains usually upto 1000m. Canopy is of 2 or 3 storeys. Epiphytis orchids are present. Climbers and canes are common. Top canopy consists of Artocarpus sp, Dalbergia latifolia, Hopea sp. The second storey consists of species of Actinodaphne, Aglaia, Bischofia, Drypetes and Symplocos. Species of Glycosmis, Ixora, Lasianthus, Leea, Memecylon, Pavetta etc. form the shrubby vegetation. The common climbers are Butea parviflora, Cynanchum tunicatum, Entada pursaetha and species of Calycopteris, Dioscoria, Strychnos etc. Bambusa arundanacea and Ochlandra travencorica are also common.

Primary and Secondary Survey

The primary surveys were undertaken to identify the ecological features of the area with particular reference to identify and quantify any sensitive ecological communities in the study area within 10 km radius of the proposed project. Secondary surveys Literature surveys were conducted to identify Rare, Endangered, Endemic and Threatened species (REET) and/or

habitats within the study area. The reference has been taken from The Wildlife (Protection) Act, 1972 and Red Data Book.

The filed study was undertaken from **5th -7th February 2020** (Two days). The relevant, observations noted in that assessment have been included in the current assessment and referenced accordingly.

National Park/Sanctuary

As per literature survey in various departments of Forest reveal that there are Wildlife sanctuaries or National Parks or Biosphere or Hotspots in 10 km and 25 km radius from the proposed project site. Also, there is a reserve forest patch within which Bilaspur-Marwahi Bypass passes in Bilaspur districts.

Achanakmar Wildlife Sanctuary

The Achanakmar Wildlife Sanctuary is an Indian sanctuary in Mungeli district, Chhattisgarh State. It had been established in 1975, under the provisions of the Indian Wildlife Protection Act of 1972, and declared a Tiger Reserve under Project Tiger, in 2009. It is a part of the Achanakmar-Amarkantak Biosphere Reserve.

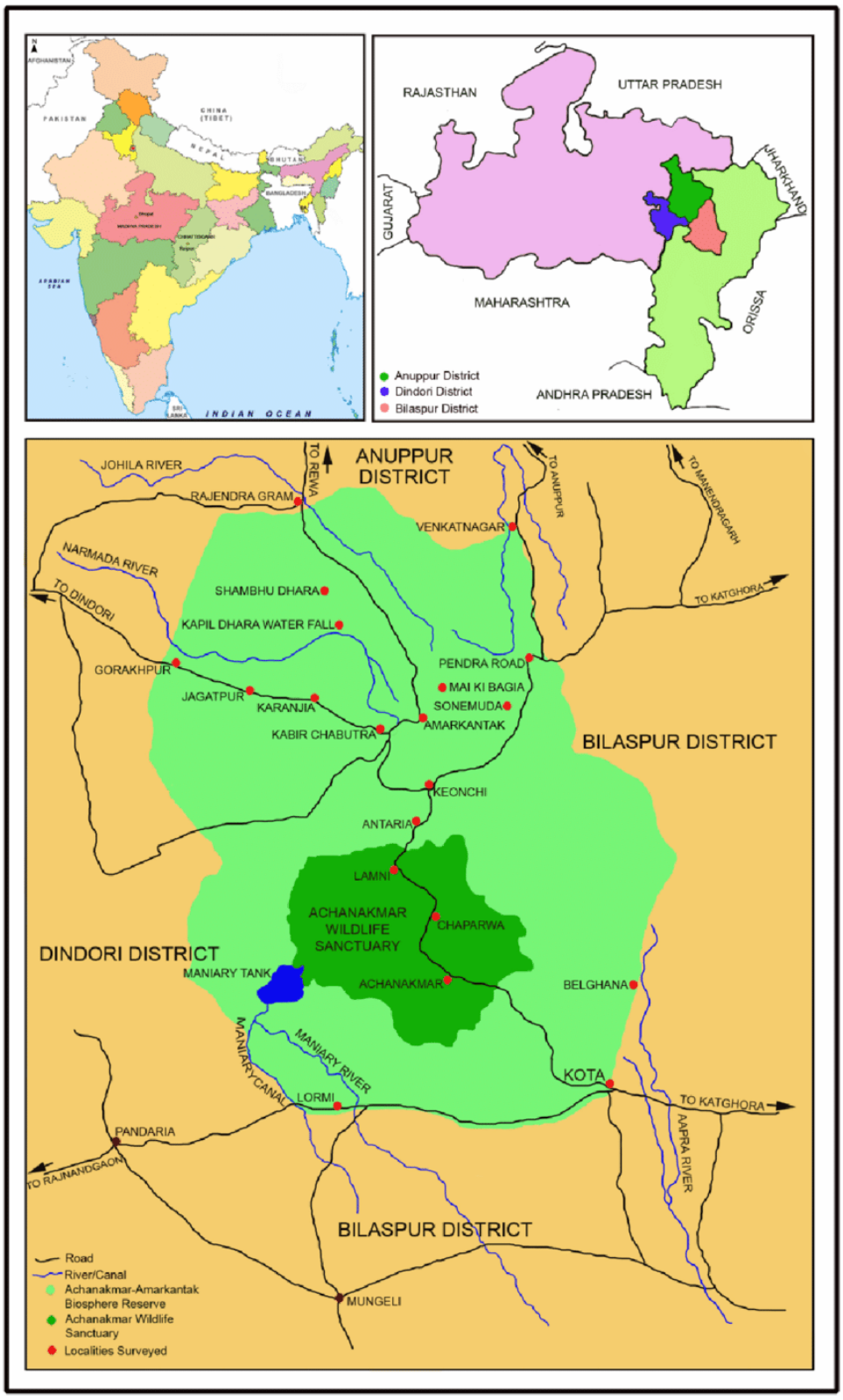
The Achanakmar-Amarkantak Biosphere Reserve is a biosphere reserve in India that extends across the states of Madhya Pradesh and Chhattisgarh, covering a total area of 383,551 hectares (3835.51 km2). The Achanakmar-Amarkantak Biosphere Reserve is located at the junction of hill ranges, with topography ranging from high mountains, shallow valleys and plains. Moist deciduous forests constitute 63% of the area. It is very rich in flora and fauna due to its tropical moist deciduous vegetation which covers the majority of the area and tropical dry deciduous vegetation to its southern part, minimum disturbed landscapes, endemism and genetic variation. It has nearly 1498 plant species belonging to 799 plant genera from thallophytes, bryophytes, pteridophytes, gymnosperms and angiosperms. There are 3 endemic and 282 regionally rare species and 39 different categories of globally threatened floral species. In animals, there are 327 species belonging to 256 genera of invertebrate and vertebrate fauna besides many taxonomically undescribed species. The Biosphere Reserve is home of 67 threatened faunal species, belonging to various categories of global threats as per IUCN 2001 categorization like Four horned antelope (Tetracerus quadricornis), Indian wild dog (Cuon alpinus), Saras crane (Grus antigone), Asian white-backed vulture (Gyps bengalensis), Sacred grove bush frog (Philautus sanctisilvaticus).

The geology of the area is unique and varied from schists and gneisses with granite intrusions, to sand stones, shales, limestone, basaltic lava and bauxite. The soil varies in composition and texture from sandy to loamy-clays, generally light brown to brownish and olive green clay at

some places. Red soil due to presence of iron oxide which is porous and fertile, alluvial soil on the banks of numerous streams in the tract and black cotton soil in many areas, support a large number of ecosystem and species. Soil and moisture conservation, construction of check dams, rehabilitation of degraded bamboo forests, grass meadow development and conservation of landscapes are being done to improve the ecosystem.

Amarkantak Hill Range

Amarkantak is situated in Anuppur district of the state of Madhya Pradesh at an altitude of 1065m at the meeting place of the Vindhya and Satpura mountain ranges amidst sylvan surroundings. It has an average elevation of 1048m.

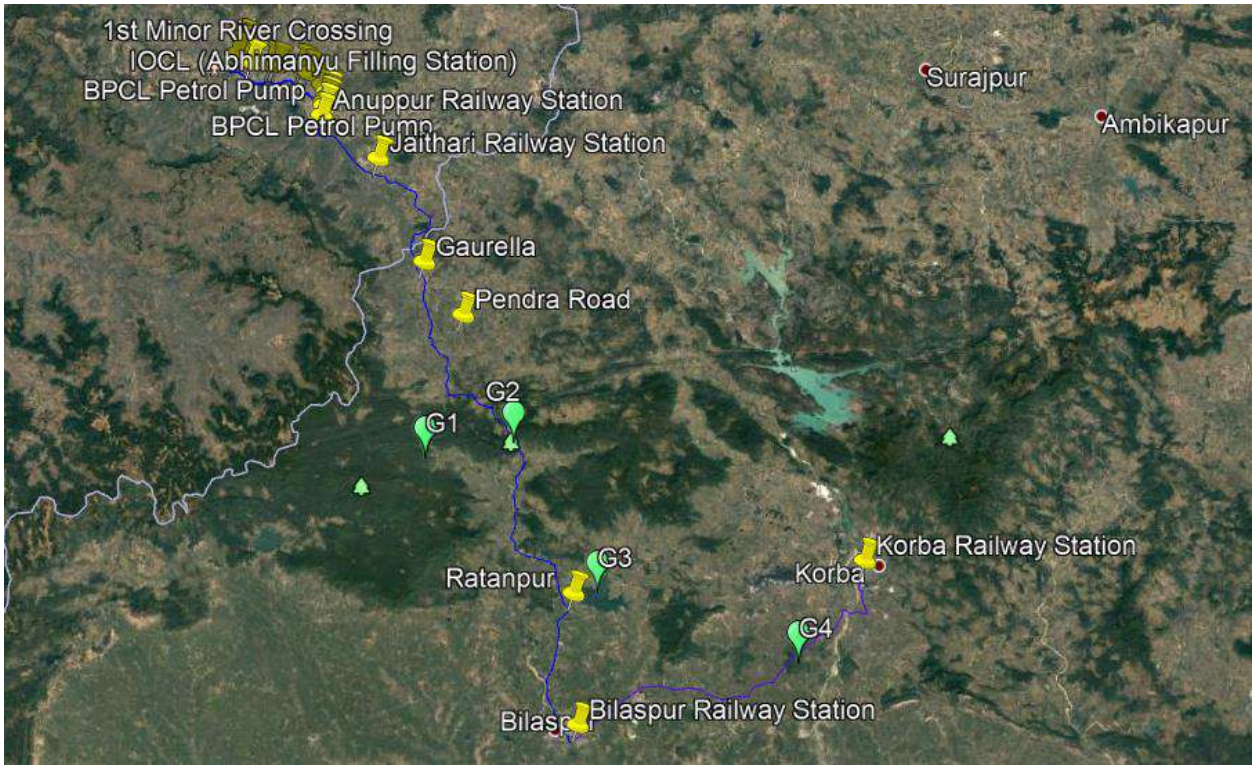


Map: Achanakmar-Amarkantak Biosphere Reserve showing explored localities and its location within India, Madhya Pradesh and Chhattisgarh

Table 3-16: GPS coordinates of the critical habitats around the project site:

GPS point	Latitude	Longitude	Remarks	Distance
F1	22° 34.478'N	81° 54.109'E	Achanakmar Wildlife Sanctuary	On the Bilaspur-Anuppur Loop
F2	22° 34.815'N	82° 3.634'E	Amarkantak Hill Range	16 Km from Bilaspur-Anuppur Loop
F3	22° 18.041'N	82° 11.474'E	Kharang Reservoir	2 Km from Bilaspur-Anuppur Loop
F4	22° 11.717'N	82° 34.834'E	Nawapara Forest	On the Bilaspur-Korba Loop

Figure 3-5: Map showing the eco-sensitive habitats identified in the proposed project area



Ecological sensitive habitat	Direction and Distance from the project site.
National Parks/ Wildlife Sanctuary/ Biosphere reserves/ Elephant Reserve/ Any Other Reserve	Achanakmar Wildlife Sanctuary on the Bilaspur-Anuppur Loop Amarkantak Hill Range 16 Km from Bilaspur-Anuppur Loop Nawapara ForestOn the Bilaspur-Korba Loop

Reserved Forests	Kharang Reservoir 2 Km from Bilaspur-Anuppur Loop
Wildlife Corridors & Routes	Achanakmar Wildlife Sanctuary is present in the vicinity.
Wetlands / Water bodies	Sone River, Arpa River, Hasdo River and many other small river and tributeries
Ramsar Site	NIL
Important Bird Habitats	Nil
Breeding/nesting areas of endangered species	Not present
Mangroves	Nil

3.12.2 FLORA

General Ecology of the Study Area

According to Champion and Seth (1968), four types of forests are present in the study area viz; I) Moist Peninsular High Level Sal (I/3C/C 2e) and Moist Peninsular Low Level Sal (I/3C/C 2e) II) West Gangetic Moist Mixed Deciduous Forests (I/3C/C 3a) III) Riparian Fringe Forests (I/4E/RS1). IV) Southern Dry Mixed Deciduous Forests (II/5A/C 3) and Northern Dry Mixed Deciduous Forests (II/5B/C 3) V) Dry peninsular Sal (II/5B/C 1C). As per forest composition given in the working plan, 29.96% area consists of open forest, 25.23% dense mixed forest, 8.67% are blanks and 5.08% are encroachments. Teak and bamboo plantation is 3.52% due to adequate rainfall coupled with the restricted runoff thus there is no acute shortage of water. The area falls in the catchment of various perennial rivers such as Son and Bakan. Along with this there are small reservoirs and nallahs such as chachai nallah, suthana nallah and ram sagar reservoir which have water in pools even during summer.

The most dominant species is Sal and Teak. Sal forests of Madhya Pradesh are ecologically very important as they mark the termination of the great Sal zone of the Central Indian Peninsula. Sal forests are located in the eastern part of the state while teak forests are localized in the western part. In between, there is a transition belt of mixed miscellaneous forests. There are also areas where Teak and Sal both species occur naturally mixed together forming unique ecosystem. Sal forests occupy an area of 7244 km², which is about 7.6% of the total forest area of the state.

The maximum forest cover in the state is that of mixed forests, which includes Teak (Tectona grandis), Sal (Shorea robusta) mixed with other species like saja (Terminalia tomentosa), lendia (Lagerstroemia parviflora), haldu (Adina
cardifolia), dhaora (Anogeissus latifolia), aonla (Emblica officinalis), amaltas (Cassia fistula) and gamhar (Gmelina arborea) etc. The ground is covered with maze of grasses, shrubs, bushes, lianas, climbers and saplings. There are many important Non Timber Forest Produce (NTFP)

found in the forests e.g. Tendu leaves or Bidi leaves (Diospyros melonoxylon), Sal seed (Shorea robusta), Chebulic Myrobolan or Harra (Terminalia chebula), Gum, Chironji (Buchanania lanzan), flowers and seeds of Mahua (Madhuca indica) and flowers, seeds, bark & roots of various plant species. Tendu leaves, Sal seed and gums are nationalized forest produce in Madhya Pradesh whereas the other NTFPs are nonnationalized. These non-nationalized NTFPs can be collected and traded freely but the collection and trade of nationalized forest produce is regulated by the state.

Table 3-17: List of Flora within the core project Area

Sr. No.	Species	Family	Common Name
1	*Acacia nilotica*	Mimosaceae	Babul
2	*Aegle marmelos*	Rutaceae	Bel
3	*Anogiessus latifolia*	Combertaceae	Dhawra
4	*Azadirachta indica*	Meliaceae	Neem
5	*Andrographis paniculata*	Acanthaceae	Kalmegh
6	*Bombax malabarica*	Malavaceae	Semal
7	*Buchanania lanzan*	Anacardaceae	Charonji
8	*Bauhinia variegate*	Caesalpiniaceae	Kachanar
9	*Carica papaya*	Caricaceae	Papeeta
10	*Dioscorea globosa*	Dioscoriaceae	Suarikand
11	*Diospyros melanoxylon*	Ebenaceae	Tendu
12	*Ficus racemosa*	Moraceae	Gular or Dumer
13	*Ficus glomerata*	Moraceae	Dumer
14	*Gymnema sylvestre*	Asclepiadaceae	Gurmar
15	*Trigonella foenum*	Fabaceae	Methi
16	*Termminalia tomentosa*	Combertaceae	Saaj
17	*Momordica charantia*	Cucurbitaceae	Karela
18	*Moringa oleifera*	Moringaceae	Munga
19	*Musa paradisica*	Musaceae	Kela
20	*Madhuca indica*	Sapotaceae	Mahua
21	*Paspalamscrobiculatum*	Poaceae	Kodo
22	*Pterocarpus marsupium*	Fabaceae	Bijasal
23	*Syzygium cumini*	Myrtaceae	Jamun
24	*Shorea robusta*	Diptherocarpaceae	Sal
25	*Zingiber officinales*	Zingiberaceae	Adark
26	*Cassia tora*	Caesalpiniaceae	***
27	*Cuscuta reflexa*	Convolvulaceae	Amarbel

List of Flora within the buffer project Area

Sr. No	Scientific Name	Family
1	*Terminalia arjuna*	Combertaceae
2	*Buvhanan lanzan*	Anacardiaceae
3	*Ficus hispida*	Moraceae
4	*Dilenia pentagaina*	Dilleniaceae
5	*Bridelia retusa*	Euphorbiaceae
6	*Korea arborea*	Mirtesi
8	*Anogeissus latifolia*	Combertaceae
9	*Diospyros melanoxylon*	Ebenaceae
8	*Schleichera oleosa*	Sapindaceae
9	*Garuga pinnata*	Burseraceae
10	*Feronia limonia*	Rutaceae
11	*Mitragyna parvifolia*	Rubiaceae
12	*Acacia catechu*	Mimosaceae
13	*Melina arborea*	Bobinaceae
14	*Ficus glomerata*	Moraceae
15	*Albizzia odoratisssima*	Mimosaceae
16	*Holoptelia intogrifolia*	Ulmaceae
17	*Syzygium cumini*	Myrtaceae
19	*Holarrhena antidysenterica*	Apocynaceae
20	*Semecarpus anacardium*	Anacardiaceae
21	*Elaeodendron glaucum*	Celastraceae

Sr. No	Scientific Name	Family
22	*Hymenodictyon excelsum*	Rubiaceae
23	*Cassia fistula*	Fabaceae
25	*Woodfordia fruticosa*	Lytharaceae
26	*Nyctanthus arbor-tristis*	Oleaceae
27	*Boswellia serrata*	Burseraceae
28	*Haldina cordifolia*	Rubiaceae
29	*Dalbergia bracteolate*	Fabaceae
30	*Albizia procera*	Fabaceae
31	*Butea monosperma*	Fabaceae
32	*Oroxylum indicum*	Bignoniaceae
33	*Stereospermum suaveolens*	Bignoniaceae
34	*Erythrina suberosa*	Fabaceae
35	*Kydia calycina*	Malvaceae
36	*Aegle marmelos*	Rootaceae
37	*Cloroxylon swietenia*	Rutaceae
38	*Silene dichotoma*	Caryophyllaceae
39	*Boswelhia serrata*	Bursericeae
40	*Eragrostris interrupta*	Poaeceae
41	*Eragrostis tenelia*	Graminace
42	*Heteropogon contortus*	Poaceae
43	*Zizyphus oenoplia*	Rhamnaceae
44	*Celastrus paniculatus*	Celastraceae
45	*Bauhinia vahlii*	Fabaceae
46	*Saceharum spontaneum*	Graminae
47	*Embelia robusta*	Myrsinaceae
48	*Maghania semiaata*	Leguminaceae
49	*Thespesia lampas*	Malvaceae

3.12.3 FAUNA

List of fauna either spotted or reported from the core study area

Sr. No	Common Name	Scientific name	Conservation status as per WPA (1972)
1	Squirrel	*Funambulus pennantii*	Sch-IV
2	Field rat	*Bandicota bengalensis*	Sch-IV
3	Monkey	*Macaca mulata*	Sch-II
4	Porcupine	*Hystrix indica*	Sch-IV
5	House crow	*Carvus splendens*	Sch-V
6	Common myna	*Acridotheris tristis*	Sch-IV
7	Parakeet	*Psittaculata krameri*	Sch-IV
8	Koel	*Eudynamys scolopaceus*	Sch-IV
9	Wild crow	*Corvus macrorhynchos*	Sch-IV
10	Common krait	*Bungarus caeruleus*	Sch-II
11	Water snake	*Enhydris enhydris*	Sch-IV

List of Fauna in Buffer Zone

Common Name	Scientific Name	Conservation status as per WPA (1972)
Striped Hyena	*Hyaena hyaena*	Sch-III
Jackal	*Cianis aureus*	Sch-II
Wild dog	*Cuon alpines*	Sch-II
Wild cat	*Felis chaus*	Sch-II
Wolf	*Canis lupas*	Sch-I
Sloth bear	*Melursus ursinus*	Sch-I
Spotted dear	*Axis axis*	Sch-III
Wild boar	*Sus scrofa*	Sch-III
Blue bull	*Boselaphus tragocamelus*	Sch-III
Common langur	*Presbytis entellus*	Sch-II
Rhesus monkey	*Macaca mulatta*	Sch-II
Indian hare	*Lepus nigricollis*	Sch-IV
Barking deer	*Muntiacus muntjak*	Sch-III
Chinkara	*Gazelle gazella*	Sch–I
Indian Mole rat	*Bandicota bengalensis*	Sch-III
Common Indian porcupine	*Hystrix indica*	Sch-IV

Common Name	Scientific Name	Conservation status as per WPA (1972)
Four Horned Antelopes	*Tetraceros quadricornis*	Sch–I
Pangolian	*Manis crassicaudata*	Sch–I
Five striped palm squirrel	*Fuanambulus pennata*	Sch-IV
Indian Gaint Squirrel	*Ratufa indica*	Sch-II
Common monitor lizard	*Varanus bengalensis*	Sch-I
Red junglefowl	*Galluus gallus*	Sch–IV
Peafowl	*Pavo cristatus*	Sch–I
Rock pigeon	*Columbia livia*	Sch–IV
Common kite	*Milvus migrans*	Sch–IV
Common Indian nightjar	*Caprimulgus asiaticus*	Sch–IV
India roller	*Coracias bengalensis*	Sch–IV
Pond heron	*Ardiola grayii*	Sch–IV
Indian cuckoo	*Cuculus micropterus*	Sch–IV

3.12.4 BIRDS

Sr. No.	Technical Name	English Name / Local Name	Wildlife Act (1972)
1	*Milyus migrans*	Common Kite	Sch-IV
2	*Quills contronix*	Grey quail	Sch-IV
3	*Corvus splendens*	House crow	Sch-IV
4	*Turdoides striatus*	White headed babbler	Sch-IV
5	*Aegithina tiphia*	Iora	Sch-IV
6	*Pycnonotus cafer*	Red vented bulbul	Sch-IV
7	*Pycnonotus jokokus*	White browed Bulbul	Sch-IV
8	*Saxicoloides fulicata*	Indian robin	Sch-IV
9	*Columbus livibus*	Rock Pigeon	Sch-IV
10	*Copsychus saularis*	Magpie Robin	Sch-IV
11	*Tchitrea paradisi*	Paradise Fly catcher	Sch-IV
12	*Tephrodornis pondiceraianus*	Common Wood shrike	Sch-IV
13	*Lalage sykesi*	Black headed cuckoo Shrike	Sch-IV
14	*Artamus fuscus*	Ashy Swallow Shrike	Sch-IV
15	*Dicrurus macrocerus*	Black Drongo	Sch-IV
16	*Dicrurus longicaudatus*	Grey Drongo	Sch-IV
17	*Dissemurus paradiseus*	Rackete tailed Drongo	Sch-IV
18	*Oriolus oriolus*	Indian Oriole	Sch-IV
19	*Black Headed Oriole*	Oriolus xanthornus	Sch-IV
20	*Temenuchus pagodarum*	Brahmny Myna	Sch-IV
21	*Acridotheres tristicus*	Common myna	Sch-IV
22	*Ploceus philippines*	Weaver bird	Sch-IV
23	*Uroloncha striata*	Spotted munia	Sch-IV
24	*Passer domisticus*	House Sparrow	Sch-IV
25	*Redrumped Swallow*	Hirundo daurica	Sch-IV

26	*Cinnyris asiatica*	Purple Sunbird	Sch-IV
27	*Brachypternus bengalensis*	Malabar Golden backed woop	Sch-IV
28	*Megalaima merulinus*	Indian Cuckoo	Sch-IV
29	*Hierococys varius*	Common Hawk Cuckoo	Sch-IV
30	*Eudynamis scolopaceus*	Koel	Sch-V
31	*Centropus sinensis*	Crow Pheasant	Sch-IV
32	*Psittacula Krammeri*	Rose ringed parakeet	Sch-IV
33	*Coryllis vaeralis*	Lorikeet	Sch-V
34	*Coracias benghalensis*	Indian Roller	Sch-IV
35	*Merops orinetalis*	Common Bee Eater	Sch-IV
36	*Alcedo atthis*	Common Kingfisher	Sch-IV
37	*Halcyon smyrensis*	White breasted kingfisher	Sch-IV
38	*Microfus affinis*	House swift	Sch-IV
39	*Cyprirus parvus*	Palm swift	Sch-IV
40	*Caprimulgus asiaticus*	Common Indian jar	Sch-IV
41	*Tylo alba*	Barn Owl	Sch-IV
42	*Haliastur indus*	Brahmny kite	Sch-IV
43	*Milvus migrans*	Pariah kite	Sch-IV
44	*Circus aeruginosus*	Marsh harrier	Sch-IV
45	*Chalcophaps indica*	Emerald Dove	Sch-IV
46	*Lobvanella indicus*	Redwattled Lapwing	Sch-IV
47	*Lobpluvia malabaraica*	Yellow wattled lapwing	Sch-IV
48	*Anhinga melanogaster*	Darter	Sch-V
49	*Egretta garzetta*	Little Egret	Sch-IV
50	*Bubulcus ibis*	Cattle Egret	Sch-IV
51	*Ardeola grayii*	Pond Heron	Sch-IV
52	*Anas querquedula*	Gangney Teal	Sch-IV
53	*Anas acuta*	Common Teal	Sch-IV
54	*Aythya feroma*	White eyed Pochard	Sch-IV
55	*Gallinula chlorpus*	Moorhen	Sch-IV
56	*Sterna albifrons*	Indian River Tern	Sch-IV
57	*Galerida malabarica*	Malabar Crested Lark	Sch-IV

3.12.5 LIST OF Phytoplankton

Phytoplankton forms the basis of food chain in any aquatic water body. The diversity and abundance of phytoplankton mainly depends on the region, type of water body, either lentic or lotic, the nutrient flux in the system and the sunlight available for photosynthesis. These factors together form the dynamics of phytoplankton productivity over the seasons. The phytoplankton of given water body determines the zooplankton populations and the fish productivity of the ecosystem.

Phytoplankton group reported from three locations are Basillariophyceae, Chlorophyceae, Myxophyceae and Euglenophyceae members. About 29 species of phytoplankton were reported from all the locations. Dominance of Bacillariophyceae members followed by Myxophyceae was observed in studies samples. The highest percentage was Cymbella sp. and Spirulina sp. and the lowest percentage was Synedra sp. during study period was observed.

Zooplankton

The zooplankton of the aquatic water body are the primary consumers and also in cases secondary produces which play an important role for the fisheries of that system. The diversity and abundance of zooplankton also depends on whether the water body is eutrophic or oligotrophic. About 10 species of zooplankton were reported from all the locations. They also are good representation of the ecosystem health. The amount and type of pollutants in the water body determine the type of zooplankton species. Species of copepod will usually dominate in the tropical region while more eutrophicated waters with high nutrient or organic loads will harbor high number of crustaceans and arthropods.

Sr. No.	Phytoplankton	Zooplankton
1	*Chlorella* sp.	*Asplancha* sp.
2	*Chloro coccum* sp.	*Arcella* sp.
3	*Pediastrum duplex* sp.	*Cypris* sp.
4	*sirogyra* sp.	*Cyclops* sp.
5	*Cosmarium* sp.	*Condylostoma* sp.
6	*Cymbella* sp.	*Daphnia* sp.
7	*Euglena* sp.	*Kertella* sp.
8	*Fragillaria* sp	*Macrotric* sp.
9	*Gleocapsa* sp.	*Brachionus* sp.
10	*Gomphonema* sp.	*Filinia* sp.
11	*Melosira* sp	-
12	*Merismopedia* sp	-
13	Microcystis sp	-
14	*Navicula* sp	-
15	*Nitzschia* sp.	-
16	*Oscillatoria* sp.	-
17	*Scendesmus* sp.	-
18	*Speciesirulina* sp.	-
19	*Tetradron* sp.	-
20	*Moughtia* sp.	-
21	*Aanabaena* sp.	-
22	*Rivularia* sp.	-
23	*Crucigenia* sp.	-
24	*Facus* sp.	-
25	*Cyclotella* sp.	-
26	*Chroococcus* sp.	-
27	*Spirulina* sp.	-
28	*Synedra sp.*	-
29	*Pandorina*	-

3.13 DEMOGRAPHY & SOCIO-ECONOMICS

A meeting with the project proponent was initially conducted to develop a common understanding of the project activities, land acquisition for tap off point and status of payment of

compensation to the affected PAP, and to identify a continuous point of contact for all future correspondence.

The baseline information included aspects like demographic information, economic activities, literacy profile, land use, infrastructure resource, economic facilities, cultural heritage, lifestyle and other value system.

The following methods were used as a benchmark to collate the baseline information:

- Stakeholders consultation meeting which included the Project Influenced and benefitted Population in Anuppur, Bilaspur, and Korba;
- Consultations with along the pipeline route to understand the socio-economic status, education facilities and the literacy levels.

The delineation of Preliminary Stakeholders was based on the following points,

- The type of stakeholders, and;
- Their connection and influence levels on the project.

An open ended questionnaire was prepared for the focus group discussions prior to the start of the consultation process to obtain the information from the population. Different stakeholder groups were consulted to understand the concerns/ issues, expectations/ benefits and other advantages that they have on the project.

3.13.1 ANUPPUR, BILASPUR, AND KORBA DISTRICT PROFILE

Anuppur

Anuppur is situated in eastern corner of Madhya Pradesh. It came into existence on 15th August 2003, by reorganization of Shahdol district. The Anuppur is one of the tribal district of Madhya Pradesh. Anuppur is also famous for Amarkantak hill and pilgrim station, where from two important rivers namely, Narmada and the son originates. District Anuppur is surrounded by Shahdol district in north, Umariya and Dindori districts in west and south-west, Bilaspur and Korea districts of Chhattishgarh State in south and east sides. The district lies between North latitude 22º 7’ and 23º25’ and East longitude 81º10’ and 82º 10’, falling in Survey of India toposheet nos. 64E, 64F and 64 I. It extends for about 86 Km from north to south and 117 Km from east to west.

The area of district is 3724 Sq. Km, and it has been divided into four tehsils and blocks. There are 585 villages in the district.

Bilaspur

In May 1998 the original Bilaspur District was divided into 3 districts namely Bilaspur, Janjgir Champa & Korba. Bilaspur district is located on the northwestern part of the Chhattisgarh state It covers an area of 8569 sq.km. It is surrounded by Durg and Raipur districts on the south, Kawardha and Mandla districts (Madhya Pradesh) in the west, Koriya district in the north, Korba and Janjgir-Champa districts in the east (Plate-I). Bilaspur is the district headquarters and is 120

km away form the State capital Raipur. It is well connected with State capital by road and railways.

National Highway No. 200 passes through the town. It is on the Mumbai- Howrah main railway line. The district is well connected by all weathered roads.For the convenience of administration, the district is divided into 8 no. of tehsils, 10 no. of Community Development blocks & 858 no. of gram panchayats In the district there are 16 urban centers. The Bilaspur town is managed by Municipal Corporation, Mungeli town is managed by Municipality and rest 14 towns (Baitalpur, Belha, Bodri, Deori, Ghutku, Gaurela, Kota, Lingiyadih, Lormi, Mahmand, Ratanpur, Sirgiti, Pendra and Takhatpur,) are covered by Nagar Panchayats. The urban population constitutes 25.50% of the total population in the district and the Bilaspur town is having a population of 4, 54,000. There are no major industries except one in Belha block. Dolomite is the major mineral mined around Hirri area. Laterites and limestones are used as building materials and are mined at isolated patches.

Korba

The Korba district covers an area of 7145.44 sq. km. It consists of 717 no of villages. For administrative convenience these villages are grouped into 5 tehsils and 5 development blocks. Korba is the district headquarters. The block head quarters are Korba, Pali, Poudi Uprora, Katghora and Kartala. The district is known mainly for its industrial development and mineral wealth. It is one of the leading Hydro and Thermal electricity producing districts of Chhattisgarh state.

3.13.2VILLAGES FALLING UNDER STUDY AREA

Pipeline runs parallel along the main roads hence accessibility is not an issue. Project pipeline runs along major national and state highway connecting Anuppur, Bilaspur, and Korba districts. The route covers 93 villages in 8 talukas and 3 districts and 2 States.

Table 3-18: List of villages, cities, talukas and districts of B Anuppur, Bilaspur, and Korba falling in the project area

S. No	City/ Village		Taluka	District	State
1	12. Shahdol 13. Burhar 14. Lakeran Tola 15. Saabo 16. Amlai 17. Batura	18. Kodaili 19. Bakeli 20. Pondi 21. Manpur 22. Sitapur	Manpur	Anuppur	Madhya Pradesh

2	6. Barbaspur 7. Anuppur City 8. Kusmahai	9. Belia 10. Chullah	Gunderdehi	Anuppur	Chattisgarh
3	14. Jaithari 15. Lahapur 16. Pachauha 17. Jhangawan 18. Shaktitola 19. Khuntatola 20. Paprauri	21. Lapta 22. Amdand 23. Munda 24. Kadamsara 25. Khairi 26. Venkat Nagar	Jaithari	Anuppur	Chahttisgarh
4	7. Kusumkheda 8. Sodha Khurd 9. Parsapani	10. Amamuda 11. Banabel 12. Majhwani	Budni	Anuppur	Chahttisgarh
5	14. Bansajhal 15. Chapora 16. Khaira 17. Pondi 18. Ghansipur 19. Ratanpur 20. Dulhara	21. Pandwara 22. Mohtarai 23. Gatauri 24. Sendri 25. Badi Kon 26. Sarkanda	Kota	Bilaspur	Chahttisgarh
6	20. Khairjiti 21. Lalapur 22. Andu 23. Sadhwari 24. Ranijhap 25. Barjorkha 26. Jogisar 27. Belpat 28. Dungra 29. Semra	30. Bilaspur City 31. Torwa 32. Mopka 33. Charpara 34. Baloda 35. Jhharradih 36. Bhilai 37. Sarai Shringar 38. Kenda	Bilaspur City	Bilaspur City	Chahttisgarh
7	14. Lagra 15. Khaira 16. Pandhi 17. Janji 18. Sipat 19. Gudi 20. Khanda	21. Dhaniya 22. Bhauradih 23. Lathara 24. Khamhariya 25. Kuli 26. Sultanar	Masturi	Bilaspur	Chahttisgarh

8	14. Dongri 15. Nagwa 16. Hardibisal 17. Khirosa 18. Nawapara 19. Pantora 20. Bhada	21. Tarda 22. Kudurmal 23. Urga 24. Bharbaspur 25. Bilaikhurd 26. Korba Town	Korba	Korba	Chahttisgarh

Source: Primary Survey, TUV SUD

3.13.3 DEMOGRAPHIC DETAILS

Anuppur

An official Census 2011 detail of Anuppur, a district of Madhya Pradesh has been released by Directorate of Census Operations in Madhya Pradesh. Enumeration of key persons was also done by census officials in Anuppur District of Madhya Pradesh.

In 2011, Anuppur had population of 749,237 of which male and female were 379,114 and 370,123 respectively. In 2001 census, Anuppur had a population of 667,155 of which males were 340,204 and remaining 326,951 were females. Anuppur District population constituted 1.03 percent of total Maharashtra population. In 2001 census, this figure for Anuppur District was at 1.11 percent of Maharashtra population.

There was change of 12.30 percent in the population compared to population as per 2001. In the previous census of India 2001, Anuppur District recorded increase of 20.00 percent to its population compared to 1991.

Table 3-19: Demographic Profile of Anuppur Districts

Anupur /Description	2011	2001
Population	7.49 Lakhs	6.67 Lakhs
Actual Population	749,237	667,155
Male	379,114	340,204
Female	370,123	326,951
Population Growth	12.30%	20.00%
Area Sq. Km	3,747	3,747
Density/km2	200	178
Proportion to Madhya Pradesh Population	1.03%	1.11%
Sex Ratio (Per 1000)	976	961
Child Sex Ratio (0-6 Age)	950	977
Average Literacy	67.88	60.23
Male Literacy	78.26	73.76
Female Literacy	57.30	46.10
Total Child Population (0-6 Age)	106,071	109,669

Male Population (0-6 Age)	54,388	55,485
Female Population (0-6 Age)	51,683	54,184
Literates	436,595	335,751
Male Literates	254,120	210,016
Female Literates	182,475	125,735
Child Proportion (0-6 Age)	14.16%	16.44%
Boys Proportion (0-6 Age)	14.35%	16.31%
Girls Proportion (0-6 Age)	13.96%	16.57%

Source: Census of India, 2011

Religion wise Demography details

The religion-wise demography profile indicates that maximum population belongs to Hindus (91%) followed by Muslims (3.00%) in all three districts and Christians (0.5%). The details of religion-wise demography status o are given below in Table 3-20.

Table 3-20: Religion-wise demographic Profile as per Census data, 2011

District/ Anuppur	Total	Percentage
Hindu	686,524	91.63 %
Muslims	21,473	2.87 %
Christian	2,132	0.28 %
Sikh	606	0.08 %
Buddhist	86	0.01 %
Jain	1,653	0.22 %
Others	35,434	4.73 %
Not Stated	1,329	0.18 %

Source: Census of India, 2011

Bilaspur

An official Census 2011 detail of Bilaspur, a district of Chhattisgarh has been released by Directorate of Census Operations in Chhattisgarh. Enumeration of key persons was also done by census officials in Bilaspur District of Chhattisgarh.

In 2011, Bilaspur had population of 2,663,629 of which male and female were 1,351,574 and 1,312,055 respectively. In 2001 census, Bilaspur had a population of 1,998,355 of which males were 1,013,875 and remaining 984,480 were females. Bilaspur District population constituted 10.43 percent of total Maharashtra population. In 2001 census, this figure for Bilaspur District was at 9.59 percent of Maharashtra population.

There was change of 33.29 percent in the population compared to population as per 2001. In the previous census of India 2001, Bilaspur District recorded increase of 17.91 percent to its population compared to 1991.

Table 3-21: Demographic Profile of Bilaspur District

Bilaspur /Description	2011	2001
Population	26.64 Lakhs	19.98 Lakhs
Actual Population	2,663,629	1,998,355
Male	1,351,574	1,013,875
Female	1,312,055	984,480
Population Growth	33.29%	17.91%
Area Sq. Km	8,272	8,272
Density/km2	322	242
Proportion to Chhattisgarh Population	10.43%	9.59%
Sex Ratio (Per 1000)	971	971
Child Sex Ratio (0-6 Age)	961	965
Average Literacy	70.78	63.51
Male Literacy	81.54	78.43
Female Literacy	59.71	48.17
Total Child Population (0-6 Age)	407,835	348,030
Male Population (0-6 Age)	207,995	177,140
Female Population (0-6 Age)	199,840	170,890
Literates	1,596,560	1,048,167
Male Literates	932,474	656,225
Female Literates	664,086	391,942
Child Proportion (0-6 Age)	15.31%	17.42%
Boys Proportion (0-6 Age)	15.39%	17.47%
Girls Proportion (0-6 Age)	15.23%	17.36%

Source: Census of India, 2011

Religion wise Demography details

The religion-wise demography profile indicates that maximum population belongs to Hindus (95%) followed by Muslims (2.00%) in all three districts and Christians (0.8%). The details of religion-wise demography status o are given below in Table 3-22.

Table 3-22: Religion-wise demographic Profile as per Census data, 2011

District/ Bilaspur	Total	Percentage
Hindu	2,540,763	95.39 %
Muslims	57,973	2.18 %
Christian	20,745	0.78 %

Sikh	6,373	0.24 %
Buddhist	2,979	0.11 %
Jain	2,357	0.09 %
Others	29,122	1.09 %
Not Stated	3,317	0.12 %

Source: Census of India, 2011

Korba

An official Census 2011 detail of Korba, a district of Chhattisgarh has been released by Directorate of Census Operations in Chhattisgarh. Enumeration of key persons was also done by census officials in Korba District of Chhattisgarh.

In 2011, Korba had population of 1,206,640 of which male and female were 612,915 and 593,725 respectively. In 2001 census, Korba had a population of 1,011,823 of which males were 515,147 and remaining 496,676 were females. Korba District population constituted 4.72 percent of total Maharashtra population. In 2001 census, this figure for Korba District was at 4.86 percent of Maharashtra population.

There was change of 19.25 percent in the population compared to population as per 2001. In the previous census of India 2001, Korba District recorded increase of 22.51 percent to its population compared to 1991.There was change of 13.33 percent in the population compared to population as per 2001. In the previous census of India 2001, Mayurbhanj District recorded increase of 17.98 percent to its population compared to 1991.

Table 3-23: Demographic Profile of Korba Districts

Korba /Description	2011	2001
Population	12.07 Lakhs	10.12 Lakhs
Actual Population	1,206,640	1,011,823
Male	612,915	515,147
Female	593,725	496,676
Population Growth	19.25%	22.51%
Area Sq. Km	6,598	6,598
Density/km2	183	153
Proportion to Chhattisgarh Population	4.72%	4.86%
Sex Ratio (Per 1000)	969	964
Child Sex Ratio (0-6 Age)	966	978
Average Literacy	72.37	61.71
Male Literacy	82.48	75.86
Female Literacy	61.93	46.99

Total Child Population (0-6 Age)	172,016	171,840
Male Population (0-6 Age)	87,487	86,860
Female Population (0-6 Age)	84,529	84,980
Literates	748,759	518,372
Male Literates	433,391	324,912
Female Literates	315,368	193,460
Child Proportion (0-6 Age)	14.26%	16.98%
Boys Proportion (0-6 Age)	14.27%	16.86%
Girls Proportion (0-6 Age)	14.24%	17.11%

Source: Census of India, 2011

Religion wise Demography details

The religion-wise demography profile indicates that maximum population belongs to Hindus (93%) followed by Muslims (2.5.00%) in all three districts and Christians (1.75%). The details of religion-wise demography status o are given below in Table 3-24.

Table 3-24: Religion-wise demographic Profile as per Census data, 2011

District/ Korba	Total	Percentage
Hindu	1,133,176	93.91 %
Muslims	30,195	2.50 %
Christian	21,059	1.75 %
Sikh	3,666	0.30 %
Buddhist	897	0.07 %
Jain	753	0.06 %
Others	15,649	1.30 %
Not Stated	1,245	0.10 %

Source: Census of India, 2011

4 ANTICIPATED ENVIRONEMENTAL IMPACTS & MITIGATION MEASURES

This section of the report provides an assessment of the potential impacts on different identified environmental components, which are likely to occur during the laying of pipeline and supply of Petroleum products through the pipeline. However, by adopting appropriate management measures, the majority of the assessed impacts can be mitigated.

The major potential impacts associated with the proposed project are impact on soil, impact on water resources and area drainage, air quality degradation, noise impacts, impact on ecological environment, impact on agriculture, land use changes, impact on health and safety, impact on socio-economic features, impact on community activities, impact on cultural heritage and impact on aesthetics. These impacts can occur at any one of the three stages i.e. planning or design stage, the construction stage and the operation stage.

The identified impacts due to the proposed project can be mitigated through the incorporation of appropriate measures at different stages of the project. This will ensure the best design with minimal damage to or loss of significant or sensitive features such as roadside vegetation, local water resources, etc.

4.1 IDENTIFICATION OF ENVIRONMENTAL IMPACTS

The environmental impacts associated with the proposed project on various environmental components such as air, water, noise, soil, flora, fauna, land, socioeconomic, etc. has been identified using Impact Identification Matrix.

Table 4-1: Impact Identification matrix for the proposed pipeline route and the CNG stations

	Physical				Biological		Socio-Economic		
	Ambient Air Quality	Ground/Surface Water (Quantity/Quality)	Ambient Noise	Land (Land use, Topography, drainage, soil)	Flora	Fauna	Livelihood and Occupation	Infrastructure	Health & Safety
Augmentation of Facilities									
Construction Phase									
Civil and mechanical works	●	●	●	●	●	●	●	●	
Movement of vehicles	●		●			●		●	●
Hydro testing									●
Waste generation, handling and disposal				●					●
Operation Phase									
Operation of pumps and compressors	●	●	●						
Storage of Gas/ Crude	●								
Cleaning & maintenance		●		●					
Movement of vehicles	●		●			●			
Waste generation, handling and disposal		●		●				●	●
Leakage from Pipeline	●	●							
Laying of New Pipeline									
Construction Phase									
Preparation of Right of way	●		●	●		●	●	●	●
Pipe laying	●			●					●
Chemical use/handling		●		●					
Movement of vehicles	●		●			●		●	●
Hydro testing		●							●
Waste generation, handling and disposal				●					●
Operation Phase									
Operation of compressors	●		●						
Cleaning & maintenance									
Waste generation, handling and disposal			●						●

Movement of vehicles	●					●		●	
CNG Stations									
Construction Phase									
Civil and mechanical works	●		●	●	●		●		●
Movement of vehicles	●	●	●			●			●
Waste generation, handling and disposal		●		●	●			●	●
Operation Phase									
Movement of vehicles	●		●						●
Waste generation, handling and disposal		●	●						●
Leakage due to corrosion, equipment failure, accidents, human error and as a result of third party interference	●	●							

4.2 IMPACT AND MITIGATION MEASURES- CONSTRUCTION PHASE

4.2.1 AIR ENVIRONMENT

The air quality along the project stretch may get affected during the construction period. Particulate matter will be the predominant pollutant affecting the air quality during the construction phase. As the construction activities are likely to generate dust. Mostly the additional automobile traffic and construction machineries involved during construction activities will generate petroleum pollutants. However, this will not lead to any tangible effect, as the additional traffic volume related to construction activities will be low.

a. Impacts

Potential emissions sources during construction phase include the following:

- Deterioration of air quality due to fugitive dust emissions from construction activities (especially during dry season) like excavation, back-filling and dumping of earth materials, from construction spoils, vehicular movements along unpaved roads, loading / unloading and transportation of construction materials
- Equipment deployed during the construction phase is also likely to result in marginal increase in the levels of SO2, NOX, and particulate matter
- Operation of equipment and machinery for earth-moving, grading, pipeline laying and civil works at pipeline ROW and other sites
- Operation of temporary Diesel Generator (DG) sets, emission of PM, CO, NOx, & SOx

b. Mitigation Measures

During construction phase of the proposed project appropriate mitigative measures have to be implemented to ameliorate the anticipated air quality problems. The following mitigative measures will be employed during construction period to reduce the pollution level to acceptable limits

- Proper and prior planning, appropriate sequencing and scheduling of all major construction activities have to be done, and timely availability of infrastructure supports needed for construction to be ensured to shorten the construction period vis-à-vis reduce pollution.
- Construction materials to be stored in covered godowns or enclosed spaces to prevent the windblown fugitive emissions.
- Stringent construction material handling / overhauling procedures to be followed.
- Adequate dust suppression measures such as regular water sprinkling on unpaved haul roads, at vulnerable areas of construction sites to be undertaken to control fugitive dust during material handling and hauling activities particularly near habitations especially in dry seasons.
- The construction material delivering vehicles to be covered in order to reduce spills.
- Low emission construction equipment, vehicles and generator sets to be used
- It has to be ensured that all construction equipment and vehicles are in good working conditions, properly tuned and maintained to keep emission within the permissible limits and engines tuned off when not in use to reduce pollution
- Vehicles and machineries to be regularly maintained so that emissions confirm to standards of Central Pollution Control Board (CPCB)
- Monitoring of air quality at regular intervals to be conducted during construction phase
- Construction workers to be provided with masks to protect them from inhaling dust.

4.2.2 NOISE ENVIRONMENT

During construction phase, noise will be generated due to movement of vehicles, and operation of light and heavy construction machineries including pneumatic tools (hot mixer, dozer, tipper, loader, excavator, grader, scrapper, roller, concrete mixer, generator, pump, vibrator, crane, compressor, HDD etc.). During construction the noise generating range will be approximately between 55-70 dB(A). The main sources of noise during construction period are:

- Movement of vehicles during the construction period for procurement of construction material.
- During site preparation, surface preparation, pipeline laying etc.

Noise generated from sources mentioned above will be mostly during daytime. Moreover, villages / settlements being near to the route, significant impact on local people is apprehended

(as a few congested human habitations are along the site), as the noise generated will be a problem. However, the workers are likely to be exposed to high noise levels that may affect them.

a. Impacts

- Increase in noise level due to construction activities like operation of construction equipment and vehicular traffic
- Operation of construction machinery will lead to rise in noise level to the range between 80-100 dB(A). The magnitude of impact from noise will depend upon types of equipment used, construction methods and also on work scheduling.
- Since there is a mix of residential, commercial and industrial area in the vicinity of the project, noise have to be kept in check.
- The impacts will be significant on construction workers, working close to the machinery.

b. Mitigation Measures

- Construction camp and temporary labour sheds will be located away from the immediate vicinity of construction sites and major road traffic.
- Protective gears such as earplugs, etc. will be provided to construction personnel exposed to high noise levels as preventive measures.
- It will be ensured that all the construction equipment and vehicles used are in good working condition, properly lubricated and maintained to keep noise within the permissible limits and engines tuned off when not in use to reduce noise.
- Construction activities carried out near residential locations will be scheduled to the daytime (i.e. from 10.00 a.m. to 6.00 p.m.) only so as to have minimum disturbance to the residents.
- Whenever possible static noisy machinery will be placed on vibration isolators or temporary sheeting will be provided to check noise propagation.

Noise level will be monitored at regular intervals during construction phase, which will help in taking appropriate action to maintain it within the prescribed limit

4.2.3 WATER ENVIRONMENT

Small quantity of water will be used during construction process and hydro testing of the pipeline. Wastewater from construction activities would mostly contain suspended impurities. Other pollutants, which may find their way to it, will be insignificant concentrations and may not cause significant impact on the receiving water bodies. The deterioration of water quality during construction phase is expected due to wastewater disposal from the workers camp and sludge generated from construction sites. If adequate arrangements are not made to ensure proper drainage of wastewater from construction sites, such waters may form stagnant pools and

aggravate soil erosion. Stagnant pools of water promote breeding of mosquitoes and create generally unsanitary conditions.

a. Impacts

- Increase of sediment / silt load in the runoff from construction sites / earth moving activities and increase in turbidity in receiving stream / water bodies.
- Erosion of soil into the water bodies due to removal of vegetation.
- Contamination by fuel and lubricants by spills from machineries.
- Contamination of water bodies due to improper sanitation and disposal of wastes at the construction Camps.
- Contamination of water bodies due to water from Hydrotesting of the pipeline.
- Impact on ground water quality due to leachates from the solid waste dumpsites.

b. Mitigation measures

- Quality of construction wastewater emanating from the construction site to be controlled through suitable drainage system with sediment traps (silting basin as water intercepting ditch) for arresting the silt / sediment load before its disposal into the main natural drainage system around the site.
- The trench shall be excavated only so far in advance of pipe laying that it do not causes increased soil erosion and silting of water bodies.
- The discharge of the trench de-watering pumps shall be conveyed either to drainage channel or to natural drains after passing through a catch pit for settling the silt.
- The trench shall be excavated to the exact gradient specified so that no making of the sub-grade by back filling is required and the concrete bed, where required, may be prepared with greatest ease giving a uniform and continuous bearing and support for the pipe.
- All the construction and preparatory activities to be carried out during dry seasons only.
- Construction materials to be stacked together by fencing it with brick or earth in order to prevent spillage into the water bodies, also these materials to be stacked away from the water bodies.
- Proper sanitation facilities to be provided at the construction site to prevent health related problems due to water contamination.
- Waste disposal and sanitation to workers in the construction camp to be properly maintained or taken care off in order to check their entry into the water bodies like ponds, streams etc.
- Vehicle maintenance and refueling to be confined to areas near construction camps designed to trap discarded lubricants and fuel spills from entering into the water bodies;

- Drinking water supply for the workers in the construction camps to meet the Indian National Standards. In order to assess the portability of the supplied water to the construction labour camps water quality to be periodically monitored.
- Garbage to be collected in tanks and disposed off daily in order to check the solid wastes entering into the ponds, streams etc

4.2.4 LAND & SOIL ENVIRONMENT

The construction activities such as earth moving may lead to reduction in vegetal cover on ground thus leading to soil erosion. During the construction period the movement of heavy vehicles will result in compaction of soil by making it hard and impermeable. The erosion at construction stretches will result in increased sediment load in recipient streams. Any leakage of lubricants in equipment yard will cause soil contamination. Solid waste disposal along roadside also adds to impact on the land environment during the construction. During construction activity for laying of pipeline cutting of existing land will be done and the dug material generated will be replaced back after laying of the pipes.

a. Impacts

- Loss of topsoil from excavation areas.
- Loosening of topsoil and loss of vegetative cover (land clearing) along the route and construction areas due to excavation and back filling which lead to enhance soil erosion.
- Compaction of alluvial soils by earth moving equipment.
- Solid waste disposal along the route also adds to impact on the land environment during the construction phase.

b. Mitigation measures

- During excavation, care will be taken to see that the topsoil and the subsoil are stored separately. Topsoil (50cm) of route pits will be conserved and restored after excavation is over and will be replaced back for filling of the pit areas. Whereas the top soil (25cm) stripped from agricultural field and forest area will be stacked separately as top soil dump of not more than 1m in height and the same will be redistributed to the pit after laying of pipeline. During refilling, care will be taken to see that the topsoil is replaced back at the top while refilling after laying of pipeline. This will help grasses growing earlier on the surface, to grow back. Also, the less fertile soil of lower horizon will not be placed on the top thus avoiding degradation of land.
- Back filling shall be carried out immediately after the pipeline has been laid in the trench. On no account the topsoil from ROW shall be used for this purpose. The backfill material shall not contain any extraneous material and/or hard lumps of the soil. After the initial backfill has been placed into the trench to a level slightly above the surrounding ground, the backfill material shall be compacted.

- When the trench has been dug through driveways or roads all backfills shall be executed with sand or a suitable material and shall be thoroughly compacted
- Trench excavated in dykes which are the property of the railways or which is part of main road shall be graded and backfilled in their original profile and condition
- Also necessary contour bunding, gully plugging and staggered trenching shall be carried out wherever required in the pipeline corridor and in areas where excavated soil will be dumped to check soil erosion
- Stone pitching will be provided at the slopes near the irrigation and natural drainage / rivers to prevent silting of soil into these water bodies.

4.2.5 ECOLOGICAL ENVIRONMENT

The initial construction work at the pipeline route involves land clearance, but it would not include clearing of trees. However, the pipeline runs along/ in the protected forest area as well as the ecologically sensitive region.

All the construction work will be carried out in the premises of the pipeline boundary and the CNG station boundary only. Development of Green belt all around the stations will be started along with the construction activities to contain the dust and noise due to construction activities within the boundary. Therefore, no impact on the ecological environment is proposed due to the construction activity of the project.

a. Impacts

- The proposed pipeline passes through notified protected forest land, but no vegetation clearance will be undertaken as part of the pipeline route laying activity.
- The proposed project may not cause any impacts on fauna and wildlife of the study area during construction phase.
- No wildlife corridor and migratory routes comes in the pipeline route. Construction activity during monsoon and post monsoon period may not cause any impact on the movement of wildlife.

b. Mitigation measures

- No vegetation clearance will be undertaken in the pipeline route as well as the CNG stations plot boundary
- While planning / selection of route care to be taken to route the pipeline alignment in such a way to avoid areas with trees and shrubs and thus no major impact of loss of vegetation is anticipated.

4.2.6 SOCIO-ECONOMIC ENVIRONMENT

The project will provide either direct or indirect job opportunities to the local population as far as possible. There will be some migration of skilled labor force from outside the project area during

construction phase, which may put some pressure on the local settlements and resources. Considering the size and type of construction activities envisaged the immigration of work force for construction phase (including contractor' labours) would have marginal impact on demography (e.g. changes in total population, sex ratio, literacy level, main workers etc.) of the immediate vicinity area.

In addition, Traffic volume might will increase on nearby roads and the project roads due to movement of heavy vehicles during the construction phase, which may cause public inconvenience. This will have minimal affect considering the size and nature of the Project.

a. Impacts

- Strain on civic amenities (like road, transport, communication, water supply and sanitation, health care and recreational utilities etc.) due to increase in floating population.
- Increase in traffic volume and congestion in the areas and roads.
- Increase in employment opportunity to non-workers in the project area as nonskilled and semi-skilled workers.

b. Mitigation Measures

- It is difficult to assess the above impacts quantitatively on a measurable scale. However, most of these impacts will be short term and limited to the construction period only.
- Development of traffic management plan to ease the situation.
- Transport of construction materials and machineries shall be carried out during lean traffic period of the day or during night.

4.3 IMPACTS & MITIGATION MEASURES- OPERATION PHASE

The impact during the operation phase will be continuous in nature. For a gas-based pipeline and CNG station the potentials for imparting adverse impacts is not high. However whatever impact on environment is present will be minimized through incorporation of efficient technologies for pollution control measures.

4.3.1 AIR ENVIRONMENT

a. Impacts

- The pipeline will be 1.2-2 m below the ground and thus no air pollution due to operation of the project is anticipated.
- Some vehicular emission from maintenance is anticipated during maintenance phase, which will be temporary

- The impacts of the operational CNG station would not have any impacts on Air pollution of the area. The increased frequency of the vehicles at the station would not lead to any increased air pollution.

b. Mitigation Measures

Not Required

4.3.2 NOISE ENVIRONMENT

a. Impacts

- The pipeline will be 1.2 m below the ground and thus no noise pollution due to operation of the project is anticipated
- The residents / staff may be exposed to high noise levels during maintenance phase, which will be temporary.
- Noise and vibration during operations will be gas engine, various major and large compressors, air compressor, ventilation fans and miscellaneous equipment's for the CNG stations

b. Mitigation Measures

- In the stations, a closely spaced green belt to be planted all around the premises to attenuate noise
- Machinery to be maintained and lubricated as per manufacturers' guidelines to reduce noise generation.
- Personnel deployed in compressor stations will be issued personal noise protection equipment (ear plugs, ear muffs)
- If necessary, their duty hours will be regulated to keep noise exposure levels within standards.
- All equipment in the station would be designed / operated to have a noise level not exceeding 85dB, as per the requirement of Operational and Safety and Health Administration Standard (OSHA).
- Adopting modern design and the use of sound-absorbing materials will minimize noise and vibration from the station.

4.3.3 WATER ENVIRONMENT

a. Impacts

- The material/product to be transported is compressed gas, so during the operation period, the expected impacts on the water resources are not anticipated.

- The aquatic biological environment in the vicinity of the proposed project pipeline will not be affected, as no discharge is proposed form the CNG stations. Hence, there will be no impact on aquatic ecosystem due to operation of the project.

b. Mitigation Measures

- The discharge from the toilets from the stations will be routed to through the sewage pipelines to the nearest treatment plant, No open discharge will be done.

4.3.4 ENVIRONMENT, HEALTH AND SAFETY

c. Impacts

5. There could be impacts on environment, health and safety due to leakage from pipelines from likely external physical forces, e.g. seismicity, floods, landslides, permafrost, vegetation;

- . **Mitigation Measures**
  - Leak Detection and Control System shall be in place
  - SCADA monitoring shall be carried out by AGL
  - Mock Drills shall be conducted at regular intervals in line with Emergency Response and Disaster Management Plan of AGL

Prevent leaks by

- Installing positive pipe corrosion control measures, for example, coatings, cathodic protection, chemical additives, heaters;
- Ensuring that the SCADA is well maintained and used correctly to control flow and pressure.
- Detect leaks by installing leak detection equipment, e.g. monitoring the flow in the pipe through pressure sensors connected to alarms and automatic pump shutdown systems;
- Continuous metering to provide a comparison between input and output for leak detection;

- **Emergency response**

- Introduce accident, fire and explosion precautions and emergency response procedures;
- These should be tested and drills should occur regularly with appropriate reporting on response times etc.;
- Introduce environment, health and safety training for all employees and contractors;
- Plan the route of the pipeline to reduce the impact on the surrounding area;
- Bury pipelines along the entire length to a minimum of 1m to the top wherever possible;
- Schedule periodic inspection and maintenance to avoid disturbance/disruption of sensitive habitats;
- Good housekeeping should be maintained at all times in all areas of the site;

Prevent unauthorised or unintentional intrusion to protected areas through fencing or flagging;

5 ADDITIONAL STUDIES

5.1 QUANTITATIVE RISK ASSESSMENT

Quantitative Risk Assessment (QRA) study should be undertaken for the proposed 8"& 4" diameter underground pipeline for the transfer of compressed natural gas. The aim of QRA study will be to identify potential hazards, assess the consequences and frequency of hazards and evaluate the risk to personnel, property and public. To assess the relative level of risk posed by the proposed project, a comparison will be made with risk criteria that is considered tolerable (ALARP) for similar operations

The overall approach and methodology employed for the study will be based on the guidelines given in IS 15656 : 2006, Indian Standard – Hazard Identification and Risk Analysis – Code of Practice, May 2006, using PHAST Software/Correlations.

The pipeline system will be provided with state of the art safety systems like protection system, SCADA, leak detection system / pipeline application software, Fire and gas detection systems, etc. The proposed transfer of gas will be examined for inherent hazards or the potential to result in an unplanned event or sequence of events at different sections along the pipeline route. Several hazards that can cause failure of pipelines will be identified. These included loss of integrity/ damage due to interference from third parties, corrosion, accidents, human error, sabotage, etc., during normal operation. Analysis of past accidents are to be used to establish the credibility of accident scenarios.

5.2 GUIDELINES FOR EMERGENCY RESPONSE PLAN

Emergency response plan will be developed with the resources available within the company. The important stages of the response plan are declaration of an emergency, identification of resources & manpower, ending of an emergency and rehearsal of the plan. Declaration of an emergency would involve recognizing a leak and reporting to Station in charge of nearest compressor station.

Other features are summarized below:

Emergency Response Structure: An emergency response structure will be developed for effective response to the emergency. The structure defines the main functions of the decision makers and the individual roles as well.

Roles & Responsibilities of Team: Emergency response team (ERT) to respond to fire, accidents and technical emergencies will be constituted from operations personnel, who can be called upon 24 hours a day, supported by senior management field personnel as and when

required. The ERT will receive specific training for their roles and exercised on a regular basis. The proposed functions of employees that are planned to be deployed will be finalized prior to commissioning.

Operations Control: The pipeline operation will be monitored and controlled through Local control system and POC in command which will have the provision for emergency shut down or isolation of Pipeline. Security: Surveillance of the entire pipeline will be held periodically through ground patrolling. Using operators with knowledge of local area will be deployed for ground patrolling of the pipeline route.

Medical and First Aid: All arrangements will be made available at SHPPL site offices and camps for medical and first-aid. First–Aid facility will be provided at compressor stations, master pipeline operation center/ local control center, MLVs and M&Rs. Adequate first-aid training will be provided to employees at these locations.

Communication: Responsibility for external and internal communication will be assigned at each station. Dedicated fiber optic cable based communication system will be provided for quick communication between the control stations, dispatch and delivery station(s) of the pipeline. The backup system will consist of appropriate combination of fixed telephone lines/data-bandwidth of the local service provider, mobile phones, VHF sets etc.

Emergency control room: A safe location will be designated as emergency control room (ECR) within the compressor stations.

Emergency Procedures: SHPPL will evolve easy-to-follow procedures for responding to the identified situation. The plan will be rehearsed once in three months.

Ending of an emergency: After controlling an emergency, the site ERT Leader will declare as “All Clear”. The siren will be sounded for 2 minutes to indicate that the Emergency is over.

The basic elements for an effective plan have been included in the development. Prior to the commissioning of the project, copies of the plan are to be given to the authorities.

5.3 STAKEHOLDER CONSULTATIONS

Stakeholder Consultation” refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project or activity are

ascertained with a view to taking into account all the material concerns in the project or activity design as appropriate.

Consultations were done at all districts of the projects, along the pipeline route. These meeting included the Project Influenced and benefitted Population in three districts. This was undertaken to understand the socio-economic status, education facilities and the literacy levels of the population as well as their interest in the upcoming project in their area.

The delineation of Preliminary Stakeholders were based on the following points,

- The type of stakeholders, and;
- Their connection and influence levels on the project.

An open-ended questionnaire was prepared for the focus group discussions prior to the start of the consultation process to obtain the information from the population. Different stakeholder groups were consulted to understand the concerns/ issues, expectations/ benefits and other advantages that they have on the project.

Representatives of AGL

Sr. No.	Name	Project Site/Corporate Office	Department
1	Mr. Vinod Sahu	Project Site	Project
2	Mr. Prashant Kumar	Project Site	Project

Discussions with Local Inhabitants Village 1

Name of the village : Bilaspur
Panchayat : Bilaspur Tehsil/Taluka : Bilaspur
District : Bilaspur

Participants:

S.No.	Name	Village	Occupation	Land ownership/Local Inhabitants in vicinity of Project Site
1	Ram Bachan	Bilaspur Town	Farmer/ Business	--
2	Turiya Jhor	Bilaspur Town	Farmer/Shop Owner	--
3	Kishna Kujur	Bilaspur Town	Salaried Employee	--

Sr.No.	Questions	Responses
1	Total population of the area:	2,663,629
2	Average Household Size:	5-6
3	Literacy rate:	88.13 %
4	Caste/tribe details:	Schedule Caste (SC) constitutes 20.8% while Schedule Tribe

		(ST) were 18.7% of total population in Bilaspur district of Chhattisgarh
5	Religion:	88% Hindu, 7 % Muslim, 3 % Christian
6	Ethnic Group	Indians
7	Major Occupation:	Farming, Service, Business
8	Crops Grown:	Paddy, wheat, pulses
9	Land Holding details:	1-10 Acres
10	Type and number of livestock per household:	Cows, Bulls, Goat
11	BPL Holders/Other government scheme:	20%
12	Educational facilities:	Higher Secondary School
13	Transport facilities:	State Bus
14	Health care facilities:	Hospital
15	Water Supply facilities:	Tap and handpump
16	Electricity facilities:	24 Hrs
17	Role of Women:	Household work
18	Veterinary facility	Yes
19	Fertilizer shop	Yes
20	Fair price shop	Yes
21	NGO working in the area	None
22	Government scheme	MNREGA
23	Cultural Site	None

Summary of Responses received from locals residing in area

Questions	Summary of responses received from affected parties
What is the present mode of cooking (Fuelwood/ LPG/Kerosene Stove)	Fuel-wood/ LPG Cylinder
Is there any piped gas supply in the vicinity?	No
Any apprehensions/concerns/odour/safety issues w.r.t. present project in the area	Yes, about fire and explosion safety. Suggests that a demo to be given to the village about the safety aspects of gas pipeline
Are people contended with fuel switchover from present mode to Piped Gas Supply?	Yes, very much willing. Had heard of the project and are eagerly waiting as it will help in business and residential proliferation.
Are the people contended with the present upcoming project in the area?	No

Have any of the locals objected so far/raised Grievance related to similar projects/proposed project?	No
What is the general perception about CGD projects?	Very positive
Other projects nearby or any other industry	--

Summary of Responses received from land sellers (near to Tap Off Station in case of Pvt. Land Parcel)

Questions	Summary of responses received from affected parties
What is the Land Use of the project site?	Non irrigated farmland. Exact land is not yet decided.
Has any land from local villages been acquired for the project?	--
Are the land disbursers contended with the remuneration received?	--
Have any of the landowners who sold their land for the project gone landless?	--
What is the general perception about CGD Projects?	Positive
Other projects nearby or any other industry	The CGD project is coming in the major towns of the district. There are no other gas distribution project in the districts.

Source: TUVSUD Primary Survey

6 ANALYSIS OF ALTERNATIVES

Route selection is a process of identifying constraints, avoiding undesirable areas and maintaining the economic feasibility of the pipeline. Diversion of pipeline around obstacles can be very costly. The ideal route, of course, would be a straight line from the origin to the terminal point. However, physiographic, environmental, design and construction constraints usually alter the route

The pipeline route should be optimized based on the following considerations:

- Safety of public lives and property and safety of the pipeline from engineering and other considerations.
- Shortest pipeline length.
- Easy and favorable terrain condition free of large water bodies, low lying marshy lands, obstacles like ravines, depressions and unstable grounds, meandering rivers, etc.
- Ground profile for pipeline hydraulics and avoidance of steep rising and falling ground, hills and valleys having sloping right of way.
- Availability of infrastructure and access to the pipeline route during construction and maintenance.
- Environmental impact and avoidance of environmentally sensitive lands, such as reserved forests, marine parks, built-up areas, places of worship, burial and public events.
- Minimum crossing of existing pipelines, transmission lines, parallel alignment, etc.
- Minimum road, rail, river and canal crossings.
- Avoidance of rugged and intricate grounds with hard strata, exposed rocks, boulders and quarries.
- Existing and future developments in the region, such as roads, rail lines, canal network, reservoirs, townships, industrial units, etc.
- Scope for future expansion of the pipeline.

The Petroleum and Natural Gas Regulatory Board (PNGRB) was constituted under The Petroleum and Natural Gas Regulatory Board Act, 2006 (NO. 19 OF 2006) notified via Gazette Notification dated 31st March, 2006. The Act provide for the establishment of Petroleum and Natural Gas Regulatory Board to protect the interests of consumers and entities engaged in specified activities relating to petroleum, petroleum products and natural gas and to promote competitive markets and for matters connected therewith or incidental thereto.

Further as enshrined in the act, the board has also been mandated to regulate the refining, processing, storage, transportation, distribution, marketing and sale of petroleum, petroleum products and natural gas excluding production of crude oil and natural gas so as and to ensure uninterrupted and adequate supply of petroleum, petroleum products and natural gas in all parts

of the country. Hence the project was acquired through the bidding process and the area, number of customers, total CNG stations were already mentioned in it. So the route selection was done within the allotted area.

The options for applying and analysis for alternatives was not a feasible option, as the deadlines have been already mentioned and the work was supposed to start from the date of signing the document. Since all the requirements in the projects were predefined, scope for alternate analysis was quite slim, as to which the route passes through mix and heavily populated area, eco-sensitive zones and the notified protected forest zones.

Currently the project is in conceptual stage and pipeline route are still being assessed and finalized.

7 PROJECT BENEFITS

7.1 CONTRIBUTION TO NATIONAL ENERGY SECURITY

Energy is the key input for economic growth and Indian Energy sector play a vital role in country's Economy. Energy is a key input to the production processes that transform inputs to goods and services. India became the third largest energy consumer in the world after United States and China. Key drivers for increasing energy demand in India are population growth, industrialization and urbanization. Energy security and sustainability are interdependent because emissions from energy consumption contributes to climate change in greater extend globally. Indian government is also committed to increase the share of natural gas in country's energy mix up to 15% by 2030 and Ministry of Petroleum and Natural Gas intervening with policy reforms in natural gas sector. India requires a sustained supply of energy to support its ambitious growth and welfare targets for the coming years. In a survey by NITI Aayog, it was noted that India's energy consumption will reach 2,300 million tonnes of oil equivalent (mtoe) by 2047 out of which natural gas will contribute 173 mtoe under the determined effect scenario.

According to the International Energy Agency(IEA), Indian gas market is considered one of the most growing energy markets in the world, the Agency expected that Indian gas demand will increase in the coming decades at 5.4% per annum over 2007-30 (IEA ,2009) reaching 132 BCM by 2030. India had about 43.8 TCF of proved natural gas reserves by the end of 2012; production of natural gas arrived in 2011, 2012 to 47.559 BCM, India was self-sufficient in natural gas until 2004, where it began to import liquefied natural gas from Qatar to meet the growing needs where India occupied the sixth rank globally in the import of natural gas. In spite of the Indian increase production of gas in 2010, an increase of up to more than 44%, but India and because of the high economic growth has increased the import at an annual rate of 10 % from 2001-2011. In 2011, India consumed 2.3 trillion cubic feet (TCF) which is equivalent to a quarter of the Indian natural gas needs. Qatar is India's main supplier of liquefied natural gas, where the parties signed long-term contracts to supply India around 7.5 million tons of LNG every year from Qatar for 25 years and the first shipments has reached to India in 2004.

With the growing need for oil and gas in India since the nineties of the last century, the Indian government has worked to develop the oil and gas sector through the development of mechanisms of action and the issuance of new regulatory laws, 1993, private investors have been allowed to import and market liquefied petroleum gas (LPG) and kerosene freely, private investment is also allowed in lubricants, which are not subject to price controls. In the 11th Five Year Plan, the Indian government has focused in particular on the energy sector in order to self-reliance for energy resources, particularly oil and gas by encouraging of exploration and

extraction operations and reduce dependence on overseas. The government also worked on the development of oil and gas infrastructure such as pipelines, refinery, ports, and railways. India currently has 22 refineries with a capacity (215.066 MMTPA),17 refineries under public sector and 3 under private sector. The Indian government is also working to improve of the oil and gas pipelines, and in spite of networks of gas and oil pipelines are still weak but the government is seeking to develop it, in collaboration with private sector companies.

7.2 REDUCED RISKS & COSTS

Natural gas pipeline has been regarded as the most cost effective and safest channel of gas transportation and has extraordinary strategic significance for the country. Pipeline is regarded as the most cost effective and safest channel to transport the oil and gas from upstream oil field or port to the downstream users or refineries. The gas is significantly replaced by oil in all sectors i.e. power generation, domestic and transportation due to price hike in oil prices globally and cheaper availability of natural gas. During the last five years the oil import has reduced by 8 %. The other reason for that may be the availability of cheaper, safe and durable mode of gas transportation system (main and distribution network of pipeline), which is continuously expending.

The gas pipeline projects help in reducing the travel cost in comparison to other resources and it is also very safe and cheaper for domestic, commercial and industrial uses. The proposed pipeline project would be very feasible and cost effective as it is totally underground and there will be continuous access to the gas for the use.

7.3 SOCIO- ECONOMIC DEVELOPMENT

The proposed project will create socio-economic development across the pipeline route and in the near vicinity as well. The project will provide employment during construction and operation phase to the local labours. Further, it also helps in the development across the project area by providing the CNG stations along the roads and gas pipeline supplies to the households and commercial establishments. The proposed project will provide 40 CNG stations and 01 LNG station throughout the project route due to which the local community can easily access the cheapest way for their transportation.

8 ENVIRONMENTAL MANAGEMENT & MONITORING PROGRAM

8.1 INTRODUCTION

The Environmental Management Plan (EMP) provides an essential link between predicted impacts and mitigation measures during implementation and operational activities. EMP outlines the mitigation, monitoring and institutional measures to be taken during project implementation and operation to avoid or mitigate adverse environmental impacts, and the actions needed to implement these measures. The likely impacts on various components of environment due to the project during developmental activities have been identified and measures for their mitigation are suggested. The EMP lists all the requirements to ensure effective mitigation of every potential biophysical and socio-economic impact identified in the EIA. For each attribute, or operation, which could otherwise give rise to impact, the following information is presented:

- A comprehensive listing of the mitigation measures
- Parameters that will be monitored to ensure effective implementation of the action.
- Timing for implementation of the action to ensure that the objectives of mitigation are fully met

The EMP comprises a series of components covering direct mitigation and environmental monitoring, an outline waste management plan and a project site restoration plan. Therefore, environmental management plan has been prepared for each of the above developmental activities.

8.2 ENVIRONMENT MANAGEMENT PLAN

Table 8-1: Environment Management Plan

Aspect	Impacts	Mitigation Procedure	Monitoring Action	Responsibility	Timing
Air Pollution	Dust generation	• Access limited to demarcated ROW and specified access roads. · Strict enforcement of project speed limits · • Reinstatement as early as practical · • Damping down of ROW · • Identification of areas of particularly sensitive receptors (e.g., villages or crops)	• Review and approval of the contractors Transport management plan, Pollution Prevention Management Plan, detailed construction method statements and Reinstatement Plan	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction

	Metal Vapour Emissions	Ensure adequate ventilation and dispersion of vapours Ensure welding is undertaken by appropriately trained personnel	• Review and approval of the contractors Employment and Training Management Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
	Combustion gases (CO2, CO, NO2, NO, SO2, PM, CH4, VOCs)	• Maintenance of all vehicles and plant to meet relevant international standards and manufacturer's recommendations· • Monitoring of vehicle and plant emissions · • Optimization of plant running time (where appropriate)	• Review and approval of the contractors Transport management plan, Pollution Prevention Management Plan, Construction Camp Management Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period

			• Spot checks on the contractor's performance • Routine review of discharge monitoring data	AGL	• Throughout Construction Period
	Vehicle movements	• Selection of appropriate routes for vehicles using public road network and project access roads · • Provision of environmental training for vehicle drivers and equipment operators · • Control of operational speeds and operating times · • Maintenance of vehicles and plant	• Review and approval of the contractors Transport Management Plan, Infrastructure and Services Management Plan and Employment and Training Management Plan	AGL	• Pre-construction
			• Routine monitoring, documentation and review of traffic management and training processes	Contractor	• Throughout Construction Period
			• Collection and review of incident and near miss data	Contractor	• Throughout Construction Period
			• Spot checks on procurement and waste management processes Routine review of incident and near miss reports	AGL	• Throughout Construction Period
Noise Pollution	Noise emissions	• Control of vehicle and plant noise generation · • Control of operating hours ·	• Review and approval of the contractors Transport management plan, Construction Camp	AGL	• Pre-construction

		• Appropriate selection and maintenance of plant, vehicles and access routes · • Appropriate selection of construction techniques · • Community liaison • Ensure environmental considerations are incorporated into the siting and design of camps · • Implement workforce education with respect to minimising disruptive activities. • Incorporate into the project induction training· • Implementation of camp rules including restrictions on noisy activities	Management Plan, Pollution Prevention Management Plan, Infrastructure and Services Management Plan, Community Liaison Management Plan, Procurement and Supply Management Plan and detailed construction method statements.		
			• Routine monitoring, documentation and review of application of mitigation measures	Contractors	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-monitoring
Water Pollution	Disposal of liquid wastes/water (Hydro test Specific Measures)	• Risk assessment to be undertaken before any chemical additives are used in hydro test water	• Review and approval of the contractors Pollution Prevention Management Plan, Procurement and Supply Management Plan, Waste	AGL	• Pre-construction

		• Controlled discharge of water to reduce soil erosion Testing and treatment of water before discharge • Responsible disposal of waste water; no disposal of incompatible water in areas of groundwater or surface water vulnerability	Management Plan, Infrastructure and Services Management Plan and detailed construction method statements		
			• Routine monitoring, documentation and review of application of mitigation measures	Contractors	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
	Abstraction of Ground Water	• Sampling and analysis of water from existing boreholes . • Adherence to national and local licensing policy for abstractions · • Test-pumping of new abstractions and monitoring of impacts on existing abstractions · • Monitoring of water levels in wetlands	• Review and approval of the contractors Pollution Prevention Management Plan, Infrastructure and Services Management Plan, Community Liaison Management Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractors	• Throughout Construction Period

		• Ensure appropriate consolidation of backfill · • Implementation of erosion control measures • Ensure that groundwater disposal is undertaken in accordance with the Construction Environmental Management Plan· • Filter discharge if contains visible suspended solids · • Use of appropriate measures to minimise scour at the discharge point	• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
	Disruption of drainage / irrigation channels	• Undertake pre-construction surveys of irrigation and drainage systems as necessary to identify existing systems and devise temporary replacement measures if required, · • Undertake liaison with land owners/land occupiers/land users · • Include provisions for	• Review and approval of the contractors Infrastructure and Services Management Plan, Community Liaison Management Plan, Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period

		drainage/irrigation management	• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
	Increased flood risk	• Ensure that gaps are left in topsoil stacks to allow floodwater through · • Ensure the continued viability of pre-existing drainage and irrigation systems throughout the project	• Review and approval of the contractors Infrastructure and Services Management Plan, Community Liaison Management Plan, Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
	Disposal of	• Ensure that trench-water	• Review and approval of the	AGL	• Pre-construction

	trench-water	disposal is undertaken in an appropriate manner	contractors Pollution Prevention Management Plan, Waste Management Plan, Reinstatement Plan and detailed construction method statements		
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
	Sediment release	• Avoid open cut river crossings during monsoon season· • Include environmental considerations in the selection of crossing design and choice of methodology	• Review and approval of the contractors Pollution Prevention Management Plan, Emergency Response Plan, Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
	Modified river flow		• Review and approval of the contractors Infrastructure and Services Management Plan, Community Liaison	AGL	• Pre-construction

			Management Plan, Reinstatement Plan and detailed construction method statements		
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
Land & Soil	Use of raw materials & natural resources	• Development and implementation of procurement, supply and waste management procedures	• Review and approval of the contractors Procurement and Supply Management Plan and Waste Management Plan	AGL	• Pre-construction
			• Routine monitoring, documentation and review of procurement and waste management processes	Contractor	• Throughout Construction Period
			• Spot checks on procurement and waste management processes	AGL	• Throughout Construction Period
	Railway Crossing	• Mitigation measures to be formulated in conjunction with	• Review and approval of the contractors Transport	AGL	• Pre-construction

		local railway department	management plan, Infrastructure and Services Management Plan, Community Liaison Management Plan, Community Safety Management Plan and Procurement and Supply Management Plan		
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Throughout Construction Period
	Potential for accidental spillage of hazardous materials (e.g. lubrication fluids, oils, paints, diesel etc.).	• Development and implementation of specific procedures for hazardous materials management • Minimisation of acquisition and storage of hazardous materials Training of personnel in safe use &	• Review and approval of the contractors Pollution Prevention Management Plan, Employment and Training Management Plan, Transport Management Plan, Procurement and Supply Management Plan, Waste Management Plan,	AGL	• Pre-construction

		handling of hazardous materials • Provision of appropriate spill response equipment and spill response training Rapid response in event of spillage	Emergency Response plan, and construction method statements		
			• Recording and regular review of incidents and near misses	Contractor	• Throughout Construction Period
			• Routine monitoring, documentation and review of training, procurement, storage and waste management processes	Contractor	• Throughout Construction Period
			• Spot checks on contractor performance and record keeping Routine review of incident and near miss data.	AGL	• Throughout Construction Period
	Disturbance of land surface & vegetation	• Vehicle movements confined to defined access routes • Provision of environmental training to drivers and plant operators • Community liaison to discourage local use of ROW as road Common access routes to be used for pipeline were practical Traffic movements to be preceded by an assessment of ground conditions	• Review and approval of the contractors Transport Management Plan, Infrastructure and Services Management Plan, Community Liaison Management Plan and Community Safety Management Plan	Contractor	• Throughout Construction Period
			• Routine monitoring, documentation and review of traffic management and community liaison processes	Contractor	• Throughout Construction Period
			• Spot checks on traffic management, training and	AGL	• Throughout Construction Period

			• community liaison processes. • Routine review of access route condition and adherence to defined access routes.		
	Soil compaction	• Protection of soil storage areas from vehicle movements · • Protection of soil surface in areas of soft ground · • Provision of appropriate drainage and regular regrading	• Review and approval of the contractor's management plans, detailed construction method statements and Reinstatement Plan	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
	Soil erosion	• Implementation of erosion control measures · • Compaction of soil stack surface to minimize erosion · • Preparation & implementation of approved crossing methods	• Review and approval of the contractors Pollution Prevention Management Plan, Reinstatement Plan and detailed construction method statements (with specific attention to those concerning river crossings)	AGL	• Pre-construction

			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
	Loss of soil structure and fertility	• Ensure appropriate segregation, storage, management and reinstatement of stripped soil	• Review and approval of the contractor's management plans, detailed construction method statements and Reinstatement Plan	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
	Loss of viability of soil seed bank	• Undertake an environmental review of the route to identify areas where preconstruction seed collection, harvesting of seeds from surrounding areas and/or the establishment of	• Review and approval of the contractor's management plans, detailed construction method statements and Reinstatement Plan	AGL	• Pre-construction
			• Routine monitoring,	Contractor	• Throughout

		nursery crops should be carried out · • Ensure appropriate segregation, storage, management and reinstatement of topsoil	documentation and review of application of mitigation measures		Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
	Modified topography	• Ensure that reinstatement is sympathetic to existing contours	• Review and approval of the contractors Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
	Disposal of surplus subsoil	• Ensure that the generation of surplus soil is minimised and that disposal is conducted appropriately · • Ensure that any potential subsoil disposal sites and disposal plans are subject to an environmental review prior	• Review and approval of the contractors Waste Management Plan, Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of	Contractor	• Throughout Construction Period

		to their adoption	application of mitigation measures		
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary additional assessments and development of appropriate mitigation actions	AGL	• Pre-construction
	Disturbance of known/unknown contaminated land	• Avoid construction in areas of known or suspected contamination as far as is practical · • Ensure that where contaminated land is encountered it is effectively managed	• Review and approval of the contractors Pollution Prevention Management Plan, Waste Management Plan, Reinstatement Plan and detailed construction method statements	AGL	• Pre-construction
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary additional assessments and development of appropriate mitigation actions	AGL	• Pre-construction
	Potential for	• Adequate geotechnical	• Review and approval of the	AGL	• Pre-construction

	drilling fluid breakout/spillage (During HDD)	survey work conducted during design · • Risk assessment to be undertaken before drilling in vicinity of sensitive surface waters · • Storage of drilling muds in bunded area · • Avoid use of toxic chemicals in drilling fluid	contractors Pollution Prevention Management Plan, Emergency Response Plan, Waste Management Plan and detailed construction method statements		
			• Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period
			• Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			• Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
Ecology	Loss of habitat	Development and implementation of: · • Environmental management plans· • Construction method statements (including clearance) • Transport Management	Review and approval of the contractor's management plans, detailed construction method statements and reinstatement plan	AGL	• Pre-construction
			Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout Construction Period

		(including route selection) • Reinstatement Plan Additional ecological surveys and translocation programmes	Spot checks on the contractor's performance	AGL	• Throughout Construction Period
			Spot checks on completion of all necessary pre-construction assessments and development of mitigation actions for sensitive sites	AGL	• Pre-construction
			Routine monitoring of species translocation programmes	AGL	Pre-construction and during construction in sensitive areas
	Impeded movement of wild animals, and domestic herds	• Ensure that gaps are left in soil stacks at strategic locations · • Leave gaps in welded strings at critical locations to allow passage of domestic herds · • Minimise interval between welding and ditching	Review and approval of the contractors Community Liaison Management Plan, Infrastructure and Services Management Plan, detailed construction method statements and Reinstatement Plan	AGL	• Pre-construction
			Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout construction period
			Spot checks on the contractor's performance	AGL	• Throughout construction period
	Public & animal safety	• Erection of warning barriers	Review and approval of the contractors Community Safety	AGL	• Pre-construction

		where significant risk to public and livestock exists · • Installation of soft plugs in ditch with sloped edges to allow animal egress	Management Plan, Infrastructure and Services Management Plan, Reinstatement Plan and detailed construction method statements		
			Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout construction period
			Spot checks on the contractor's performance	AGL	• Throughout construction period
Social	Vehicle Movements	• Selection of appropriate routes for vehicles using public road network and project access roads · • Provision of environmental training for vehicle drivers and equipment operators · • Control of operational speeds and operating times · • Maintenance of vehicles and plant	Review and approval of the contractors Transport Management Plan, Infrastructure and Services Management Plan and Employment and Training Management Plan	AGL	• Pre-construction
			Routine monitoring, documentation and review of traffic management and training processes	Contractor	• Throughout construction period
			Collection and review of incident and near miss data	Contractor	• Throughout construction period
			Spot checks on procurement and waste management processes Routine review of incident and near miss reports	AGL	• Throughout construction period
	Partial road closure	• Use non-open trench crossing techniques for major roads ·	Review and approval of the contractors Transport Management Plan, Infrastructure	AGL	• Pre-construction

		• Minimise duration of closure of roads and provide temporary access where necessary · • Use steel plates across trench to maintain access · • Institute temporary traffic control, where necessary · • Undertake community consultation	and Services Management Plan, Community Safety Management Plan, Community Liaison Management Plan, Reinstatement Plan and detailed construction method statements		
			Routine monitoring, documentation and review of application of mitigation measures	Contractor	• Throughout construction period
			Spot checks on the contractor's performance	AGL	• Throughout construction period
	Loss of boundaries	• Reinstatement of boundaries following construction · • Ensure consultation with landowners, occupiers and users	Review and approval of the contractors Infrastructure and Services Management Plan, Community Liaison Management Plan and Reinstatement Plan	Contractor	• Throughout construction period
			Routine monitoring, documentation and review of traffic management and community liaison processes	Contractor	• Throughout construction period
			• Spot checks on community liaison processes. • Routine review of access route condition and adherence to defined access routes.	AGL	• Throughout construction period

	Grievance Redressal Mechanism	Community Grievance Process	Spot follow up of complaints recorded in complaints register to assess whether process has been carried out correctly.	AGL	• Monthly during Construction period
		Implementation of general construction mitigation measures	Spot checks at ROW, construction sites and affected communities to ensure mitigation measures are being implemented. This will look specifically at: · • Implementation of measures to avoid disruption to infrastructural services such as telecoms, electricity, gas and water. · • Implementation of community safety measures (fencing near residential areas, fencing on public trench crossings, warning lights and warning signs at open areas of trench). • Suitable diversions are in place where necessary · • Dust and noise mitigation measures are in place · • Alternative water sources are provided as appropriate	AGL	Monthly for first 3 months. If implementation of mitigation measures is proceeding appropriately, reduce monitoring to bimonthly with review of written activity reports submitted on a weekly basis.

Health and Safety		Community Safety	• Spot monitoring of health and safety incidence rates for community members and full review of any serious incidents. • Spot monitoring of community traffic safety meetings	AGL	Monthly Two to three times in first four months and if training is seen as acceptable, revert to once every six months. If training is not of sufficient quality, then continue at two to three every four months.
		General Safety Measures during	Spot monitoring of implementation of safety measures during construction as outlined in 'Implementation of general construction mitigation measures', General Construction Impacts section above.	AGL	Monthly for first three months. If implementation of mitigation measures is proceeding appropriately, reduce monitoring to bimonthly with review of written activity reports submitted on a weekly basis
		Health and safety training	Monitor HR records to ensure training is provided to all workers and spot monitor all courses (general health and safety, safe driving training, job specific health and safety) provided to ensure training is adequate	AGL	

8.3 MONITORING SCHEDULE

The objectives of monitoring are:

- To check effectiveness of mitigation measures
- To evaluate the adequacy of Environmental Impact Assessment
- To assess status of compliance to legal requirements
- To assess if the Environmental Management Plan needs revisions/ updating.

The proposed environmental monitoring program during both construction and operation phases of the project are given in Table below:

Table 8-2: Environment Monitoring program- Construction & Operation Phase

S. No	Component	Location	Parameters	Frequency
Construction Phase				
1	Stack emission characteristics	Stacks attached to emission sources (e.g. DG sets)	Stack monitoring for PM, SOx, NOx and HC	Once in a month
2	Ambient air quality	Nearest Residential Areas, and busy commercial locations	Ambient air quality parameters as per NAAQS viz. PM10, PM2.5,SOx, NOx, CO	Once in a month
3	Ground water quality (used as source of domestic water)	Point used for drinking water	Parameters listed in ISO:10500	Once in a month
4	Effluent quality	Discharge header of hydrotested pipeline/ tank	According to general discharge standards	As per requirement
5	Waste (including hazardous)	Construction sites and camps	Quantity/ volume generated and disposed	Once in a day
6	Equipment noise levels	1 m from DG set	dB(A)	Once in a month
7	Ambient noise levels	Nearest residential areas/ Silent zones etc	Ambient noise levels (Leqday & Leqnight)	Once in a month
Operation Phase				
8	Greenbelt development		Plant density, health, growth and survival rate	Once in 6 months
9	Waste (including hazardous)	At CNG stations	Quantity/ volume generated and disposed at new CNG facilities	Once in a month

10	Effluent quality	At CNG stations	Monitoring of treated water from outlets of ETP & STP	Once in 6 months

9 SUMMARY & CONCLUSIONS

9.1 SUMMARY OF IMPACTS

Among the pipeline lifecycle stages of construction and operations, due to temporary nature of the pipeline laying/construction, most impacts are likely to be short term and reversible in nature. The impacts that shall be most significant and of primary concern are summarized in the subsequent sections.

9.2 IMPACT DUE TO PIPELINE ROUTE SELECTION

The proposed pipeline route has been so selected such that there are:

- Shortest length of the pipeline between source and destination points
- Avoidance of sensitive areas such as national parks, sanctuaries and wildlife corridors
- Minimum impact to reserve forests and other sensitive areas
- Minimum number of water crossings
- Minimum impact to the environment
- Avoidance of populated areas/ industrial area
- Easy access to the route during construction, operation and maintenance of the pipeline.

9.3 IMPACTS DURING CONSTRUCTION OF PIPELINE

- There will be no impact along any stretch as the pipeline route is not falling near any sensitive ecological area.
- Earth work excavation, embankment formation, transport of construction materials, handling, laying and jointing of pipelines - These activities would cause a general increase in levels of dust and suspended particulate matter in the ambient air. However, this increase in concentration would be of temporary nature and localized.
- Movement of vehicles for transportation of construction material – These activities would cause a marginal increase in the levels of oxides of nitrogen, carbon monoxide and hydrocarbons.
- Impact from sediments being washed into the water bodies while the pipeline is laid across them. The pipeline will not be laid in rainy season, which will avoid adverse impacts on water body.
- Drinking water for base camps will be made available through local supply system. The domestic sewage from the construction camps will be either disposed off into the local sewage system and if required, will be treated in soak-pits and septic tanks.

- Water consumption during hydro-testing of pipeline - Efficient use of water will be made to reuse test water in different test sections. Water will be tapped from different sources along the pipeline route, without unduly disturbing its normal users.
- At major crossings, Horizontal Directional Drilling (HDD) method will be deployed so there will be no disturbance to the natural water flow or cause any pollution to the water body. Hence there will not be any obstruction/damage to fishing, recreational and navigation activities. The pipeline will be laid at a minimum depth of 2.5 meter below the bed level of water crossings.
- The pipeline will be buried all along its length hence impact on land use pattern will be marginal and reversible.
- Some quantity of earth excavated for pipeline laying will become surplus after installation of the pipeline and may be required for disposal.
- However, as this excess of earth will be taken to low lying area for filling purpose, the aesthetics of the pipeline and soil quality will not be affected.
- Noise Generation - The major human settlements are along the pipeline route where the noise levels due to construction activities are estimated to be around 70-90 dB(A). Such onetime exposure is not expected to last for more than few weeks and shall not exceed the stipulated standards. The pipeline laying work would be done in night only as there is lots of traffic in day time and creates disturbance to the locals.
- Selection of the pipeline route has been done in such a way that eco-sensitive areas which may be affected during the construction of the pipeline are minimised.

9.4 IMPACTS DURING OPEARTION OF PIPELINE

- No impact on any ecological sensitive area is envisaged during operation
- No air emissions will be generated during the operation phase.
- The compressing station enroute will be kept in a built-in-area that will reduce the noise level to minimum. The incremental noise level in the nearest village due to the proposed operations will be minimal.
- There will be no significant impact on ecological environment during the operational phase of the project.
- The probability of leakage will be significantly reduced by adoption of appropriate safety measures and SCADA system.
- The probability of leak from a pipeline is remote. Pipeline will be buried minimum 1.5 m and 2.5 meter below the bed level at major crossings.

9.5 MITIGATION AND ENVIRONMENTAL MANAGEMENT PLAN

General

The mitigation measures to reduce environmental impacts, described in this EIA, can be divided into the following categories:

- Those which can be regarded as good working practice.
- Project decisions taken by AGL with environmental protection in mind.
- Such measures are designed to avoid, eliminate or reduce potential impacts that may occur to the environment in the course of the proposed activities.

Post Monitoring Program

The implementation of mitigation measures during construction and operation phases will be monitored. The monitoring plan would provide for periodic revision, if necessary, in light of the baseline status to indicate progress in project implementation and changing environmental conditions so as to provide a basis for evaluation of project impacts. The post monitoring program would include the following:

- Approved means of leak detection would be employed as per the provisions of Schedule I -E of PNGRB Regulations, 2008 and as per ASME B 31.8, Appendix - M.
- Regular and adequate patrolling of pipeline particularly at crossing locations and settlements.
- Monitoring of pressure, coating conditions and cathodic protection

9.6 CONCLUSIONS

There will be a beneficial effect from pipeline project that will directly and indirectly boost the living standards of the people, save foreign exchange and with increase in industrial activities, create more jobs in the local economy. Thus, it can be concluded on a positive note that after the implementation of the mitigation measures and EMP, the proposed activities of AGL will have negligible impact on environment and will improve economy of the nation.

Annexures

Annexure 1: AGL QHSE Policy

adani
Gas

QUALITY, HEALTH, SAFETY & ENVIRONMENT POLICY

We, at **ADANI GAS LIMITED (AGL)** engaged in providing energy solution to the nation with efficient, environment friendly, safe & cost effective fuel.

"Safety first in everything we do at AGL" is an integral part of AGL culture

AGL firmly believes that all types of injuries, illness & incidents are preventable.

We at AGL are committed to ensure continuity of natural gas supply & reliability of services to the customers and also committed to demonstrate continual improvement in our Quality, Occupational Health, Safety & Environmental (QHSE) management performance by:

- Assessing needs & expectations of Interested Parties and satisfying them with continual improvement effort;
- Continual Improvement by reviewing and monitoring Organizational Context & Strategic Direction by use of process approach and risk based thinking;
- Adopt and implement the best available technology and systems from design to the delivery of gas to customers and also the work practices to reduce the QHSE risks as low as reasonably practicable and minimize the impact on environment; public and assets
- Integrate QHSE aspects in all our business processes;
- Pro-actively comply with all applicable legislation & other requirements; Establish, review and strengthen our QHSE Management Systems and CGD network integrity in an ongoing and auditable manner;
- Institutionalize practices for pollution prevention, waste avoidance an prevention of injury & ill health;
- Enhancing the competencies and commitment of employees through suitable training programs, involvement and motivation

We shall make this policy available to all our stakeholders.

Date: 05-11-2018

Suresh P. Mangtani
Chief Executive Officer

Annexure 2: EHS Organogram of AGL

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Adani Gas Limited

EMERGENCY RESPONSE & DISASTER MANAGEMENT PLAN (ERDMP)

Doc. No. :HSE-102
Rev No : 01
Eff. Date: 01.03.15

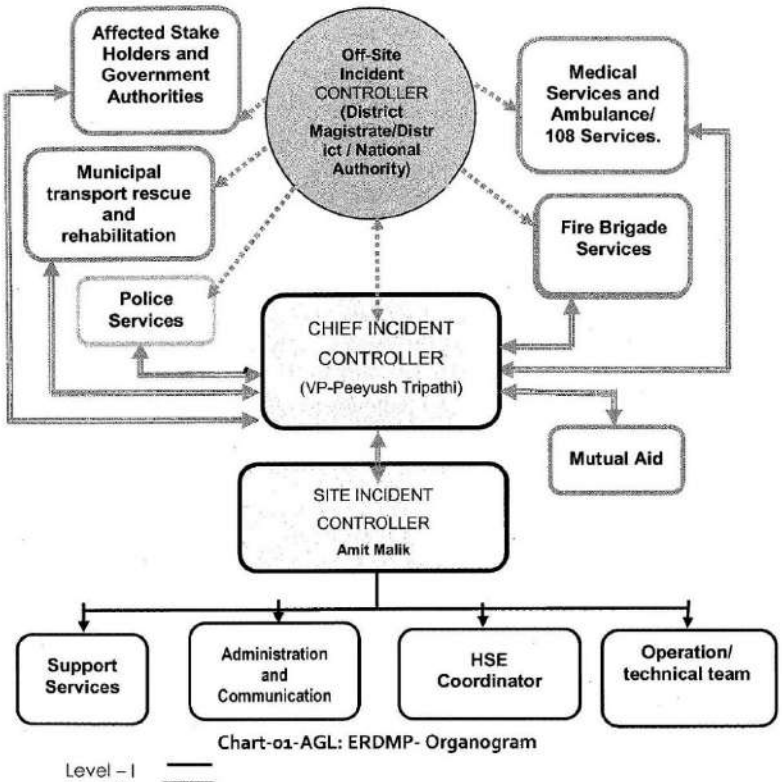

Chart-01-AGL: ERDMP- Organogram

Level – I
Level II
Level III

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Annexure 3: Mock Drill Format of AGL

adani Adani Gas Limited	EMERGENCY RESPONSE & DISASTER MANAGEMENT PLAN (ERDMP)	Doc. No. :HSE-102 Rev No : 00 Eff. Date: 01/03/15

adani Adani Gas Ltd.	EMERGENCY PREPAREDNESS MOCK DRILL RECORD

Mock Drill Date & Time : Mock Drill No. :

Sr. No.	Item Description	Standard Time	Time Start	Time End	Total Time Taken
1	Emergency Hooter / Operation of manual call points Started at [Time]	0 sec			
2	Evacuation started to Assembly Point at [Time]	60 sec			
3	Last person arrived at Assembly point at	Within 60 sec			
4	Activation of emergency control center	30 sec			
5	Information of Incident to Emergency Team	10 sec			
6	Information to all key members at Perticular Location	45 sec			
7	Safe shut down activities in the plant	45 sec			
8	Fire Mitigation started by Security/members at [Time]	55 sec			
9	Fire Mitigation completed at [Time]	Within 55 sec			
10	Emergency vehicle arrival at entrance	Actual			
11	Head count started at [Time]				
12	Head count completed at [Time]				
13	Total Head Count				
14	Nearest Fire station distance from the site.				
15	Nearest hospital distance from the site				
16	Hooter for returning back to work started at				
17	Last person returned to work at				

Observations on overall preparedness effectiveness :

Area of Improvement of the Mock-drill exercise:

Action Planned to mitigate the draw backs:

Target Date	Person Responsible	Action Taken	Review By	Remarks [if any]

Report Prepared by: Report Reviewed by:

Annexure 4: Geographical Area and project detail